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Are Structured Products Fairly Priced? – Barrier Reverse Convertibles and Turbo Warrants in the Swiss Market

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November, 2020



BUSINESS
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Resumo

Os investimentos em produtos estruturados têm vindo a aumentar nos últimos anos e, a par dessa evolução, também a complexidade desses produtos se tem intensificado substancialmente.

Neste sentido, esta dissertação foi desenvolvida com o objetivo de retratar o estado atual do mercado de produtos estruturados, nomeadamente na Suíça, por ser um dos mercados mais desenvolvidos da Europa. Deste modo, foi analisada uma amostra de *Barrier Reverse Convertibles* e *Turbo Warrants* emitidos pelas maiores instituições financeiras suíças, o que permitirá uma visão clara dos preços destes derivados financeiros e, consequentemente, suportar decisões de investimento mais precisas e informadas.

A presente tese foi baseada em estudos anteriores, os quais revelaram que o preço da grande maioria deste tipo de produtos está substancialmente inflacionado. Assim, além de apresentar resultados práticos e representativos dessa realidade, outro objetivo principal passou também por entender as razões e motivações dos investidores que justificam o aumento da procura de tais produtos.

Com base no preço teórico obtido pelo modelo Black & Scholes (1973) e Merton (1973), e comparando esse valor com o preço de mercado, foi possível concluir que, em geral, todos os produtos apresentaram uma inflação de preço considerada economicamente relevante, sendo este resultado mais evidente em *Barrier Reverse Convertibles* comparativamente a *Turbo Warrants*. Em relação aos principais emissores de cada tipo de produto, o Banco Vontobel foi a instituição financeira com preços mais justos, relativamente a *Turbo Warrants*, enquanto o Banco Julius Baer deverá ser a escolha mais segura para investimentos em *Barrier Reverse Convertibles*.

Palavras-chave: Produtos Estruturados; Preços; Mercados Financeiros; Modelo Black-Scholes-Merton

Classificação JEL: G12 (Asset Pricing); G24 (Investment Banking)

Abstract

The investments in structured products have been increasing in the past few years and, jointly, also the complexity of such products has substantially intensified.

In accordance, this thesis was developed with the objective to present the current status of the structured products market, namely in Switzerland, as it is the one of the most developed markets in Europe. Hence, it was analysed a sample of Barrier Reverse Convertibles and Turbo Warrants issued by the biggest Swiss financial institutions, which will permit a clear overview of the price fairness of these financial derivatives and, consequently, support more accurate and informed investment decisions.

In fact, this thesis was based on previous studies which revealed that the vast majority of this type of products is substantially overpriced. Thus, besides than presenting a practical overview of this reality, other main objective was to understand the reasons and motivations of investors that could justify the increasing demand for such products.

Based on the theoretical price obtained using the Black & Scholes (1973) and Merton (1973) model, and comparing that value with the market price, it was possible to conclude that, in general, all products presented an overprice considered economically relevant, being Barrier Reverse Convertibles typically more overpriced than Turbo Warrants. Regarding the main issuers of each type of product, Bank Vontobel was the financial institution with most fairly priced products related to Turbo Warrants, while Bank Julius Baer should be the safest choice for investments in Barrier Reverse Convertibles.

Keywords: Structured Products; Pricing; Financial Markets; Black-Scholes-Merton Model

JEL Classification: G12 (Asset Pricing); G24 (Investment Banking)

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List of Abbreviations

AMF – Autorité des Marchés Financiers

Adj - Adjusted

AT – Austria

BE – Belgium

BRC – Barrier Reverse Convertibles

CEV – Constant Elasticity of Variance

CH – Switzerland

CHF – Swiss Franc

CMVM – Comissão do Mercado de Valores Mobiliários

DE – Germany

EMH – Efficient Market Hypothesis

ESMA – European Securities and Markets Authority

ETF – Exchange Traded Fund

EUREX – Eurex Exchange

EUSIPA – European Structured Products Investment Association

FCA – Financial Conduct Authority

FINMA – Swiss Financial Market Supervisory Authority

FR – France

FSMA – Financial Services and Markets Authority

ICB – Industry Classification Benchmark

IOSCO – International Organization of Securities Commissions

IT – Italy

KID – Key Information Document

MBRC – Multiple Barrier Reverse Convertible

MPT – Modern Portfolio Theory

NL – Netherlands

OTC – Over-the-counter

SFI – Swiss Finance Institute

SMI – Swiss Market Index

SPARQS – Stock Participation Accreting Redemption Quarterly-pay Securities

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SRI – Summary Risk Indicator

SRP – Structured Retail Products Limited

SSPA – Swiss Structured Products Association

TER – Total Expense Ratio

VaR – Value at Risk

Introduction

The structured products market has experienced an exponential growth in the past few years. As a matter of fact, it has witnessed a significant booming in this market justified by the engagement of innumerable banks and other financial institutions. This broad-spectrum provides a correspondence to any desirable conditions imposed by clients, leading to an increase in investment opportunities due to the multiple combinations of different instruments.

The increasing complexity mentioned above has raised some questions that are going to be answered, namely: Which product is the most suitable considering the features and goals desired by the investor? Are the theories of behavioral finance applicable in this specific matter? How fairly priced are structured products?

In accordance, the goal of this dissertation will be to analyse the current situation of the structured products markets, namely the Swiss market, offering an enhanced and clear conception and enabling a better judgement of the price fairness of these financial derivatives. This dissertation is addressed to first-time investors as well as small investors or even to the general public that might have some curiosity in this theme which is becoming increasingly important.

In this dissertation, it will be analysed exotic options, specifically the Barrier Options, and a warrant, namely a Turbo Warrant. As the name suggests, the exotic options tend to be more complex which leads to a trading volume significantly lower when compared to a simpler option, which can be explained by several studies regarding behavioral finance that will be presented later on.

Having in mind the achievement of the objectives presented above, this thesis will be divided in two main sections: the first component will have a theoretical nature, where it will be presented intuitions and fundamental definitions that will serve as base for a deeper knowledge, such as a proper definition of structured products and the innumerable derivatives offered in the financial markets. In addition, it will also be pointed out the behavioral finance theme, which will help us to better understand the preferences of the

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investors. Thus, in this first section, we aim to give a response to the two first questions raised above.

In the second section, we will focus on the pricing of the two products chosen, considering Swiss companies, and the results of the priced products will be compared with the market prices in order to understand whether they are fairly, over or underpriced. This section should answer the last issue we propose to analyse.

1. Creation of Structured Products

The first transaction of a structured product occurred in the United Kingdom in the early 1990s, with the objective to simplify the access of retail investors to stock market returns without risking capital. Structured investments were created based on the need of companies to issue debt more cheaply. Although this objective could be reached by issuing a convertible bond, this trade-off was dependent on the company's equity value, which can be very uncertain and therefore undermine the initial goal (since in a scenario where the equity value decrease, the bond could no longer be converted at a profit).

With that said, investment banks decided to add some features to those basic convertible bonds, generating a pre-packaged product that investors could replicate themselves using options and all types of derivatives, but would require higher levels of knowledge and undertake higher margins and costs.

Rapidly, this type of products proliferated through all Europe due to its capacity of being an efficient channel to invest in multiple asset classes with tailored and predefined protection characteristics.

As a point of fact, the creation of complex financial products such as structured products is only possible due to a technique called financial engineering that basically proceeds to the combination of elementary components and the outcome is a new product that can be addressed to the miscellaneous needs of customers. In other words, "investment bankers act similarly to engineers or natural scientists when planning and creating complex financial innovations, on the basis of some elementary building blocks, in order to meet their costumers' needs" (Breuer & Perst, 2007). This branch of engineering has two main concerns that will dictate the potential success of each product: the costs of the construction for the issuer and the benefits that they will bring to the client. Higher complexity will accentuate the apprehension over those two variables, as is the case of structured products.

2. What are Structured Products?

At this point, it becomes important to clarify what are structured products. Even though the term has arisen just a few decades ago, there is a myriad of possible definitions, being one of them: “structured financial products are a combination of elementary instruments from the spot and futures markets (e.g., stocks, interest rate products, derivatives) and promise tailor-made risk/return profiles for investors” (Stoimenov & Wilkens, 2005).

In more detail, it can be said that structured products are financial tools that give the possibility to combine an instrument that will serve as a base (it can be a deposit, note, insurance contract or even a fund) with an embedded derivative that will be the element that establish the connection with the market exposure to reference portfolios, assets or indexes and, in specific times, the investor will receive a payoff directly linked to their performance.

In other words, this type of financial product could be interpreted as a combination of three main components: a bond, at least one underlying asset, and financial instruments linked to the underlying assets. The first component mentioned is important because it is through the bond’s interest that the investor raises funds to buy the financial instrument responsible for the derivative strategy. Therefore, it is important to verify the rating of the issuer attributed by the credit rating agencies since if the issuer defaults, the capital guarantee is not assured. From the underlying component and its performance, will derive the final return. And, finally, the financial instrument can be chosen from any type of derivative and it is what is responsible for the derivative strategy. This is an important decision that should be made based on the desired risk level, the preferred time horizon, the market conditions, the level of exposure and, as consequence, the level of return.

Therefore, all types of derivatives can be included in the composition of a structured product, being this the main characteristic that convert those investments into tailor-made solutions since they can be adjusted to a given derivative strategy, adapting to different market conditions, expectations, and comprise different risks. Consequently, these products are “ideal for investors seeking innovative, flexible investment instruments as an alternative to direct financial investments” as stated in SSPA website¹.

¹ Source: <https://www.svsp-verband.ch/en/>

3. Structed Products Classification

There is no unique or unanimous way of grouping structured products. Thus, the classification of these financial products can be made according with specific characteristics or features in study.

Nevertheless, structured products are the result of three scopes: underlying, payoff and wrapping. Regarding the underlying, they are classified in accordance with their constitution (single, baskets, or indexes) and their asset class (equity, or the so-called FICC – fixed income, currency and commodities). With respect to the wrapping, it is dependent upon many variables, namely the size of the investment, the restrictions imposed by the investor, market access and tax issues. Thus, the optimal choice could be to wrap an investment idea in, for example, a structured product, an exchange-traded fund or a mutual fund.

Finally, concerning the payoff, Burth, Kraus & Wohlwend (2001) defend that structured products can be also divided in accordance with the payoff framework: convex and concave profile.

3.1. Types of Structured Products

With that said, it is now appropriate to present and describe the main categories of structured products, emphasizing the peculiarities that allows to distinguish between the different types of products. This categorization was originally developed by the Swiss Structured Product Association (SSPA) together with several associations, namely Payoff.ch, *Finanz und Wirtschaft* (a financial newspaper) and SIX Structured Products derivatives exchange. After its conception, this cataloging was adopted by EUSIPA – the European Structured Products Investment Association – and, consequently, used and accepted throughout Europe.

Before introducing a brief description of all categories, it is important to make the disclaim that all instruments, regardless of their product class, can be constructed with various features, and, therefore, the choice should be assessed according to their specific terms and not by general product grouping. Likewise, the lack of comparability is a reality even within the same category, since products vary from each other, from the payment structure to the associated risk (since that just the difference of the underlying asset, everything else equal,

can be extremely modificative and comprise a completely opposite reaction to future developments of market).

3.1.1. Capital Protection Products

Beginning with the Capital Protection products, as the name announces, this kind of products present a significant capital protection – around 90% to 100% of the total nominal value, even if the market has moved against the investor's expectations. However, as it was expected, the growth potential is lower comparing to other products, and can be even limited to an upside potential. They are usually composed by a traditional bond, used to protect the initial investment at the maturity, and a derivative, usually options, that will be responsible for generating a return above the initial investment. Some examples of this type of products are: Capital Protection Certificate with Participation, Barrier Capital Protection Certificate, Capital Protection Certificate with Twin-Win and Capital Protection Certificate with Coupon.

3.1.2. Yield Enhancement Products

In the next group are examined the Yield Enhancement products. This type of product does not offer protection for the initial investment and provide a predefined yield in exchange for a downside risk. They are appropriate when investors are expecting the market to be stable or moving sideways, given that in these kinds of products the risk occurs when the prices of underlying assets go down. It is forecasted by investors the full participation in the increase of the underlying's price until a threshold of participation called a cap. In return of this growth potential, it is given to the investor a coupon, namely a reverse convertible or a discount certificate. In the case that the underlying asset's price falls below the cap, the investor loses everything as he would if he had invested directly in the underlying asset. However, the coupon is redeemed anyways and that is why these products are often called interest-bearing shares. The most common products of this category are: Discount Certificate, Barrier Discount Certificate, Reverse Convertible, Barrier Reverse Convertible, Express Certificate without Barriers or Barrier Express Certificate.

3.1.3. Participation Products

Moving on to the Participation products, the straight difference between participation products and the two categories presented above is that there is no cap level in this type of

products. They are suitable for investors that are interested in a participation in the performance of an asset, for instance, equities, funds, bonds, indexes or a combination of them. Those products usually do not have up or down limitations and, in most cases, no coupon or dividends are paid, since issuers use them to finance the bonus. As an example, when the participation rate of outperformance certificates goes up beyond a prespecified strike, the investor foregoes dividends in favor of the outperformance mechanism. Some instruments incorporate a return calculated when the product reaches its maturity, and it is based on the percentage of the performance of the underlying asset, called the participation rate and can be applied both in upside and downside. Trader Certificate, Outperformance Certificate, Bonus Certificate, Bonus Outperformance Certificate and Twin-Win Certificate are the main products available relative to Participation products.

3.1.4. Leverage Products

The next category is Leverage products. They allow short-term speculation or hedging and provide a further enhanced yield, compared to Yield Enhancement products, and often without any limit to the upside participation. The most known are Put or Call Warrants with a fixed lifetime and knockouts, that expires once the barrier is reached. Another example are the Leverage Certificates, which provide enhanced participation to an underlying with intrinsic leverage. All leverage products follow the underlying price movements but magnifying those price fluctuations, called the leverage mechanism, making it possible to obtain an outsized gain with a low capital. However, this effect has also the negative side, since the leveraged exposure is also disposed on the downside performance of the underlying, driving to big losses if the prediction of the investor does not become a reality. That is the reason why those products usually come with a stop-loss in order to limit potential capital losses. Some other examples are the Spread Warrant, Mini-Future and Constant Leverage Certificate. Those products are more appropriated to investors who are experienced, willing and able to bear risks since they answer disproportionately to price moves in the underlying asset, making them more advisable for investors who have already gained experience with other riskier forms of investment.

3.1.5. Investment Products with Reference Issuers

Lastly, there are the Investment Products with Reference Issuers. This group was added in 2011 and they provide additional prospects to diversify debtors and increase yield and have the peculiarity of having securities from other sources that not banks as the fixed-interest component. In this type of products, it is included the Reference Entity Certificate with Participation, Reference Entity Certificates with Yield Enhancement and Reference Entity Certificate with Conditional Capital Protection. To know and understand all these products, it should be investigated the features of the categories that they have emerged in, that is, the Reference Issuer Certificate with Participation have the market expectations in conformity with Participation products.

To conclude, making a general visualization of all categories, it is generally considered that Capital Protection products have a small exposure to risk, followed by Yield Enhanced products and after those, the Participation products, being the Leverage products the riskier ones.

3.2. How to Choose the Right Product

There are innumerable opinions that claim that investing in structured products is riskier comparing to simpler trades – of shares, for example. However, as it is explicit in the product's description, there are multiple choice possibilities that could offer safer mechanisms or even guarantees of total capital protection that, compared to direct investments, are more secure and less exposed to risk and uncertainty. On the other hand, there are also products that pose a greater risk of loss than a direct investment, that will certainly offer a higher rate of return that will serve as compensation for the extra exposure to risk. Therefore, given all those different possibilities, it is expectable that the choice of the right investment decision turns out to be difficult.

The choice of the product must consider the utility function of the investor, personal preferences, perceived risk, private signals and psychological characteristics, meaning that “when investors decide whether to invest in structured products, they actually go through an optimization process based on a risk-value trade-off” (Chen, Wang, Deng, & Fang, 2019).

It is known that, as any other type of investment, structured products have merits and demerits; however, it is true that the exact same product can bring lots of advantages to an investor and massive disadvantages to another, which shows that most of the times, the demerits attributed to structured products are more related to a weak evaluation of the performance of the product and a bad investment decision rather than a bad product itself. The fundamental solution to avoid this problem is not only analyse all the features and possible risks of the product, but also the implications and benefits that the product will add (or not) to a certain portfolio. In addition, it is crucial to have a strong understanding of the underlying's prospective of future development and, to have a feasible expectation, it is implied that the investor must dominate the market mechanisms and the basic financial expertise, at the very least.

With that said, and after presented all the categories of structured products, it is important to highlight the main risks associated with this type of investment.

3.2.1. Risks Associated with Investments on Structured Products

One of the golden rules is to verify the creditworthiness of the issuer, since, in the view of the issuer, a structured product is a debt obligation, which make the security of the product dependent on the issuer's creditworthiness. Therefore, every investor should verify the credit ratings, credit spreads and core capital ratios (tier 1 rating)².

Besides the risk linked to the issuer, also the product itself has risk associated that must be evaluated and taken into consideration. To facilitate this issue for the costumers, the SSPA estimates the market risk of the products and, for that, it is used the Value at Risk (VaR) method to increase the transparency and confidence of costumers. The standard time used for the calculations is a 250-day with a holding period settled at ten days. Regarding the confidence interval, it was established the parameter used internationally when computing VaR, an 99% confidence interval. After that, the products are listed into six risk classes, from the less risky (Class 1) – that can be compared to money market and deposits risk – to the ones that comprises a higher risk (Class 6) – that represents a risk similar to options or futures.

² A tier 1 core capital ratio is the ratio of core capital to risk-weighted assets. According to Basel III (31th March 2019), equity requirements call for a common equity tier I ratio of 5.5%, at a minimum.

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The values are reevaluated and reallocated on a weekly basis to assure that the relative market risk of the product is kept with the maximum assurance possible.

To combine those two types of risk, the volatility of a financial instrument, and the credit risk, the SSPA also created the Summary Risk Indicator (SRI). Based on that association, the financial instrument is classified on a seven-point scale, where 1 represents the lower risk. This classification is one of the several mandatory information presented in the Key Information Document (KID), a document that assembles all the most important information relative to the product to assure investors make an informed investment decision.

Although the risk associated with both the issuer and the product itself are known and relatively easy to access, one key fundamental principle that must be implemented by the investor is the diversification. Related with the issue previously pointed out, the payments are an issuer's liability to the extent of all his assets. Therefore, it is vital to use several issuers rather than concentrate all the investments in a single financial institution since, if an issuer defaults, the loss is limited to that one issuer. In addition, besides the differentiation of the issuers, the portfolio must also be diversified in terms of the distinct asset types in an attempt to limit the exposure to a single asset or risk.

As mentioned by Wallmeier & Diethelm (2009), "normally one thinks of a portfolio as moderating risk by diversification, but in this case, the more stocks in the portfolio, the higher the risk involved". In other words, this means that the investor must always consider that the addition of a stock will increase the portfolio's risk. Nevertheless, although the diversification is strongly recommended to all investors, a considerable amount of them do not apply this rule and end up by holding "poorly diversified portfolios, resulting in unnecessarily high levels of diversifiable risk, and many are unduly influenced by media and past experience" (Barber & Odean, 2013).

3.2.2. Steps for Investing

Now, that all the main categories and the inherent risks of structured products are known, to assure the investor does the right choice, it is important to follow the steps advised by the SSPA. Firstly, the investor should clarify his expectation in regard to the market's performance and adjust the product to his belief (since there are products for rising, falling or sideways-trending markets and also with a higher or lower volatility). Next, the investor

must understand the underlying asset and its past performance, as well as the product issuer and concomitant risk (as previously discussed). In addition, the market evolution must not be outguessed, considering that even if the prediction is correct this time, the “luck” will not be present every time. So, instead, it is essential to run some scenario analysis and stress tests to have a better conception and estimation of the market’s future performance and make sure the way the underlying should develop to produce a profit is well aligned with the expectations he holds for the market.

Furthermore, besides the scenarios where the investor will profit, it is essential to also examine the market scenarios which will lead to a loss since, even with the most precise prediction indexes, in the final instance, the market is unpredictable and it can rise as easily as it can fall, which indicates that investors must always be prepared for the unexpected. Finally, and before making the investment, the product has to be within the limits of the risk profile of the costumer (if he is risk averse, should give preference to Capital Protection products; if he has limited risk, Yield Enhancement products and Participation products can suit better; in the case where he is willing to undertake high risks, Participation and Leverage products could be a better choice).

Therefore, following these steps and ensuring that all those details are covered and understood by the investor, can be a great assistance and strong support in making the right decision.

However, it must be disclaimed that the choice of the most suitable product is never easy and should not be viewed as a linear road. An investigation regarding the investor’s realized risk-adjusted performance in structured products found that, even ignoring all transaction costs, investors typically incur in a financial loss and those bad results are improved by the increase in product complexity. The results of that paper, conducted by Entrop, McKenzie, Wilkens, & Winkler (2014), suggest that, in general, investors do not benefit from the financial innovation that one are witnessing, making, instead, the task of selecting a correct product ever harder: “investors also make poor choices when selecting the underlying assets for their structured product investments”, being this considered “a reflection of the poor stock selection abilities” (Entrop *et al.*, 2014) leading, as predictable, to significant losses on equity portfolios of those investors.

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To conclude, the choice of a structured product can be much more challenging comparing to the choice of a stock, mainly due to the wide choice range of payoff profiles, issuers, maturities, underlying assets and other product's features.

4. Behavioral Finance

Linked to the choices of investors, explored above, some studies started to be concerned about those decisions and, since they could not be explained by straightforward logical theories, a new area of investigation known as behavioral finance was developed during the 1990s, with the aim of understanding those choices. In order to achieve that objective, this field of study composed some models that linked financial models and rational reasonings of preference with behavioral bias which strongly affect the individuals' choice.

Making a parallelism with traditional finance, it is based on the assumption that both investors and markets are rational, and that they gather all the information needed and make their decisions using that data. Thus, the habitual finance literature simply assumes that investors can process all information unbiasedly and, therefore, do not base their decision-making process on emotions. The foundation of traditional finance is associated with the Modern Portfolio Theory (MPT), that claims the existence of an efficient frontier where investors can construct portfolios to maximize expected return based on a given level of market risk, and the efficient market hypothesis (EMH), stating that prices reflect all existing information. Therefore, stocks always trade at their fair value, making impossible to outperform the overall market through perfect timing or stock selection. So, higher returns are only possible through the engagement of riskier investments.

With regard to behavioral finance, it is supported by three pillars: psychology, sociology and finance, which proves the vital interdisciplinary relationship between different areas of study, being, however, traditional finance the centerpiece. Thus, behavioral finance tries to bring the human perspective into financial models or, in other words, “attempts to explain and increase understanding of the reasoning patterns of investors, including the emotional processes involved and the degree to which they influence the decision-making process” (Ricciardi & Simon, 2000). Thus, this area “incorporates evidence on how people actually behave into models of decision-making” (Baker & Ricciardi, 2014) and can actually explain all types of market anomalies, especially in the stock market.

Henderson & Pearson (2007) have conducted a study concerning the patterns in the payoffs of equity structured products and came to conclusion that “it is difficult to rationalize investor demand for structured equity products within any plausible normative model of behavior of

rational investors” (Henderson & Pearson, 2007), suggesting the existence of behavioral biases and cognitive differences that make it difficult to explain the choice of such products by rational theories only.

Based on this study, Abreu & Mendes (2018) tried to explain the popularity and the choice of structured products relying on mental bias. They based their analysis on Portuguese individual investors, clients of the top five Portuguese banks and in a survey conducted by the CMVM (the Portuguese securities commission), in 2011, in order to understand the main characteristics of Portuguese investors. In fact, they ended up by confirming the suspicious of the study they based on, reaffirming that behavioral biases such as overconfidence and gambling have a huge influence in the investor’s choices, which make it impossible for rational theories to explain their options. As such, the popularity of complex products can be motivated by investors’ overconfidence which usually devalues negative public information that suggests the prices are above the true value of the product and, consequently, taking on excessive risk along with gambling longing. In other words, “overconfident investors are more prone to take on excessive risk for which there is no apparent reward and thus to invest and trade in SRP. Research also postulates that some retail investors view trading in the stock market as an opportunity to gamble” (Abreu & Mendes, 2018).

This issue was also explored by Chen *et al.* (2019). The study’s objective was to understand the phenomenon of overconfidence and how the decision-making can be affected by this bias. Hence, it was conducted an investigation that allowed to understand some anomalies in the financial markets. The study, based on bearish and bullish binary structured products, explored the risk perception and the decision process of investors. Although the measurement of risk is dependent on the investor’s utility function and that every individual has his own preferences, private signs and psychology characteristics, most of the times that valuation is not understood. In this line, and according with the results of this particular study, one of the possible explanations for that phenomena is overconfidence, that affects both expectations and prospects of investors.

The authors concluded that there are many overoptimistic investors and that overconfidence severely affects the discernment and the management of expectations, since the perceived risk is significantly lower than the real risk: “overconfidence can lead investors to

overestimate the probability, and the overestimation is intensified with increasing overconfidence. Simultaneously, overconfidence can lead the investor's subjectively estimated probability to increase, which finally contributes to a lower perceived risk" (Chen *et al.*, 2019).

In 2014, Hens & Rieger were successful in trying to explain the demand for structured products using behavioral finance, evoking a few biases such as gambling to avoid sure loss, over and under confidence, misestimation of probabilities and loss aversion. They showed that structured products can be the optimal choice since the gains from this type of investment can be generous considering the Prospect Theory which defends that investors prefer to take risks instead of being certain to lose. The authors computed the expected utility for both an optimal structured product and an optimal mix between the market portfolio and the risk-free asset in pursuance of answering the question: "under what circumstances the added potential improvement of structured products is sufficiently significant to undertake the risk associated with those products?". Hens & Rieger (2014) found that structured products can be an attractive alternative in two particular cases: (i) when the prospect theory of Kahneman & Tversky (1979) is taken into account and, therefore, investors prefer to take extra risk rather than be certain about a loss; (ii) and in the case where investors have a breach in reasonable thinking and do not apply market beliefs in their optimization. In summary, the demand for structured products in a utility maximization framework could not be explained by the classical von Neumann & Morgenstern (1944) expected utility with correct beliefs. On the other hand, there is one scenario where those complex products can be an optimal choice: "for prospect theory utilities with loss aversion and risk taking to avoid sure losses or for non-rational beliefs, some structured products can be considered utility optimizing" (Hens & Rieger, 2014).

Other important discover in the field of behavioral finance that can be particularly useful for banks and other financial institutions that trade financial products is that investors are more attracted to financial products that are communicated in simpler terms. This phenomenon can be explained through multiples studies concerning investor behavior, given that those investigations lead to a unique and straightforward conclusion: investors (specifically small-investors and first-time buyers) are more attracted to financial products when the information

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is presented in humbler and simplified terms, instead of a more professional and technical way, which is substantiated by Döbeli & Vanini (2010): “the presentation of a structured product in a way that is easy to understand is effective”.

To conclude, it is unquestionable that investors are influenced by behavioral and psychological bias, which theories of traditional finance fail to explain. To minimize the influence of those inclinations that can deeply affect a reliable discernment and conduct to a poor financial choice, investors must apply a disciplined trading strategy, that is, they “should implement several safeguards that can help control mental errors and psychological roadblocks” (Ricciardi & Simon, 2000).

5. Market History

Since the early 1990s, the retail finance markets have suffered a massive development. Clustered with it, came the complexity that is justified by the huge demand of these products, which drives to the introduction of additional features to these assets in order for them to be more personalized. This will increase the variety available to the costumers, reason why this type of investments is considered a tailor-made solution. Nonetheless, this action and reaction effect will be analysed later on, in order to understand if the complexity arises from the demand or if, on the contrary, is the increase in complexity that creates the higher demand (in the view of the fact that more sophisticated products presupposes less acquaintance of costumers).

This market has been growing since the first product's conception. However, it suffered a decline of 27% in 2009 due to the credit crunch and economic downfall that succeeded after the Lehman Brothers' collapse, starting a global finance crisis (in fact, the worst since the stock market crash of 1929). This company was the fourth largest investment bank in United States, behind Goldman Sachs, Morgan Stanley and Merrill Lynch. The bankruptcy was supported by the issuance of structured products to raise funds at a low cost since it was considered this was an alternative to issuing debt and equity. However, "the structured products carried a lower implied yield not because the investments were safer than a simple bond, but because investors did not understand how badly overpriced the products were" and, having in mind that the complexity of those type of products, "Lehman could make it virtually impossible for retail investors to even roughly determine what the value the products were and what the expected returns were" (Securities Litigation and Consulting Group, 2009).

As a result, Lehman Brothers sold more than 1,300 structured products between 2007 and 2008, raising roughly 19.2 billion dollars at a lower interest rate compared with current market values at the time.

"Lehman employed a cadre of accountants and risk professionals to continually monitor its balance sheet, key ratios, and risks. It undertook desperate and some questionable actions to stay alive. Nevertheless, Lehman ultimately failed because of an inability to finance itself". (Wiggins, Piontek, & Metrick, 2015). The bankruptcy was unavoidable since the toxicity of

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the company's assets made it infeasible the possibility of external rescue. In other words, "there just were not enough banks willing to lend it sufficient funds against the assets that it could offer". (Wiggins *et al.*, 2015)

Twelve years have passed, but this crisis left permanent and irremediable effects and consequences. Figure 1 represents the development of the Swiss and German markets and the European average evolution, from 2005 to 2014.

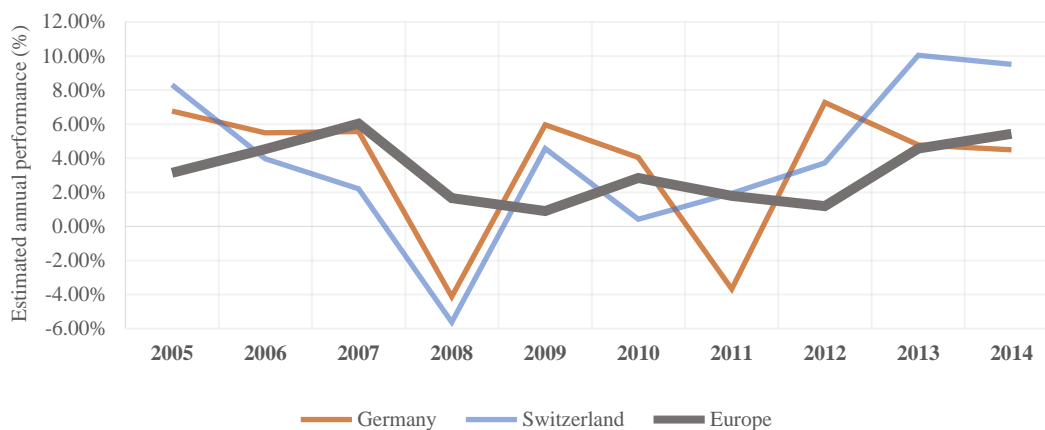


Figure 1. Estimated annual performance, in %, of the Swiss and German markets. Source. SRP (adapted)

Analysing the graph, it is possible to verify the huge decrease of the estimated annual performance (in %) of the two biggest markets in Europe in the corresponding years after the financial crisis.

Moreover, countries like United Kingdom, Norway and Netherlands still have not recovered from the drop of structured products' sales caused by this crash. It can be said that this financial crisis has changed the behavior of investors and, as a consequence, they increased their awareness and reliance on the financial institutions.

Although the Leman's Brothers crash was the most mediatic financial collapse, there were multiple more in the last few decades, for instance: "In 2006 the hedged fund Amaranth lost 6 billion dollars because of trading risks taken by Brian Hunter. In 2008, Jérôme Kerviel lost over 7 billion dollars trading equity index futures for *Société Générale*" (Hull, 2018).

Nevertheless, some lessons can be taken from those occurrences and all traders and actors that operate in the market must learn from past mistakes and be aware that occurrences like

Brexit, Middle East's tensions, terrorism, the social activism in some South American countries or, more recently, the COVID-19 pandemic, have a huge influence in markets.

It is important to remind that overpriced financial products survive in the market due to their complexity, which turns into opaqueness and masked risk, costs and fees demanded by underwriters. However, nowadays, the market has become more regulated with the objective to restore the reputation and prestige to financial institutions, creating a safer and trustful banking system. Nonetheless, in order to reach this ambition, it also requires the effort of investors, in the sense that they have to deeply understand the financial products that they buy and the risk associated with that operation, making the investment decision responsible and conscious and, consequently, less difficult to work with these challenging markets.

5.1. Absence of Knowledge and Information *versus* Higher Complexity

In this section, it will be analysed the issue previously pointed out: the lack of knowledge and available information about structured products.

As mentioned above, the development of financial markets has led to an increase in product's complexity over the past two decades. However, according to a paper published in the United Kingdom's Financial Conduct Authority (FCA), "there is little evidence of a comparable increase in consumers' financial capability" (Hunt, Stewart, & Zaliauskas, 2015). This shortcoming is a motive for some apprehension since it potentializes mis-selling in view of the fact that investors do not properly understand the products they are buying. In addition, this unsuitableness of the clients to the evolution of the market helped banks and other issuers to exploit some extra profit since pricing those complex products has become extremely difficult for the vast majority of customers.

In order to support the study and provide more empirical evidence to substantiate some final conclusions, the authors conducted a survey where it was evaluated the expected returns that 384 retail investors had in five popular types of three structured products. To distinguish the optimism in the evaluation of the market and the unawareness relatively to these products, they also questioned the same investors about their interpretations of the performance of the FTSE 100 index. Analysing the outcomes, the authors concluded that "while investors' expectations of the FTSE 100's growth were, on average, well-aligned with the assumptions used in the author's quantitative model, investors significantly overestimated the expected

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returns of all structured deposits, even the most simple”(Hunt *et al.*, 2015) which, in other words, indicates that the investors do not have a clear understanding on this subject and they are not able to judge and properly evaluate the investment that they are doing (even the ones that presented a correct prediction about the performance of the index, proving that they have quite some expertise about financial issues).

In addition, the five structured products that they presented in the survey were unlikely to offer more return than a cash deposit (the latter involving substantively less risk). However, investors were not able to recognize that: “they did not require a premium for the incremental risks of the products. Investors were valuing structured products as if they were risk-free” (Hunt *et al.*, 2015).

Bringing out the debate raised in the beginning of the market history topic, it is important to understand if the crescent complexity of financial products is a consequence of the natural course of the market or a goal of the issuers. In fact, as mentioned above, the market is experiencing a significant booming of the commercialization of structured products and it is obvious that this would lead to a continuous creation of products with different and new characteristics and combinations. However, some studies turned this question in the opposite perspective, that is, the sophistication and complexity of financial products is not natural and not just a result from the higher demand. Instead, it is wittingly adopted to diminish the real perception of investor regarding the risk he is accepting. To illustrate this point of view, Carlin (2008) conducted a study to prove that exists a notable price dispersion in retail financial markets, even amongst analogous products, which suggests that “as competition increases, firms tend to add more complexity to their prices as a best response, rather than make their disclosures more transparent” (Carlin, 2008). This study leads us to the conclusion that the response of the financial institutions to competition is increasing the price complexity in order to gain market share and not the other way around announced by issuers. That is, the complexity is just a result of a raise of investor’s demand that forces the creators of structured products to increase the complexity in order to respond to what is requested by the clients and, therefore, became more competitive by presenting them a product that is the exact fit for their profiles.

According to the author, the complexity can be added through many channels, that is, “make it more difficult for households to become informed by partitioning prices into direct feed and indirect involuntary surcharges” (Carlin, 2008). Procedures such as omitting significant information, the application of a more technical language to describe the products and different from one financial identity to another, makes it more complicated for consumers the comparison between them. All of those measures and several others instigate the ignorance of investors, which represents more income for the seller, as deduced by the same study: “Complexity increases the market power of the firms because it prevents some consumers from becoming knowledgeable about prices in the market” (Carlin, 2008).

Respecting the strategies implemented by the issuers in what concerns the creation of the financial products, Henderson & Pearson (2011) emphasized that the innovation and crescent complexity applied in the conception of the products combined with hidden information is intentional and have the purpose of reducing the wisdom of the investors regarding the pricing and the products’ modus operandi, which will allow the prices to be higher than they would be if investors fully understood the features involved in the product. The authors priced 64 issues of a popular financial product – SPARQS (Stock Participation Accreting Redemption Quarterly-pay Securities) – and they concluded that, on average, the real price was around 8% greater than their estimation, which led them to suggest that there were no rational reasons to invest in that product since “SPARQS expected returns are less than the risk-free rate” (Henderson & Pearson, 2011) and, therefore, it would be preferable to invest in bank certificates of deposit.

In contrast with the idea presented above, which considered that the necessary information is not presented to the investors, there is also the belief that the excess of data can become overwhelming for investors, especially to the ones that are less informed. In fact, this upshot is supported by some literature about decision-making, which underlines the fact that as the complexity of a certain decision increases, the effort applied tends to decrease. So, in the same light, Agnew & Szykman, (2011) drew attention to the fact that what is important is the way the information is presented, and not so much the quantity of available data, saying that “simply providing more information about investment options may not be enough to help investors make good decisions (...) if is presented in a simpler way, investors should suffer

less information overload and be more likely to use it” (Agnew & Szykman, 2011). However, in conformity with the previous studies, the authors once again underlined the importance of knowledge for a right choice of the product according to the profile and expectation of the investor that will have impact on his satisfaction and, as a result, permitting a reduction of the reported overload.

In consideration of the foregoing, it is extremely important to follow closely the product innovation and understand the dynamism of trading in order to overcome complex derivatives and structured products.

5.2. Protection Rules

All individuals involved in the commercialization of structured products, from its creation until the sale, are aware that this market has experienced a massive growth in the past few years and, gathered with it, it can also be noticed an increasing number of problematics and worries.

Following this reasoning, there are also many associations that have as first concern the protection of customer’s interests. Therefore, those associations are responsible for the creation of several rules and mandatory requirements that are designed aiming the implementation of standards that facilitates the investor’s perception of the real risk and features of the product that they are interested in buying.

The growing range of statements and actions created to issuers and all involved, namely in the creation and commercialization of structured products, cannot be unnoticed. In fact, there are innumerable regulations and boards of constitutions applicable for every type of structured products, controlling issues as the conception, the way of advertising or presentation, the sale and the customer care after sales. Thus, it is impossible to reunite all the gathering related to regulation materials.

5.2.1. ESMA – European and Securities Market Authority

It must be outstanding ESMA, that was created with the objective to safeguard “the stability of the European Union's financial system by enhancing the protection of investors and promoting stable and orderly financial markets” (ESMA, n.d.)³. Therefore, to pursue that

³ Source: <https://www.esma.europa.eu/>

mission, this authority has as main activities: the risk evaluation for both investors and markets; the implementation of a universal rulebook for all European Union financial markets, endorsing the convergence of the level of supervisory in those countries; and, finally, the direct monitoring of the financial entities. For 2020, ESMA settled its priorities around four different areas: supervision, investor protection, sustainability and technological innovation and relation with third countries. With the objectives established, the ESMA Chair, Steven Maijoor, declared that “in tandem to this implementation work, ESMA will continue its focus on promoting supervisory convergence and assessing risks with a continued emphasis on the implementation of MiFID II/MiFIR⁴, tackling the issue of cost and performance of retail investment products and facilitating data-driven supervision” (ESMA, n.d.)³.

5.2.2. IOSCO – International Organization of Securities Commissions

IOSCO is one of the entities that has activity throughout the entire world. This association was responsible for the publication of the Suitability Requirement with the objective to tackle the main issues identified regarding the trading of structured products, or, in other words, to “promote robust customer protection in connection with the distribution of complex financial products by intermediaries, including guidance on how the applicable suitability requirements should be implemented” (IOSCO, 2013: 7). In this document, it is described a detailed definition of structured product’s investments along with the coverage of many areas, such as: the organization of types of costumers, disclosure regulations, the intermediary’s obligation of acting honestly and competently, and a suitable protection of investors for both non-advisory and advisory services. In addition, there is also another document that consists in a summary of the product’s features and characteristics to potentialize the costumer awareness about the investment he is considering making. This regulatory tool uses a simpler language to de-cloak some possible hidden information or data that usually is described in such a way that is not fully understood by the great majority of investors. Therefore, this document usually contains the following subjects: an explanation of the modus operandi of the product, the maturity of the investment, the potential downside

⁴ MiFID II/MiFIR is a legislative framework that was implemented in 2018, being the main objective the enforcement of investor’s protection and the improvement of the performance of financial markets, allowing it to be more transparent and efficient.

risk as well as the guarantees and loss limits, the expected return and the upside potential, an analysis of three possible scenarios (the worst, the best and the break-even possibilities), the risk indicators, the presentation of alternative products and the comparison between them, the fees and additional costs involved during the whole life of the product and, finally, the possible reasons and scenarios that can lead to early redemption of the investment.

To finalize, several IOSCO members have shown a crescent concern regarding the commercialization of structured products, specifically “in appropriately regulating the behavior of issuers and intermediaries within their respective markets when the structured products are sold to retail investors” (IOSCO, 2013: 4). With that said, quite a few countries have decided to take preventive measures and apply more rules and regulations that help preventing some of those main concerns.

5.2.3. Examples of Rules in Place

As example of rules applied to safeguard the investors, in France, the Autorité des Marchés Financiers (AMF) issued, on October 2010, a document that aims to regulate the marketing actions related to retail financial products, listing the responsibilities and duties of both producers and distributors. In Belgium, it was declared on 2011 by the Financial Services and Markets Authority’s (FSMA), a temporary suspension of an activity related with the distribution of some of the most complex structured products until the trading rules of those financial products had been revised. In Portugal, the CMVM – *Comissão do Mercado e dos Valores Mobiliários* – developed a protocol in 2014, under decree-law 211.A/2008, together with Portuguese banks that have in their activity the commercialization of structured products, which places the obligation that the sales of this type of financial product can only be carried out by highly formed and informed employees, allowing the costumers’ clarification about all features and risks associated with the product. Furthermore, all the financial identities that signed the protocol pledged that they will not introduce to retail clients⁵ certain structured products that are classified as extremely complex (some examples are products with one or more barriers, the existence of caps and/or floors or the ones that

⁵ The protocol referred retail clients as costumers that are classified as not qualified, based on the Articles 317th and 30th of *Código dos Valores Mobiliários* and, in addition, hold a capital lower than five hundred thousand euros.

presented automatic early repayment mechanisms – target redemption) or that present a negative simulated average expected rate of return between percentile 20% and 80%.

In the Asian market, there were also some measures. For example, in Hong Kong it is mandatory, since 2010, a key fact statement that must be included in the set of documents involved in the trading of structured products. Moreover, in Japan, to avoid the misinterpretations and the inadequacy of correct and detailed explanations of financial products peculiarities, the Japanese Financial Services Agency implemented several administrative actions and penalties against all distributors that demonstrate a low performance related with this subject.

Regarding specifically the case of Switzerland, the central focus of this thesis, one of the identities with major prominence is FINMA – Swiss Financial Market Supervisory Authority. FINMA exists to protect investors from prejudicial business practices and, therefore “enhancing the reputation, competitiveness and future sustainability of the Swiss financial center” (FINMA, 2018: 1). To pursue this objective, FINMA attempts to continuously protect every individual financial customer from unfair deals. Therefore, this identity obligates the respect of all rights of the market participants, disseminating innumerable circulars describing the correct “interpretation and application of financial market law and is responsible for the recognition of self-regulatory standards” (FINMA, 2018: 1). In fact, it was detected by FINMA that one of the principal issues regarding the evaluation of the financial institutions’ performance, was the cost transparency of structured products, since exists a parcel of risk related with this class of assets that will incur in additional costs for investor and, regrettably, are not clearly revealed. Following this concern, in 2018, the core activity of this authority was, in fact, related with the cost transparency of structured financial products. Hence, it was created a preamble of a derivative clearing requirement specific for some types of OTC derivatives, increasing the quantity of products that were sold on a clear basis, by presenting all the relate features in a simple and humble approach.

Other important association that deserves some attention is SSPA – Swiss Structured Products Association. SSPA is responsible for the preservation of the interests of Swiss issuers and, since its conception, “SSPA has aimed to promote and strengthen knowledge

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and understanding of structured products for the interested public and investors” as stated in the SSPA website.

One key advantage is that this association do not engage in any commercial activity, having a position of total independency and inhibiting any conflict of interests. With that said, SSPA represents the major Swiss market participants, totalizing around 95% of Switzerland’s structured product market. Some of the main accomplishments of SSPA are the introduction of a risk classification mandatory for every trade involving this type of products and also the publication of the first comprehensive study regarding the Swiss structured products, that revealed an excellent performance.

6. Structured Products Market Around the World

The trading volume of complex products is not equally distributed around the globe. As expected, the most economically developed countries have higher affluence over investments in general, rule that is also applied to structured products trading.

However, this market has been in expansion all around the world, with special emphasis in the period subsequent to the financial crisis of 2008, that led to a retraction of the structured products market, particularly over exotic instruments.

Nowadays, the market presents good prospects, as declared by Karim Faraj, Bloomberg's Global Head of Front Office Derivatives and Abdessamad Khaled, Chair of Structured Product and Derivatives Pricing: "The 7 trillion dollars structured products market is on the rise again – and the market is sizeable to say the least. While structured products account for only 1% of the 700 trillion dollars derivatives market, structured products still outsize the total ETF market (5.3 trillion dollars) and more than double the total hedge fund market (2.9 trillion dollars)" (Bloomberg, 2019)⁶.

6.1. Europe

In Europe, it must be emphasized the German structured products market, being one of the most developed right besides Switzerland, not only due to the fact that they were one of the pioneers, but also because these countries profit from the existence of exchange markets by providing an extensive variety of innovative products to investors. To get a sense of the prominence, according to the Greenwich Associations, in 2018, more than 6% of all financial assets are detained in structured products in those two countries.

These countries, Germany and Switzerland, have a huge contribution in the dominance of Europe with regard to the trading of structured products, considering the number of issued products as well as the volume of products sold. Nevertheless, the number of those type of products has been rising in many European countries, with special focus to Sweden, Austria, Italy and France. By contrast, Netherlands, United Kingdom and Norway have suffered a

⁶ Source: <https://www.bloomberg.com/professional/blog/sure-time-to-grasp-the-potential-of-structured-products/>

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massive decline in sales during the credit crises and remain with lower values of products sold.

European investors have shown that they prefer structured products with less than two years of maturity and that are available only during a pre-determined interval of time, that is, they are issued as a form of tranche. Concerning the underlying asset, the preference goes to the ones based on equity, such as indexes and shares.

In accordance with the EUSIPA Market Report on structured investment products⁷, dated 4th March of 2020, the invested market volume of leverage and investment in Austria, Switzerland, Belgium and Germany amounted 280.2 billion euros at the end of the fourth quarter of 2019, represented a 12% rise compared to the last year equivalent period.

Moreover, the EUSIPA country members were offering, in the end of 2019, 1,277,665 leverage products and 535,444 investment products, amounting 1,813,109 in total.

Mentioning the total turnover, it amounted to 27.5 billion euros, constituting a slightly decrease of 1% when compared to the last year quarter.

	AT	BE	FR	DE	IT	NL	CH	Total
Exchange Turnover (Million €)	183	775	1,050	8,737	8,325	1,116	3,367	23,553
Outstanding Volume (Million €)	14,900	15,578	n/a	65,556	n/a	n/a	184,215	280,249
Number of New Listings on Exchange	1,580	604	37,356	1,042,716	4,259	19,083	11,017	1,116,615
Number of Exchange Listed Products	7,622	2,360	52,161	1,657,305	11,717	24,151	41,546	1,796,862

Table 1. Products listing during 2019. Source: EUSIPA's Market Report on structured investment products (adapted)

In conclusion, the success of the European structured products markets is also associated with the organization and the heavy regulation system, mandatory during all the process since the creation until the selling to costumers. In addition, the aptness of the characteristics of structured products to the European investors' risk profile, mindset and objectives, contributed to the dominant position of this region.

6.2. United States

In the United States, structured products are gaining attention today in a way they were not in recent history. In fact, the Greenwich Associates reported that, in 2018, the volume of

⁷ Available at <https://eusipa.org/eusipa-publishes-q4-2019-market-report-update/>

trading in such products distributed to retail and high-net-worth individuals was over 48 billion dollars.

In the following year, 2019, the volume of structured products distributed to the same individuals increased to 70 billion dollars, representing a growth of 45% comparing to the same sample basis of the previous year.

The American distributors require issuers' minimum credit rating of BBB+ in order to accept the commercialization of their products. Moreover, about 25% of the issuers heighten the credit rating to a minimum of A-. The number of distributors is intensifying, making prices fairer and more competitive. Amongst the biggest suppliers of product are HSBC, J.P. Morgan, Morgan Stanley, Barclays, Credit Suisse and Goldman Sachs, with unquestionable dominance of the first two.

6.3. Asia

In Asia, the structured investments are also gaining an important role in the economy, but the growing rate is not so high as it is in America. In 2015, the volume of sales in the main Asian markets (namely China, Japan, Hong Kong, Singapore and South Korea) surpasses the 750 billion dollars, symbolizing a 4% compounded annual growth (Wu & Pitts, 2017).

However, it must be highlighted the relevance of the Japanese market, responsible for more than 570 billion dollars of sales of structured investments in 2015, representing more than half of the total income of the Asian markets.

Regarding the Asian investors and their preferences, the tenor is typically less than a year and the most common payoffs are fixes-coupon notes, equity-linked notes, target redemption, autocallables and dual currency investment.

6.4. South Africa

In Africa, the structured products' market is relatively recent, being the first listed product dated October 2002. Nevertheless, the return attributed to investors has been positive over the last 10 years, according to the Structured Products Market Performance Review South Africa (SRP, 2019).

The global financial crisis in 2012 and political instability had (and continue to have) a huge impact on the market. However, since 2013, returns have risen and, subsequently, there have not been any products since that date that have reimbursed annualized capital return of less than 5% above the initial investment.

According to the Structured Products Market Performance Review of South Africa, the average annualized return of those complex products was 8.59% between 2008 and the end of 2018. Moreover, only 4.18% of the analysed products had a negative return in the same interval time.

To conclude, the values of issued products and volume of sales is comparatively low, justified by instability of this region, bearing in the mind the innumerable political problems and the massive poverty of the vast majority of citizens throughout the entire continent.

6.5. Switzerland

In this section, the case of Switzerland will be deeply analysed since it is the main concern of this thesis. Under the fact that the market of complex products in Switzerland is one of the most developed and profitable in the world, there have been some studies regarding this subject based on Swiss data. More than having the analysis region in common, all the studies presented next explored the same issue regarding structured products: pricing and valuation. In fact, those products are known for their price opaqueness, being pointed out by many investigators as one of the reasons for the success of structured products. Beyond that, another inquisitiveness is the similarity of the studies' conclusions: in general, apart from one, all the studies detected a considerable distortion between the value they obtained through the price model used and the real market value of the product.

One of the firsts papers written about this theme was by Wasserfallen & Schenk, (1996). They valued thirteen structured products, combining call options listed on the SMI and riskless investments. In fact, it was found some discrepancy between the theoretical value and the issuing price, both in primary and secondary market. However, the authors did not consider it a significant difference, having attributed that difference to gains of bank from offering such securities: "at issue, the securities generally sell for slightly more than the theoretical price. The differences, however, are not very large and do not change much with respect to the volatility measure used" (Wasserfallen & Schenk, 1996). In addition, the

transaction costs were reasonably low, being a contribution for the fair price of the product. With that said, Wasserfallen & Schenk, (1996) considered those securities an active investment opportunity, especially for small investors with a conservative risk appetite.

In 2001, Burth *et al.*, analysed the price of concave products on Swiss blue chips, issued on 1st of August of 1999, totalizing 275 products. To understand the fairness of the products' price, they compared the issued price to analogous strategies in the underlying markets and EUREX. Contrarily to the results of the previous study, the price differences were considered statistically significant. Even though the authors agreed with the compensation to the issuer, they raised the question of how much the banks are receiving as net-profit, interrogation that could not be answered due to the lack of information, in other words, "the difference compensates the issuer for his effort associated with the management of the product. Based on our data, we are not able to judge what portion of this difference is caused by [marginal] cost and what portion goes to the issuing bank as net-profit." (Burth *et al.*, 2001). Furthermore, the authors pointed out a possible explanation of the success of structured products and the bank's effort to continuously invest in products' diversification and bring more complexity to those (already complex) products: "The potential for additional profits in this business seems to be considerable, due to a limited transparency in this market and due to a limited sophistication on the side of many smaller investors" (Burth *et al.*, 2001).

A few years later, in 2005, Wohlwend & Grünbichler examined the valuation of 192 no-capital protection products, in the issuing time and in the secondary market. The results revealed a significantly difference between primary and secondary markets, with a positive difference in volatility of 6.8% *versus* 60% respectively, which implied a more favorable pricing in the secondary market, from the customer's point of view. In fact, the mean difference in volatility of products at the time of issue was negative by 4.25%, showing an evidently price disadvantage for investors. However, the authors advertised that the significant discrepancy between the values of the primary and secondary market can be partly explained by the issuer's mark-up, that is present in the time of the issuing and that is not maintained in the secondary market. Furthermore, the authors also make the distinction between products with and without coupon payments and discovered that the ones without coupons are priced more fairly both in the primary and secondary market, as stated: "on

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average, the products without coupon payment are thus offered at considerably more favorable conditions both at the time of issue and in the secondary market than are their pendants with coupon payments and exotic characteristics” (Wohlwend & Grünbichler, 2005).

Finally, Wallmeier & Diethelm, (2009) valuated an exotic product, the Multiple Barrier Reverse Convertible (MBRC) in the primary market, that represented, at the time, a considerable portion of Swiss’ structured product total trading volume. In accordance with the previous studies, they also found that products are overpriced, with a range between 3.4% to 6%, values that were considered both economically and statistically significant. The study was expanded to other issues and allowed to explore the question raised in the previous study (of Grünbichler & Wohlwend) regarding the influence of the coupons in the products’ pricing. It was found that the overpricing phenomenon increases with the value of coupon payments, suggesting that investors tend to devalue the risks when higher coupons are offered, that is, “overpricing is positively related with the coupon, which confirms the presumption that investors tend to overestimate the importance of a sure coupon payment and underestimate the risk involved” (Wallmeier & Diethelm, 2009). Moreover, they were also able to discover that the choice of common stocks tends to reduce the amount of overvaluation of the product.

In 2015, the Swiss Finance Institute (SFI) released a report based on the analysis of 20,000 complex products through a considerable period of time, 2008 to 2014, where many oscillations happened due to financial events, namely crisis.

Actually, the first year of the study, 2008, corresponds to what some economists saw as the most serious financial crisis since the Great Depression – the global financial crisis. As previously mentioned, this crisis started in 2007 with a depreciation in the subprime mortgage market in the United States and culminated with the collapse of the fourth-largest investment bank in North America, created an international banking crisis that costed a loss of roughly 33% to the SMI (the Swiss market index). The other event that had a negative impact on the equity markets during the study time was in 2011 with the European debt crisis, negatively impacted the SMI on 9%. Accordingly, those two recessions affected the structured product’ market simply because those products are mostly equity-based.

Nevertheless, between 2012 and 2014, more than 80% of complex financial products in analysis generated average returns within 5% and 15%, varying according to the products' category, culminating, in the end of 2015, in 25.7 billion dollars from the trade of 10,165 products (SFI, 2015).

Specifying the mindset of the Swiss investors, they are recognized for their hazardous decisions, preferring structured products with exotic characteristics and, consequently, with more complex pricing models and peculiar features and payoffs, as confirmed by Wallmeier & Diethelm (2009) "a unique characteristic of the Swiss market is that structured products with "exotic" options are extremely prominent" (Wallmeier & Diethelm, 2009). Moreover, the most traded products are BRC on stocks and this specific product is notorious for higher coupons' payment when the market is experiencing a turbulent period. Thus, in this scenario, the investor can choose a lower barrier for the same coupon and have a further income than he would have if the market was stable.

To conclude with the most recent numbers, according to the Swiss Finance Institute, by the end of 2019, the Swiss derivative market was considered the largest in Europe, betting the main competitor, the German market. In that year, it was recorded on the Swiss Stock Exchange more than 35,000 structured products, representing a volume of 199 billion CHF (about 183,3 billion euros). The 35,000 products were distributed by categories as follows: 56.6% were leveraged, 36.2% yield enhancement, 4.8% participation, 1.6% capital protection and 0.8% investment products with reference entities.

7. Analysis of Structured Products: Barrier Reverse Convertibles and Turbo Warrants

As presented before, there are five major categories of Structured Products designed by SSPA: Capital Protection Products, Yield Enhancement Products, Participation Products, Investment Products with Reference Issuers and Leverage Products, which all together summing up for more than 32,000 products. In this thesis, it is going to be priced a number of Barrier Reverse Convertibles (BRC), included in the Yield Enhancement Products, and Turbo Warrants, belonging to the group of Leverage Products. Hence, it is important to have a deeper knowledge about these two products.

7.1. Barrier Reverse Convertibles

BRC, that derive from the classic reverse convertibles, are no more than bonds with a coupon where the repayments are dependent on the performance of the underlying asset. Comparing the BRC with simple reverse convertibles, the coupon of the former will always be lower due to the conditional capital protection offered by the barrier. Nonetheless, the success of this product is decided by the value chosen for the barrier: if the barrier is not reached during the life of the product, the repayment will correspond to the maximum (100%) of the nominal; in the case where the barrier is breached, the capital protection is lost and the BRC transforms itself in a classic reverse convertible, where the redemption is dependent on the value of the underlying asset upon maturity. Thus, the investment on this specific product should be made when the investor's interest is buying stocks but predicts only moderate price movements. In cases where the underlying asset experiences gently rising or falling stock prices, it will be possible a better yield comparing to direct investments in shares and, at the same time, be protected against slightly drops in prices.

Thus, by investing in a BRC, the holder will give up on the possible upside potential in return for an enhanced product. On the other hand, the holder is not exposed to downside potential, until a certain value – the barrier – that usually is settled considerably below the spot price, between 80% and 50% of spot. The BRC can also be constructed under a more conservative approach where the strike is placed at-the-money. The strike and the barrier settled will have impact on the payoff: a lower strike or barrier will imply a lower coupon.

There are three main influencing factors that, contrary to the barrier and the strike, are not pre-established: the volatility (an higher volatility will infer in an higher level of the coupon), the interest rate and dividend yield (an increment in either of the factors will imply in a greater coupon) and the skew or the volatility smile effect (in cases where the skew of the underlying asset's options is higher, a lower barrier can be established).

The following table summarizes the three possible scenarios when investing in BRC, where it is easy to observe one important feature of the BRC: the coupon payment is certain and independent of the path of the market prices.

Scenarios	Repayment	Profit
Price of equity always above the barrier	100% nominal + 7% coupon	7%
Price of equity falls below the barrier once and trades at maturity at 101%	100% nominal + 7% coupon	7%
Price of equity falls below the barrier once and trades at maturity at 98%	Pre-defined number of underlyings + 7% coupon	5%

Table 2. Scenario analysis for BRC. Source: Own

Analysing the three scenarios and the associated profit, BRC can be seen as pretty secure investments. However, the probability of the barrier being breached is actually higher than it might appear, being this reflected in the value of the coupon. In fact, the delta⁸ of the product is a decent indicative of the knock-out chances. Most of the times, the worst-case scenario can be neglected for appearing to be almost impossible when, in fact, it must be highly considered and scrutinized.

This type of products is extremely popular in Switzerland, especially during periods of serenity in the markets, being noticeable a refrainment when markets are turbulent, as is example the year of 2011, when the uncertainty about the future of the Europe Union due to the European debt crises caused a rapidly scale-up of the volatility of SMI and, at the same time, occurred a sizeable reduction of the investments in BRC. However, this is noteworthy since BRC are more valuable in cases where the volatility is higher for the reason that, in the ultimate analysis, the holder of a BRC sells a put option, being the value of that put option increased when volatility is higher. The theoretical price of a BRC is given by one of the following formula (Haug, 2007):

⁸ The delta measures the price sensitivity of an option for a particular change in the underlying asset's price.

Down-and-in call (C_{di})

$$C_{di} (if K > b) = C + E \quad (1)$$

$$C_{di} (if K < b) = A - B + D + E \quad (3)$$

Up-and-in call (C_{ui})

$$C_{ui} (if K > b) = A + E \quad (2)$$

$$C_{ui} (if K < b) = B - C + D + E \quad (4)$$

Down-and-in put (P_{di})

$$P_{di} (if K > b) = B - C + D + E \quad (5)$$

$$P_{di} (if K < b) = A + E \quad (7)$$

Up-and-in put (P_{ui})

$$P_{ui} (if K > b) = A - B + D + E \quad (6)$$

$$P_{ui} (if K < b) = C + E \quad (8)$$

where,

- $A = \phi S e^{qT} N(\phi x_1) - \phi K e^{-rT} N(\phi x_1 - \phi \sigma \sqrt{T});$
- $B = \phi S e^{qT} N(\phi x_2) - \phi K e^{-rT} N(\phi x_2 - \phi \sigma \sqrt{T});$
- $C = \phi S e^{-qT} (b/S)^{2(\mu+1)} N(\eta y_1) - \phi K e^{-rT} (b/S)^{2\mu} N(\eta y_1 - \eta \sigma \sqrt{T});$
- $D = \phi S e^{-qT} (b/S)^{2(\mu+1)} N(\eta y_2) - \phi K e^{-rT} (b/S)^{2\mu} N(\eta y_2 - \eta \sigma \sqrt{T});$
- $E = P e^{-rT} [N(\eta x_2 - \eta \sigma \sqrt{T}) - (b/S)^{2\mu} N(\eta y_2 - \eta \sigma \sqrt{T})];$
- $F = P [(b/S)^{\mu+\lambda} N(\eta z) + (b/S)^{\mu-\lambda} N(\eta z - 2\eta \lambda \sigma \sqrt{T})];$

being,

- $x_1 = \frac{\ln(S/K)}{\sigma \sqrt{T}} + (1 + \mu) \sigma \sqrt{T};$
- $x_2 = \frac{\ln(S/b)}{\sigma \sqrt{T}} + (1 + \mu) \sigma \sqrt{T};$
- $y_1 = \frac{\ln(b^2/SK)}{\sigma \sqrt{T}} + (1 + \mu) \sigma \sqrt{T};$
- $y_2 = \frac{\ln(b/S)}{\sigma \sqrt{T}} + (1 + \mu) \sigma \sqrt{T};$
- $z = \frac{\ln(b/S)}{\sigma \sqrt{T}} + \lambda \sigma \sqrt{T};$
- $\lambda = \sqrt{\mu^2 + \frac{2r}{\sigma^2}};$
- $\mu = \frac{(q-r) - \sigma^2/2}{\sigma^2};$

where,

- b: barrier level;
- K: strike Price;
- S: current value of the underlying asset;
- r: continuously compounded risk-free interest rate;
- q: continuously compounded dividend-yield rate;
- T: maturity of the BRC;

- σ : volatility;
- P : predetermined cash payoff;
- $\phi = \begin{cases} 1, & \text{for } C_{ui} \text{ and } C_{di} \\ -1, & \text{for } P_{ui} \text{ and } P_{di} \end{cases}$;
- $\eta = \begin{cases} 1, & \text{for } C_{di} \text{ and } P_{di} \\ -1, & \text{for } C_{ui} \text{ and } P_{ui} \end{cases}$.

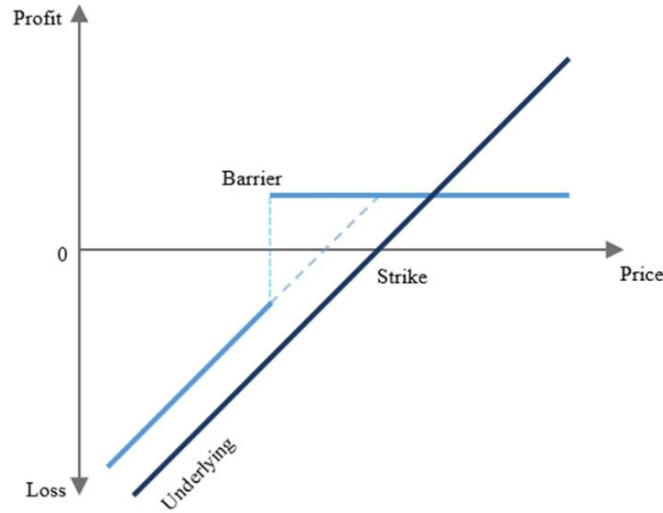


Figure 2. Payoff of BRC. Source: Own

There are two major groups of holders of BRC: point-in-time investors and through-the-cycle investors. The main objective of the former group is to explore a current market opportunity and hence, all the features (stock, barrier level and actual volatility) matters and are specifically selected. Regarding the through-the-cycle investors, their investment is independent of the stock and the market cycle, subscribing a lower risk and, as consequence, accepting a lower return (comparing to point-in-time investors).

Pursuing this thematic, it was carried out a study using BRC whose main objective was to confirm or deny the hypothesis that investors' risk perception is unfairly diminished by the selection of the assets that constitute the BRC. As a matter of fact, this theory represents a parallelism with the Dieter's Paradox that arise from the phenomenon that people tend to add a healthy ingredient into an unhealthy meal believing that the total calorie intake will decrease, which does not correspond to the truth, since adding that healthy component will always increase the amount of calories (or risk, financially speaking). Hence, the authors

considered that a “similar misperception can occur when retail investors assess the risk of BRC” (Kunz, Messner, & Wallmeier, 2017) because investors also calculate the risk average rather than the overall of the different risky assets. Indeed, with the participation of Swiss costumers that were all active in capital markets, the hypothesis was confirmed and, therefore, the risk perceived by the investors tends to decrease when are adding safer stocks to a riskier underlying stock. This outcome potentializes the danger of misperceptions since “issuers can design BRC to exploit investors’ behavioral biases via the strategic selection and composition of the BRC’ underlying assets pools” (Kunz *et al.*, 2017).

To finalize, the BRC can be divided in many variants, being the most common the Worst-of Barrier Reverse Convertible, Callable Barrier Reverse Convertible, Trigger Barrier Reverse Convertible, Lookback Barrier Reverse Convertible and the Multi-barrier Reverse Convertible.

7.2. Turbo Warrants

The first appearance of Turbo Warrants was in Germany, in 2001, and they represent a singular type of leverage investment products that combine the characteristics of both futures contracts and warrants, offering the investor an instrument that, especially in times of great volatility (such as BRC), allows him to benefit from sharp fluctuations in the prices.

Thus, with Turbo Warrants, an investor with a concrete view of the market will be able to obtain more than proportional benefits, both in the short and long term, arising from fluctuations in the prices of the underlying assets and with a relatively low capital investment. Nevertheless, it is important to beware that leverage is a door that swings both sides; hence, at the same time that it must be considered the gains that can be obtained with those products due to high leverage, it also must be taken into account the higher risk arising therefrom, which can sum up to the total loss of capital invested.

Turbo Warrants also have in its composition a barrier that has a stop-loss effect. Thus, if reached, causes the premature expiration of the product. Accordingly, a knock-out call will expire in the moment that the price of the underlying asset falls below the barrier and, oppositely, a knock-out put will expire if the value of the underlying asset exceeds the pre-defined value of the barrier.

The risk of this product can also be adapted to the investor's profile and objectives: the furthest is the strike price (and the barrier) from the current price of the underlying asset, the lowest the leverage but, conversely, the lower the probability of a knock-out event. In contrast, turbos whose strike price or barrier is closer to the current price of the underlying asset have greater leverage, but also carry a greater risk of a knock-out event. In conclusion, before the purchase of a turbo warrant, the investor must evaluate if there is a sufficient buffer between the barrier and the price of the underlying instrument.

The theoretical price of a turbo warrant is given by one of the following formulae (Eriksson, 2006):

- i. If the barrier has not been hit, and assuming that $b \geq K$, the value of a turbo call is:

$$TC(S, t) = V_c(b, \delta)w(S, t, 1) + DOC(S, t; K) \quad (9)$$

- ii. If the barrier has not been hit, and assuming that $b \leq K$, the value of turbo put is:

$$TP(S, t) = V_p(b, \delta)w(S, t, -1) + OUP(S, t; K), \quad (10)$$

where,

- $TC(S, t)$: price of a Call Turbo Warrant;
- $TP(S, t)$: price of a Put Turbo Warrant;
- $V_c(b, \delta)$: value of the rebate at activation of a call turbo warrant;
 - $V_c(b, \delta) = e^{-r\delta} E_b(e^{m(\delta)} - K)^+$
- $V_p(b, \delta)$: value of the rebate at activation of a put turbo call;
 - $V_p(b, \delta) = e^{-r\delta} E_b(K - e^{M(\delta)})^+$

being:

- $m(\delta) = \min_{0 \leq t \leq \delta} X_t$;
- $M(\delta) = \max_{0 \leq t \leq \delta} X_t$;
- $w(S, t, 1) = \left\{ \left(\frac{S}{b}\right) N\left(\eta \frac{\ln \frac{b}{S} - (r + \frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{T-t}}\right) + \left(\frac{b}{S}\right)^{\frac{2r}{\sigma^2}} N\left(\eta \frac{\ln \frac{b}{S} + (r + \frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{T-t}}\right) \right\}$;
- $DOC(S, t; K) = C(S, t; K) + (b - K)e^{-r(T-t)} N\left(\frac{\ln \frac{S}{b} + (r - \frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{T-t}}\right) - \left(\frac{b}{S}\right)^{\frac{2r}{\sigma^2}-1} \left\{ C\left(\frac{b^2}{S}, t; K\right) + (b - K)e^{-r(T-t)} N\left(\frac{\ln \frac{b}{S} + (r - \frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{T-t}}\right) \right\}$;

$$\begin{aligned} \circ \quad OUP(S, t; K) &= P(S, t; b) - (K - b)e^{-r(T-t)} N\left(\frac{\ln\frac{S}{b} + (r - \frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{T-t}}\right) - \\ &\left(\frac{b}{S}\right)^{\frac{2r}{\sigma^2}-1} \left\{ P\left(\frac{b^2}{S}, t; b\right) - (K - b)e^{-r(T-t)} N\left(\frac{\ln\frac{b}{S} + (r - \frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{T-t}}\right) \right\} + \\ &\left\{ 1 - \left(\frac{b}{S}\right)^{\frac{2r}{\sigma^2}-1} \right\} (K - b)e^{-r(T-t)}; \end{aligned}$$

being,

- b: barrier level;
- K: strike Price;
- S: current value of the underlying asset;
- t: first time the barrier is hit;
- r: continuously compounded risk- free interest rate;
- T: maturity of the turbo warrant;
- δ : time-units after the warrant knocks-in;
- σ : volatility.

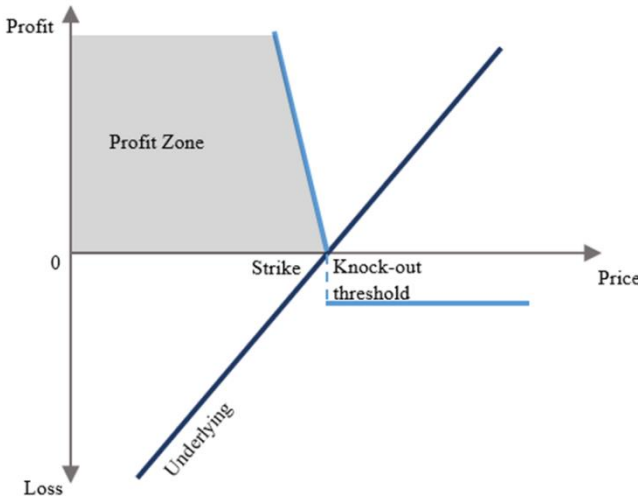


Figure 3. Payoff of Put Turbo Warrant. Source: Own

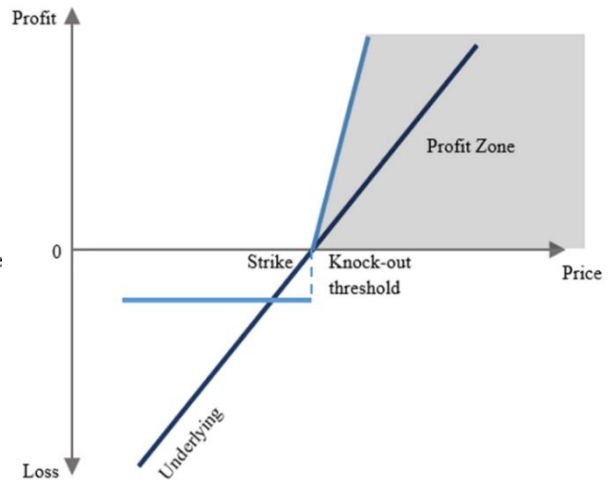


Figure 4. Payoff of Call Turbo Warrant. Source: Own

One key advantage pointed out by investors is the slightly impact of changes in the implied volatility of the underlying asset, creating the (wrong) idea that investing in those products consist on a simple bet on downward or upward movement, allied with a lower cost and a slightly volatility impact. However, recent studies have shown that this is only true under the Black & Scholes assumption that the volatility is constant. Thus, Wong & Chan (2008) have

shown that “under the CEV model, Turbo Warrants are much more sensitive to the parallel shift than their vanilla counterpart (...) This effect is silent in the Black & Scholes model in which the correlation is absent. Thus, a turbo warrant holder is actually engaging in a similar correlation risk as a vanilla option holder” (Wong & Chan, 2008).

8. Methodology

The ultimate objective of this dissertation is to provide an empirical study on market pricing of BRC and Turbo Warrants. To ensure that the database used is wide-ranging enough to produce outcomes as most reliable as possible, it was chosen Switzerland as the country to be analysed, since the market of structured products plays an important role in the investment industry of this country and is one of the most developed market in the world concerning structured products, which makes this market overloaded with precious and detailed information.

The valuation of a structured product is not straightforward, as its composition is a combination of other securities and, thus, the pricing formula is not linear. Moreover, the pricing method used by banks and other issuers is not public, being impossible to judge with exactness if the price corresponds to the fair value. Nevertheless, as the number of market players increases, the dispute by market share becomes a convenient tool to diminish the premium charged in the products' price, but still lacked strongness to ensure the total fairness of prices.

The pricing evaluation of BRC and knock-out warrants will be defined as:

$$PD = \frac{Price_{Market} - Price_{Model}}{Price_{Model}}, \quad (11)$$

where:

- PD : relative price difference;
- $Price_{Market}$: total market price quoted at a certain date;
- $Price_{Model}$: computed using a duplication strategy.

Therefore, in order to verify the suitability of the initial pricing offering, the published price ($Price_{Market}$) will be compared to values of a synthetic replication strategy ($Price_{Model}$). If the result of this formula is negative, it will indicate that the product is underpriced and, thus, the investor obtains a better offer by buying the product than in the underlying markets. In the opposite case, if the difference is positive, the product is overpriced, meaning that the investor would have a better arrangement by replicating the strategy in the underlying markets instead of buying the structured product (assuming the transaction costs are similar

in the two strategies). It is important to note that the sense of the words “underpriced” and “overpriced” does not exactly mean that the issuing price of the product is inappropriate, only that the premium charged is excessive compared to the theoretical value.

8.1. Price Decomposition of Structured Products

A theoretical price represents the price of the product if all its components were valued in an hypothetical model, where there are no bid-ask spreads, uncertainty premium for changes in parameters of price-sensitiveness, volatilities, correlations, charges for risk capital and other market imperfections. Therefore, the “fair price” is computed based on the assumption that there are no production and distribution costs and as if the issuer has no profit. However, a structured product has three fee categories that corresponds precisely to the inverse of those assumptions: production and distribution fees and risk management costs.

The first two items are fees, meaning that they are computed based on its cost plus a probable net margin and they are static throughout the life of the product. Production fees incorporate, amongst others, issuance costs, structuring costs and personal and non-personal costs attribute to the workforces that are involved in the value chain of the product, value that is not available publicly. Regarding the distribution fees, they are shared since 2015, being mandatory for issuers in Switzerland to disclose the total value charged to cover distribution costs. To conclude, it is clear that a lower fee will be more interesting for investor since it will translate in better conditions (for example, higher coupon payments, participation rate or capital protection level).

The case is not the same with regard to the last category: the risk management costs, also named as uncertainty premium, due to the fact that these costs are not measurable at the issuance date, being only known at maturity when it is possible to appraise the management effort that was needed during the life of the product. This happens because the value of the derivative changes over time and, consequently, the issuers need to adjust their position to guarantee the liability value – so-called dynamic heading. However, the future derivative’s fluctuations are not known, but the issuer needs to fix a value in the issuing date in order to price the product. Any value could be chosen, like the average, the maximum or minimum of a certain period. At the maturity of the product, traders will be able to judge whether the value chosen was too optimistic (translating into a loss for the issuer) or conservative (being

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interpreted as a profit for the trader). Nevertheless, the risk management costs are not available publicly neither in the issuance or expiration date.

The sum of those three components was defined by several Swiss issuers as TER – Total Expense Ratio – corresponding, as illustrated in Figure 5, to the difference between the issuance price and the “fair price” of all components of the product.



Figure 5. Price components of a structured product. Source. Swiss Finance Institute (adapted)

Although the decomposition of price in those specific components can be enlightening for investors, the cost transparency is far from being a reality, remaining the question about the possible moral hazard from the banks' side when pricing structured products. In fact, pricing a structured product is a challenging task even for issuers, since those financial products are forward looking in the time. For investors, the computation of the production and risk management costs is an even harder mission, being only public the value of distribution costs and known the “fair price” of the product, by the computation of the price of each product' component individually.

To conclude, it was computed the average TERs for each product category, based on the products sold between April 2012 and April 2015, by the four major Swiss issuers. The results are summarized in the table 3.

Product type	Risk management cost estimates (per annum)
Worst of Barrier Reverse Convertibles (barrier at 75%)	1-year maturity: 1.28% to 1.50% 3-year maturity: 0.51% to 0.87%
Bonus Certificates (barrier at 75%)	2-year maturity: 0.84% to 1.25%
Capital Protection Certificates (barrier at 95%)	5-year maturity: 0.06% to 0.13%
Discount Certificates	1-year maturity: 0.1% to 0.25%

Table 3. Average TER by type of product. Source. Swiss Finance Institute (adapted)

As it is notable, the products with higher TER are the Worst of Barrier Reverse Convertibles with one-year maturity, followed by the Bonus Certificates, the Worst of Barrier Reverse Convertibles with three years maturity, the Discount Certificates and finally, the Capital Protection certificates are the category with lower average values of TER.

8.2. Pricing Model

Regarding the pricing model to be used in the computations of the theoretical price of the products, this can be made using different approaches and methods. Nevertheless, the most worldwide used is the Black & Scholes (1973) and Merton (1973) Model, outstanding its simplicity and its easy adjustment to any underlying asset.

In accordance, Black & Scholes (1973) and Merton (1973) published their papers that were revolutionary. The former authors derived the general equilibrium valuation formula to price an European call option on a stock without dividends. In the same year, 1973, Merton generalized that formula to cases with dividend payments and stochastic interest rates.

Beginning with a plain-vanilla call and put, their value at time zero is, respectively, given by:

$$C_0 = Se^{-qT}N(d_1) - Ke^{-rT}N(d_2) \tag{12}$$

$$P_0 = Ke^{-rT}[1 - N(d_2)] - Se^{-qT}[1 - N(d_1)] \tag{13}$$

where:

$$d_1 = \frac{\ln(S_0/K) + (r - q + \frac{\sigma^2}{2})T}{\sigma\sqrt{T}} \quad \text{and} \quad d_2 = d_1 - \sigma\sqrt{T};$$

being,

- S : current value of the underlying asset;
- K : strike price;

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- q : continuously compounded divided-yield rate;
- r : continuously compounded risk-free interest rate;
- T : maturity;
- σ : volatility.

The value of these standard options is independent of the probability of the barrier being intersected. Thus, in the case of a barrier option, it must be considered that feature in the pricing formula because “it depends on whether the underlying spot cross some prespecified level” (Hull, 2018). Since this type of option has an extra requirement that adds some extra uncertainty, its value will never be higher than the correspondent standard option (call or put) with the same characteristics. It is important to recall that there are two main natures of barrier options: the ones that cease to exist if the predefined barrier is reached (knock-out options) and, by contrast, the ones that need to achieve some specific value to come into existence (knock-in options).

In addition, there is also another peculiarity that permits to distinguish the nature of the options and is associated with the relative position between the barrier and the initial asset price: if the barrier level is below the initial asset price, the option is either down-and-out (deriving from knock-out options) or down-and-in (deducted from knock-in options); if the barrier level is above the initial asset price, the option can be an up-and-in or up-and-out, employing the same logic previously stated. Hence, both knock-in and knock-out options could be calls or puts, amounting to eight different barrier options, as shown in Rubinstein & Reiner (1991).

Concerning the warrants, namely the Turbo Warrants, they also present a barrier in the same vein as the exotic options mentioned above. The barrier levels are also established at the same point in time as the conception of the option and can be above or below the current underlying asset price. A turbo warrant is a specific kind of derivative in which the payoff is the same as a plain-vanilla option (call or put) if the underlying asset price did not hit the barrier level until maturity. In the opposite scenario, if the barrier was reached, a rebate will be paid. In the case of a turbo call warrant, the value of that rebate corresponds to the difference between the lowest value of stock price registered in a pre-established period after the barrier is hit and the strike price. Regarding turbo put warrants, the rebate is equal to the difference

between the strike price and the highest stock price registered during a predefined period, after the achievement of the barrier level.

The Black & Scholes (1973) and Merton (1973) pricing formula presented above assumes that the underlying stock price returns follow a lognormal distribution. Although its limitations, most traders are not willing to trade this model for other pricing tool, arguing that “it is better to use a model with the smallest number of parameters to estimate” (Taleb, 2007).

9. Data

With the objective of having a close and fair vision of the structured products market in Switzerland, it was chosen a combination of the issuers and underlyings that have most prominence in the market, considering the two types of products in analysis: BRC and Turbo Warrants.

Following this rationale, the first step was to discover the most important companies whose stocks were selected to construct the product, that is, the final payoff will depend on the performance of the company's stocks. This information was collected through the SIX Swiss Exchange website, the Switzerland's principal stock exchange, using their finder tool.

Thus, for each type of product, the research allowed to identify the companies' stocks with a greater number of products issued. To restrain even more the number of companies, and for the sake of making sure that only the most interesting companies were selected to assure the results were as representative as possible, it was chosen only one company to represent each of the 11 types of industries existent, according to ICB – Industry Classification Benchmark. ICB is a global standardization for the cataloguing and comparison of companies by industries and sectors, with worldwide utilization. Thus, this categorization was made as a mean to generate more reliable, trustful and representative results, mitigating the risk of similar industry environments that could lead to bias and tendencies.

To determine the most representative company for each industry, it was used the SMI Expanded Index. This index was chosen knowing that it covers more than 90% of the capitalization of the Swiss equity market, contrasting with SMI that incorporates only the 20 largest and liquid stocks in Switzerland.

Accordingly, for each of the 11 industries (Energy, Basic Materials, Industrials, Consumer Staples, Health Care, Consumer Discretionary, Telecommunications, Utilities, Financials, Technology and Real Estate), it was chosen the company with the largest market capitalization integrated in the SMI Expanded Index as of 1st of July 2020. The results are summarized on the table below, where is possible to understand that 9 out of the 11 industries are covered by a company from the index Accordingly, only 2 industries remain without any

illustrative company in the SMI Expanded Index: Energy and Utilities. Further information on the selected companies is presented in Appendix A – The Companies.

Industries	Representative Company	Spot Price as of 21/09/2020 (CHF)
Basic Materials	Givaudan	3,999.00
Industrials	ABB	23.14
Consumer Staples	Nestlé	209.46
Health Care	Roche	333.75
Consumer Discretionary	Richemont	61.40
Telecommunications	Swisscom	502.40
Financials	Zurich Insurance Group	329.80
Technology	Temenos Group	127.80
Real Estate	Swiss Prime Site	83.95

Table 4. List of companies present in SMI Expanded Index, chosen by industry.

The second step is related with the choice of the Issuers. Once more, in conformity with SIX Swiss Exchange and accordingly with the two types of products above-mentioned, it was chosen the issuers with higher market. The final result culminated in five relevant issuers for BRC – Bank Julius Baer, Bank Vontobel, Leonteq Securities, UBS and Credit Suisse – and three significant issuers related to Turbo Warrants – Bank Vontobel, UBS and BNP Paribas.

Summarizing, and after the application of all the constraints and criteria, the final result comprises a total of 89 BRC and 70 Turbo Warrants that are going to be subjected to analysis.

9.1. Selection of Products' Characteristics

To ensure a reasonable degree of homogeneity in the sample used and in order to guarantee that the final results are accurate and compliant with some standards, a few rules and conditions were followed.

Firstly, the data was collected at a random date, more specifically on 21st of September 2020. However, it is important to notice that, although the date is completely arbitrary, the world (and, consequently, the financial markets) is currently going through a turbulent period, facing the COVID-19 global pandemic. The 21st of September 2020 corresponded to a period between two strong waves of the Coronavirus in Europe: the first peak was in March 2020 and the second was still emerging upon the delivery of this thesis. This tribulated period can be considered as a strong disturbance on global economy and, consequently, in the available data, number of products issued, prices, volatility and other market conditions.

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As referred in the theoretical section, it is important to notice that is impossible to make a perfect replication of the hedging strategy used by issuers, due to many factors as private information, volume of trading and volatility smile effect. To minimize some of possible discrepancies and in order to be considered in the sample, the structured products should: (i) have the correspondent call available, to assess if the strike price and maturity of the product is somewhat similar to the correspondent option; and (ii) the conditions of the issuance must be known.

Additionally, it was made two adjustments, one for BRC and the other for Turbo Warrants, that were considered useful and relevant to attain more fair and accurate results.

In the case of BRC, it was computed a barrier adjustment related with the type of monitoring applied in this type of products. As most models' computations assume a continuous monitoring, the reality is that they are instead discretely monitored. Hence, it was applied a rather simple correction on the barrier value, that "shifts the barrier away from the underlying by a factor of $e^{\beta\sigma\sqrt{\Delta t}}$, where $\beta \approx 0.5826$, σ is the underlying volatility and Δt is the time between monitoring instants" (Brodie, Glasserman & Kou, 1997). As this type of information is not revealed, based on the paper of Brodie *et al.* (1997), it was assumed a daily monitoring. The price computations were also made without this barrier adjustment, with the objective to compare both results and verify if the price difference between the theoretical value and the market price is indeed partially mitigated by this amendment.

For Turbo Warrants, the modification is related with the rebate paid after the expiration of the product, that happens when the barrier is hit. Thus, following Eriksson (2006) "the rebate itself can be considered as a contract initiated at the first time the underlying hits the barrier b , expiring δ time-units later." Again, as this is not disclosed, it was applied an interval of 3 hours, based on the assumption made by the same author.

Additionally, the risk-free rate used was considered as being equal to 0.191%, corresponding to the 2015-19 daily average yield from the 10-year German bond.

Finally, the vast majority of the remaining market variables were collected mainly through two sources: (i) Bloomberg Terminal, used for dividends, spot prices and volatility; (ii) SIX

Structured Products Website, where it was gather all listed products at the time that fulfill the rules applied to the database and associated information.

All in all, and after applying all filters considered and assumptions made, the list of both types of products has shrunk, culminating in a reselection on the most important and relevant issuers for both types of products. Thus, were reached 89 BRC with 3 relevant issuers (Bank Vontobel, Bank Julius Baer and Leonteq Securities) and 70 Turbo Warrants issued by Bank Vontobel and UBS.

10. Analysis of the Results

10.1. General Results

In this section, it will be presented a general overview of the results obtained, based on the sample of structured products previously mentioned.

Type of product	Median Overprice	Minimum Overprice	Maximum Overprice
Turbos	1.12%	-1.73%	14.23%
BRC with adj.	2.31%	-2.56%	6.62%
BRC w/o adj.	3.47%	-2.36%	7.02%

Table 5. General overview of the results obtained, by type of product. *Source: Own estimates*

Based on table 5, one can state that, in general, BRC are substantially more overpriced than Turbo Warrants. On average, turbos are overpriced in 1.12%, whether BRC's market price is around 2.31% above the theoretical price, considering the sample with the barrier adjustment and 3.47% without the adjustment.

In fact, the sample with the barrier adjustment revealed prices that are closer to the market price, meaning that most likely this variable is also taken into consideration by financial institutions when pricing such products. In consequence, the following analysis will rely on the results with barrier adjustment.

Thus, it can be stated that, in general, Turbo Warrants could be a fairer investment when compared to BRC, as the overall overpricing is significantly lower.

10.2. Results by Company

In this section, it will be analysed the results obtained by company and for each type of product, with the objective to compare the outcomes for each company of the 9 industries present on the database.

Company	Number of Turbos	Median Overprice	Minimum Overprice	Maximum Overprice
ABB	16	0.94%	-0.12%	3.84%
Richemont	10	1.71%	-0.05%	14.23%
Givaudan	5	1.96%	0.01%	2.24%
Nestlé	15	5.11%	-0.65%	10.05%
Swisscom	6	6.81%	5.17%	12.23%
Zurich Insurance Group	18	-0.53%	-1.73%	0.86%

Table 6. Median overprice of Turbos, by company. *Source: Own estimates.*

Company	Number of BRC	Adjusted			Unadjusted		
		Median Overprice	Min. Overprice	Max. Overprice	Median Overprice	Min. Overprice	Max. Overprice
ABB	12	0.97%	-1.06%	3.80%	1.11%	-0.97%	4.31%
Richemont	11	1.91%	-1.00%	5.35%	2.16%	-0.83%	5.93%
Givaudan	9	2.30%	0.80%	4.54%	3.13%	1.12%	5.51%
Nestlé	8	2.65%	0.84%	3.73%	3.07%	1.14%	4.51%
Roche	19	2.36%	0.64%	5.21%	2.59%	0.79%	5.97%
Swiss Prime Site	3	5.12%	3.92%	6.62%	5.58%	4.06%	7.02%
Swisscom	13	3.14%	0.44%	5.22%	3.60%	0.73%	5.99%
Temenos Group	6	0.32%	-2.56%	3.12%	0.51%	-2.36%	4.50%
Zurich Insurance Group	8	1.99%	-0.13%	4.47%	2.46%	-0.05%	5.36%

Table 7. Median overprice of BRC, by company. Source: Own estimates.

On a general analysis, one can state that, for Turbos, Zurich Insurance Group and ABB are the underlyings with most fairly priced products. On the other hand, products with Nestlé and Swisscom as underlyings are, by far, the most overpriced products. Nevertheless, this conclusion may not be the most reliable due to the lack of representativeness of the company in the database. With regard to BRC, the less overprice case is related with Temenos Group and ABB, being these two underlyings the most promising deals when it comes to price fairness. The most overpriced products are related with Swiss Prime Site (again, not much reliable due to the small sample analysed).

- **ABB**

ABB is the company with more products in the sample, possibly justified by the multiple segments in which it operates, with special regards to Automation and Robotics, two areas with increasing importance and potential that have been attracting a significant number of investors. Following the general trend, also the turbos with ABB as underlying are slightly less overpriced (0.94%) than BRC (0.97%). Nevertheless, when compared to the rest of the companies, ABB appears to be a good investment choice, as both products are below the sample's median overprice of the correspondent product. Additionally, according to the model, some products are in fact underpriced, which can be an excellent investment opportunity for investors with the ability and expertise to identify the products in question. Those results are also supported by the good performance of the company when facing the Covid-19 impacts. As the vast majority of companies were severely affected by this

pandemic, ABB have shown a good resilience and even substantial progress in some segments, as is the case of Electrification and Motion, representing a secure choice, specially in times of uncertainty.

- **Richemont**

Richemont is also one of the companies with greatest number of products in the database. This company is associated with luxury, which can transmit the idea of prestige and secureness. Again, following the general tendency, turbos are less overpriced (1.71%) than BRC (1.91%). However, it is important to remark that turbos with Richemont as underlying are one of the products with higher range between the maximum overpricing and minimum underpricing, showing a substantial volatility in products' prices. Thus, based on the model presented, an investor can buy a turbo severely overpriced (14.23%) or enjoy of an excellent market opportunity and buy a product with underpricing of about -0.05%. This uncommon event can be explained by multiple reasons, most likely a temporarily disproportion of offer and demand or even related with the hedging strategy of financial institutions.

- **Givaudan**

Givaudan's Turbos are slightly above of median overpricing of the sample analysed, with a median overprice of about 1.96%. BRC are slightly more overpriced, being the market price around 2.30% higher than the theoretical price, based on the model in place. This company is highly recognized, with multiple products that are used on a daily basis, which can justify the results obtained. Additionally, given the business the company is inserted, the COVID-19 pandemic was not harmful for Givaudan's results. Instead, the company has shown a significant growth in operational results, particularly in health, personal care, packaged foods and nutraceuticals segments. Additionally, none of the structured products associated to Givaudan were underpriced, being the minimum overprice close to 0 in the case of Turbos and 0.8% regarding BRC (with adjustment). All in all, if an investor is interested in acquiring a structured product with Givaudan as underlying, the optimal option would be Turbos, based on the lowest percentage of overpricing.

- **Nestlé**

It is fair to say that Nestlé is the most known company of the entire sample, as is the largest food company in the world. Considering the business in which the company operates, the current pandemic did not impact the key financial figures of Nestlé, experiencing an increase of about 3% in sales, with no material deterioration in any segment. According to the results obtained, for Nestlé, turbos and BRC overprice is higher when compared to the previous companies analysed. In the case of turbos, they are the second most overpriced products considered in the database, with a median overprice of circa 5.11%, tendency that is also followed by BRC, with an overprice of 2.65% (with adjustment). Hence, this is one of only two cases where the overprice of turbos is higher than the overprice of BRC.

As previously mentioned, the recognition and the globalized activity make this company one of the most traded in financial markets. As such, higher demand for these products can justify a possible higher margin charged by financial institutions.

- **Roche**

Roche, a research-based healthcare company, is only represented by BRC, as there was no Turbos, at the time of the research, issued with Roche as underlying. These products are one of the most overpriced BRC in the sample, with a median overvaluing of 2.36% (with adjustment). The results obtained are in line with the current tendency and situation, as the pharmaceutical business is receiving great attention and funding, in which lays the cure of COVID-19. Hence, an assertive bet on one company of this sector that can possibly become the pioneer in a viable vaccine for the pandemic, can be a great investment opportunity.

- **Swiss Prime Site**

Swiss Prime Site is a Switzerland-based real estate investment company. Probably due to its type of business, it was only possible to analyze 3 products, BRC more exactly. Thus, one considered that this analysis might be considered limited due to the reduced number of products in the database. Although Swiss Prime Site AG dimension, with around 235,000 properties representing a total investment value of 71.2 billion CHF, the products with this underlying are, by far, the most overpriced of the entire sample (5.12%). However, the lack

of products and its low representativeness can (and mostly likely is) the explanation for the result obtained.

- **Swisscom**

Swisscom is one of the most traded company in the Swiss Market. Products with Swisscom as underlying are also very inflated, according to the results obtained. With regards to Turbo Warrants, they are the most overpriced (circa 6.81%), when compared to the same type of products with other companies as underlying. BRC overprice is also above the median result of the sample, with a market price around 3.14% above the theoretical price (value with adjustment).

This company also does not present underprice for any of the products considered, being the minimum overpricing of 0.44% for BRC and 5.17% for Turbo Warrants. The results are supported by the performance of the company during the troubled period the world is facing, with a negative impact only on the roaming segment, but a neutral impact on the general financial results of Swisscom.

- **Temenos Group**

Temenos Group is only represented by BRC, as there were no Turbos issued at the time of the research with thus underlying. The analysis of the products shown a median overpricing of 0.32%, the lowest value of the sample, being the most fairly priced products and, thus, the most viable choice when it comes to investing in BRC. Furthermore, the minimum overprice is actually negative in 2.56%, representing an excellent investment opportunity and, thus, deserving additional attention of potential interested investors.

- **Zurich Insurance Group**

Zurich Insurance Group provides insurance products and services for individual and collective entities. With regard to the structured products linked to this company, BRC overprice is in line with the general tendency, of about 1.99%, which is supported by the high recognition that make this company one of the most traded in the Swiss financial markets. On the other hand, Turbo Warrants are, in median, underprice (-0.53% median overprice).

Thus, those products should be the best alternative for an investor interested in Turbo Warrants.

10.3. Results by Issuer

After the results were analysed through a company’s perspective, it is also important to scrutinize the outcomes of the implemented model by issuer.

Issuer	Number of Turbos	Median Overprice	Minimum Overprice	Maximum Overprice
Bank Vontobel	32	0.92%	-1.73%	10.05%
UBS	38	1.65%	-1.73%	14.23%

Table 8. Median overprice of Turbos, by issuer. Source: Own estimates.

With regard to Turbo Warrants, one can state that the number of products issued by each entity is very close, with Bank Vontobel being the issuer for 32 products and UBS responsible for the issuance of 38 Turbo Warrants. Thus, there is not an absolute dominant position in the market by any of the issuers. However, Bank Vontobel presents a lower median overprice, being a potential better financial institution for investing, especially for investors with few insights regarding structured products’ pricing, as there is a higher chance of the product being more fairly priced since UBS, besides having a higher median overprice, also have a larger range of maximum overprice.

Issuer	Number of BRC	Adjusted			Unadjusted		
		Median Overprice	Min. Overprice	Max. Overprice	Median Overprice	Min. Overprice	Max. Overprice
Bank Julius Baer	27	1.54%	-2.56%	6.62%	1.85%	-2.36%	7.02%
Bank Vontobel	51	1.79%	-0.13%	5.21%	1.97%	-0.05%	5.97%
Leonteq Securities	11	3.01%	0.64%	3.73%	3.38%	0.79%	4.51%

Table 9. Median overprice of BRC, by issuer. Source: Own estimates.

BRC have three main issuers, two of which recording very similar median overprice in the products issued: Bank Julius Baer (1.54%) and Bank Vontobel (1.79%). Although presenting a general lower median overprice than Bank Vontobel, the range of overprice is larger for Bank Julius Baer, meaning that the former should be a safer choice, especially for inexperienced investors. Nevertheless, it is with Bank Julius Baer that the investor could take a bigger advantage of more underpriced products (the same happens for some products of Bank Vontobel, as there are also underprice, but in a smaller scale). Leonteq Securities is the

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issuer with lower representativeness, restricting the power of the analysis. This financial institution is, accordingly to the model, the one that has more overpriced products (the market price is, in median terms, 3.01% higher than the theoretical price), and presenting no underpriced products (minimum overprice is 0.64%). Nevertheless, this issuer presents the lowest value for the maximum overprice.

Conclusion

The present thesis aimed to clarify the price fairness of structured products, namely Barrier Reverse Convertibles and Turbo Warrants in the Swiss market. As a matter of fact, the market of structured products has experienced an exponential growth in the past few years and, clustered with it, came the complexity. This sophistication is the base for potential overpriced products, that survive in the market due to their opaqueness and hidden risk, costs and fees.

Structured products can bring many advantages for investors, as they are tailor-made solutions for any desirable conditions imposed by the client. This type of products can be divided into five main groups, each one with specific features and, thus, that can be more suitable for each investor profile. Nevertheless, numerous studies revealed that, even ignoring all transaction costs, investors typically incur in a financial loss, which is aggravated by the increase in product complexity. Hence, the increasing demand for this type of products failed to be explained by traditional financial theories, as the Modern Portfolio Theory or Efficient Market Portfolio. Based on this gap, it was developed a new area of investigation known as Behavioral Finance, that introduced behavioral biases such as overconfidence and gambling, that can, in fact, be the explanation of investors choices.

Other important question that was explored was if the crescent complexity of financial products is a consequence of the natural course of the market expansion or a issuers' goal. If so, procedures such as omitting significant information, the application of a more technical language to describe the products, hidden information can have the purpose of reducing the wisdom of the investors regarding the pricing and the products' modus operandi, which will allow the prices to be higher than they would be if investors fully understand the features involved in the product.

Nonetheless, this market has become more regulated over the past few years, with the objective to restore the reputation and prestige to financial institutions, creating a safer and trustful banking system. As an example, since 2015, it is mandatory for issuers in Switzerland to disclose the total value charged to cover distribution costs, as other type of fees included in the products' price still remain confidential.

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Based on the price analysis of 89 Barrier Reverse Convertibles and 70 Turbo Warrants on the Swiss market, and using the Black & Scholes (1973) and Merton (1973) model, this thesis clearly illustrates the general overprice of this type of products, in line with previous studies on the same field of research. Considering this database, in general, BRC are substantially more overpriced (circa 2.31% overprice, considering the barrier adjustment applied and 3.47% overprice without the adjustment on the barrier level). With regard to issuers, Bank Vontobel was the financial institution with most fairly priced products related to Turbo Warrants. In the case of Barrier Reverse Convertibles, Bank Julius Baer was the issuer with lowest median overprice of the products considered. Future research is needed to determinate the impact and repercussions of the crisis provoked by the COVID-19 pandemic, as the financial markets are and will be exposed to the economic consequences of this global event. All in all, it was possible to accomplish a practical overview of the structured products' price, contributing to a demystification of this matter, with the main objective to increase investor's knowledge, which is the base for better and more conscious investment decisions.

Bibliography

- **Books and Journal Articles**

- Abreu, M., & Mendes, V. 2018. The investor in structured retail products: Advice driven or gambling oriented?. *Journal of Behavioral and Experimental Finance*, 17: 1–9.
- Agnew, J., & Szykman, L. 2011. Asset Allocation and Information Overload: The Influence of Information Display, Asset Choice and Investor Experience. *SSRN Electronic Journal*, 6(2): 57–70.
- Baker, H. K., & Ricciardi, V. 2014. *Investor Behavior: The Psychology of Financial Planning and Investing* (1st ed.). Wiley.
- Barber, B. M., & Odean, T. 2013. The Behavior of Individual Investors. *Handbook of the Economics of Finance*, vol. 2. Elsevier B.V. <https://doi.org/10.1016/B978-0-44-459406-8.00022-6>.
- Black, F., & Scholes, M. 1973. The Pricing of Options and Corporate Liabilities. *The Journal of Political Economy*, 81(3): 637–654.
- Breuer, W., & Perst, A. 2007. Retail banking and behavioral financial engineering: The case of structured products. *Journal of Banking and Finance*, 31(3): 827–844.
- Broadie, M., Glasserman, P., & Steven, K. 1997. A continuity correction for discrete barrier options. *Mathematical Finance*, 7(4): 325–349.
- Burth, S., Kraus, T., & Wohlwend, H. 2001. The Pricing of Structured Products in the Swiss Market. *The Journal of Derivatives*, 9(2): 30–40.
- Carlin, B. I. 2008. Strategic price complexity in retail financial markets. *Journal of Financial Economics*, 91(3): 278–287.
- Chen, X., Wang, Z., Deng, S., & Fang, Y. 2019. Risk Measure Optimization: Perceived Risk and Overconfidence of Structured Product Investors. *Journal of Industrial and Management Optimization*, 15(3): 1473–1492.
- Döbeli, B., & Vanini, P. 2010. Stated and revealed investment decisions concerning retail structured products. *Journal of Banking and Finance*, 34(6): 1400–1411.
- Entrop, O., McKenzie, M., Wilkens, M., & Winkler, C. 2014. The performance of individual investors in structured financial products. *Review of Quantitative Finance and Accounting*, 46(3): 569–604.
- Eriksson, J. 2006. Explicit pricing formulas for Turbo Warrants. *RISK Magazine*, 1–7.
- Haug, E. G. 2007. *The complete Guide to Option Pricing Formulas* (2nd ed.). McGraw-Hill. <https://doi.org/10.1017/CBO9781107415324.004>.

ARE STRUCTURED PRODUCTS FAIRLY PRICED?

- Henderson, B. J., & Pearson, N. D. 2007. Patterns in the Payoffs of Structured Equity Derivatives. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.972570>.
- Henderson, B. J., & Pearson, N. D. 2011. The dark side of financial innovation: A case study of the pricing of a retail financial product. *Journal of Financial Economics*, 100(2): 227–247.
- Hens, T., & Rieger, M. O. 2014. Can utility optimization explain the demand for structured investment products? *Quantitative Finance*, 14(4): 673–681.
- Hull, J. C. 2018. *Options, Futures, And Other Derivatives*. (D. Battista, Ed.) (9th ed.). Harlow: Pearson Education Limited.
- Hunt, S., Stewart, N., & Zaliauskas, R. 2015. Two plus two makes five? Survey evidence that investors overvalue structured deposits. *Financial Conduct Authority*. <http://www.fca.org.uk/static/documents/occasional-papers/occasional-paper-9.pdf>.
- Kahneman, D., & Tversky, A. 1979. Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47: 263–292.
- Kunz, A. H., Messner, C., & Wallmeier, M. 2017. Investors' risk perceptions of structured financial products with worst-of payout characteristics. *Journal of Behavioral and Experimental Finance*, 15: 66–73.
- Merton, R. 1973. Theory of Rational Option Pricing. *Bell Journal of Economics*, 4(1): 141–183.
- Ricciardi, V., & Simon, H. 2000. What Is Behavioral Finance? *Business, Education and Technology Journal*, (2014). <https://doi.org/10.1002/9780470404324.hof002009>.
- Rubinstein, M., & Reiner, E. 1991. Breaking Down the Barriers. *RISK*, 4(September): 28–35.
- Securities Litigation and Consulting Group, I. 2009. *Structured Products In the Aftermath of Lehman Brothers*, vol. 434.
- Stoimenov, P. A., & Wilkens, S. 2005. Are structured products “fairly” priced? An analysis of the German market for equity-linked instruments. *Journal of Banking and Finance*, 29(12): 2971–2993.
- Taleb, N. 2007. Dynamic Hedging. *Dynamic Hedging: Managing Vanilla and Exotic Options* (7th ed.): 109–120. New York: John Wiley & Sons.
- von Neumann, J., & Morgenstern, O. 1944. *Theory of Games and Economic Behavior*. Princeton.
- Wallmeier, M., & Diethelm, M. 2009. Market pricing of exotic structured products: The case of multi-asset barrier reverse convertibles in Switzerland. *Journal of Derivatives*, 17(2):

59–72.

Wasserfallen, W., & Schenk, C. 1996. Portfolio Insurance for the Small Investor in Switzerland. *The Journal of Derivatives*, 37–43.

Wiggins, R. Z., Piontek, T., & Metrick, A. 2015. The Lehman Brothers Bankruptcy A: Overview. *Yale School of Management*: 1–23.

Wohlwend, H., & Grünbichler, A. 2005. THE VALUATION OF STRUCTURED PRODUCTS : EMPIRICAL FINDINGS FOR THE SWISS MARKET. *Financial Markets and Portfolio Management*, 19(4): 361–380.

Wong, H. Y., & Chan, C. M. 2008. Turbo Warrants under stochastic volatility. *Quantitative Finance*, 8(7): 739–751.

- **Reports**

EUSIPA – European Structured Investment Products Association. 2020. *EUSIPA Market Report on structured investment products*.

FINMA – Swiss Financial Market Supervisory Authority. 2018. *Annual Report 2018*: 1-3.

Greenwich Associates. 2019. *2019 Greenwich Leaders: U.S. Retail Structured Products*.

IOSCO – International Organization of Securities Comissions. 2013. *Regulation of Retail Structured Products*: 4-7.

SFI – Swiss Finance Institute. 2015. *Structured Products: Performance, Costs, and Investments - White Paper*: 26-31. Zurich.

SRP – Structured Retail Products. 2015. *Analysis on Structured Products and Listed Equity Options in Europe: An Industry Overview and Future Prospects*.

SRP – Structured Retail Products. 2019. *Structured Products Market Performance Review South Africa*.

Wu, A., & Pitts, C. 2017. *Asian Structured Products - Research Foundation Briefs*. CFA Institute Research Foundation

- **Websites**

Bloomberg Terminal.

Bloomberg. 2019. *Sure time to grasp the potential of structured products*. Accessed online <https://www.bloomberg.com/professional/blog/sure-time-to-grasp-the-potential-of-structured-products/>, Viewed January 16, 2020.

ESMA – European Securities and Markets Authority. n.d. *Esma.europa.eu*. Accessed online

ARE STRUCTURED PRODUCTS FAIRLY PRICED?

<https://www.esma.europa.eu/>, December 10, 2019.

SIX. 2020. *Structured Products Industry: The Key Players 2020*. Accessed online <https://www.six-group.com/en/newsroom/news/the-swiss-stockexchange/2020/structured-products-industry-key-players-2020.html>, Viewed March 2, 2020.

SSPA – Swiss Structured Products Association. n.d. *Svsp-verband.ch*. Accessed online <https://www.svsp-verband.ch/en/#?r=>, Viewed September 17, 2019.

Appendixes

Appendix A – The Companies

Givaudan (ticker: GVN)

- Industry: Basic Materials
- Activities: Fragrances and Flavors
- Market Cap: 28.0B (CHF)
- Revenues FY2019: 6.0B (CHF)
- Dividend yield: 1.6%
- Number of employees: 10,701

ABB (ticker: ABBN)

- Industry: Industrials
- Activities: Electrification Products, Robotics and Motion, Industrial Automation and Power Grids
- Market Cap: 49.9B (CHF)
- Revenues FY2019: 27.1B (CHF)
- Dividend yield: 3.3%
- Number of employees: 144,400

Nestlé (ticker: NESN)

- Industry: Consumer Staples
- Activities: Nutrition, Health and Wellness
- Market Cap: 301.8B (CHF)
- Revenues FY2019: 89.6B (CHF)
- Dividend yield: 2.5%
- Number of employees: 291,000

Roche (ticker: ROG)

- Industry: Health Care

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- Activities: Diagnostics and Pharmaceuticals
- Market Cap: 268.0B (CHF)
- Revenues FY2019: 59.5B (CHF)
- Dividend yield: 2.9%
- Number of employees: 97,735

Compagnie Financière Richemont SA (ticker: CFR)

- Industry: Consumer Discretionary
- Activities: Jewellery Maisons and Specialist Watchmakers
- Market Cap: 27.7B (CHF)
- Revenues FY2019: 14.2B (CHF)
- Dividend yield: 1.6%
- Number of employees: 36,657

Swisscom (ticker: SCMN)

- Industry: Telecommunications
- Activities: Public telecommunications networks and network application services
- Market Cap: 26.6B (CHF)
- Revenues FY2019: 11.1B (CHF)
- Dividend yield: 4.5%
- Number of employees: 18,984

Zurich Insurance Group AG (ticker: ZURN)

- Industry: Financials
- Activities: Insurance-based financial services
- Market Cap: 59.4B (CHF)
- Revenues FY2019: 66.1B (CHF)
- Dividend yield: 6.5%
- Number of employees: 52,267

Temenos AG (ticker: TEMN)

- Industry: Technology
- Activities: Development, marketing, and sale of banking software system
- Market Cap: 11.2B (CHF)
- Revenues FY2019: 0.9B (CHF)
- Dividend yield: 0.8%
- Number of employees: 7,854

Swiss Prime Site AG (ticker: SPSN)

- Industry: Real Estate
- Activities: Real Estate, Retail and Gastronomy and Assisted Living
- Market Cap: 8.5B (CHF)
- Revenues FY2019: 1.2B (CHF)
- Dividend yield: 4.7%
- Number of employees: 1,482