The Pricing and Liquidity of Turbo certificates

Differences of pricing and liquidity of Turbo certificates across suppliers in the Netherlands

Master Thesis: Financial Economics

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Abstract

This thesis studies the pricing and liquidity of Turbo certificates and whether there are differences amongst different suppliers in the Netherlands. Tick data was used on a number of different products from three suppliers: ING, BNP Paribas and Goldman Sachs. First it was found that Turbo pricing is not fair, issuers charge a significantly higher premium than what they report. Second the premium is positively correlated with the leverage factor and third it was found that there are significant differences between suppliers regarding the charged premium. For the liquidity part it was found that the liquidity in opening and closing hours of the market it higher than in the other hours and that there is no difference in liquidity on days which were classified as volatile. There are also significant differences in liquidity amongst suppliers. Lastly, the same tests were conducted on the bid-ask spread and there were significant differences in that regard as well.

Keywords: Pricing, Premium, Liquidity, Bid-ask spread, Turbo, supplier

Preface

In the summer of 2015, I was an intern at the Special Client Desk for Van Lanschot Bankiers. This department of the bank provides private clients advice regarding investments in the stock market. Certain clients like to invest using turbo certificates and recently there had been a change on the supply side of turbo certificates. In September 2014, all supply from the Royal Bank of Scotland had shifted to BNP Paribas (BNP Paribas, 2015). Also recently, Goldman Sachs had taken over all activities regarding leveraged products from ABN Amro. This includes the supply of the products, marketing and market making. In the past, Goldman Sachs acted as liquidity supplier for ABN Amro's leverage products, this has remained the same (Goldman Sachs, 2015). These events caused the supply side of leveraged products to have narrowed down and therefore Van Lanschot Bankiers had asked me to gain insight in the pricing of turbo certificates and in the possible differences between suppliers. This was the inspiration to writing this thesis.

The Pricing and Liquidity of Turbo certificates

1. Introduction

In the period between 2009 and 2012, Dutch institutional investors saw their total assets grow with 29,3% whereas the total amount of invested capital in financial derivatives grew with an astonishing 509,8% (Centraal Bureau voor de Statistiek, 2015). From a total of €1.953 billion invested in 2012, €68,9 billion was invested in financial derivatives, which amounts to a proportion of 3,53%. Financial derivatives are most popular amongst pension funds (who make up for the largest part of the institutional investors in the Netherlands) where the total amount of invested capital was €978,8 billion and the amount of capital which was invested in financial derivatives was €53,6 billion, which amounts to 5,48% (Centraal Bureau voor de Statistiek, 2015).It is clear that financial derivatives have grown in popularity tremendously since 2009.

In the past eight years, the financial market has seen a couple of very volatile[1] periods, with a peak of 81,22 EUR on the 17th of October 2008, as can be seen in Figure 1 below. After the global financial crisis volatility levels shrunk down to between 10 EUR and 15 EUR from 2013 onwards but since December 2014 the average daily volatility has seen an increase to about 20 EUR, with a periodical peak of 33,96 EUR on the 13th of June 2016.

[1]Volatility = A measure for price variation of financial products over time, measured as variance of the index

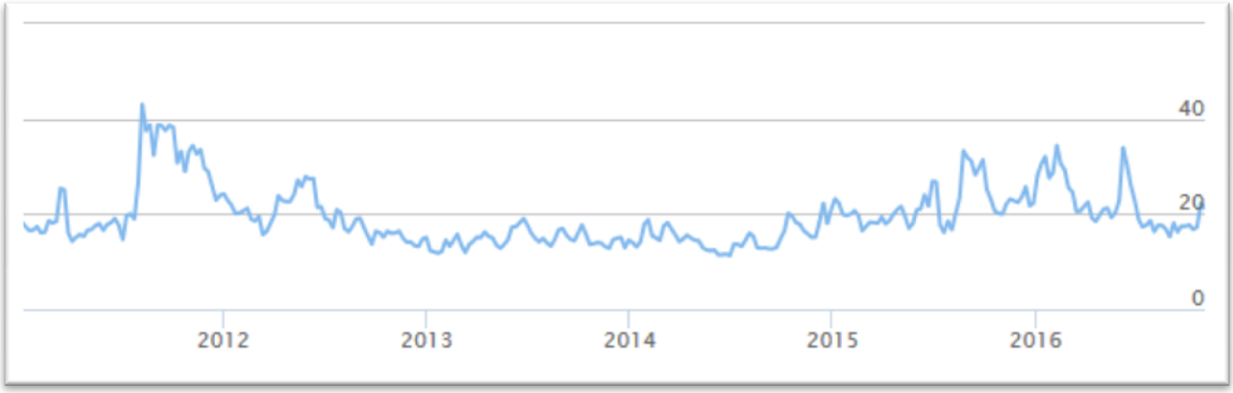

Figure 1: Volatility of the AEX-index between 2007 and 2015 (IEX, 2016)

Another example can be given by looking at the volatility of the Chinese Shanghai Stock Exchange. In April 2015, the Shanghai Stock Exchange had risen by almost 90% since December 2013 (Stallinga, 2015). Analysts compared the index with the Nasdaq in 2000 just before the infamous Internet Bubble (Kamp, 2015). This comparison became reality in July 2015 when the index quickly crashed with a negative return of about 30%. Volatility levels increased dramatically, to about 70%[2], as can be seen in the figure below.

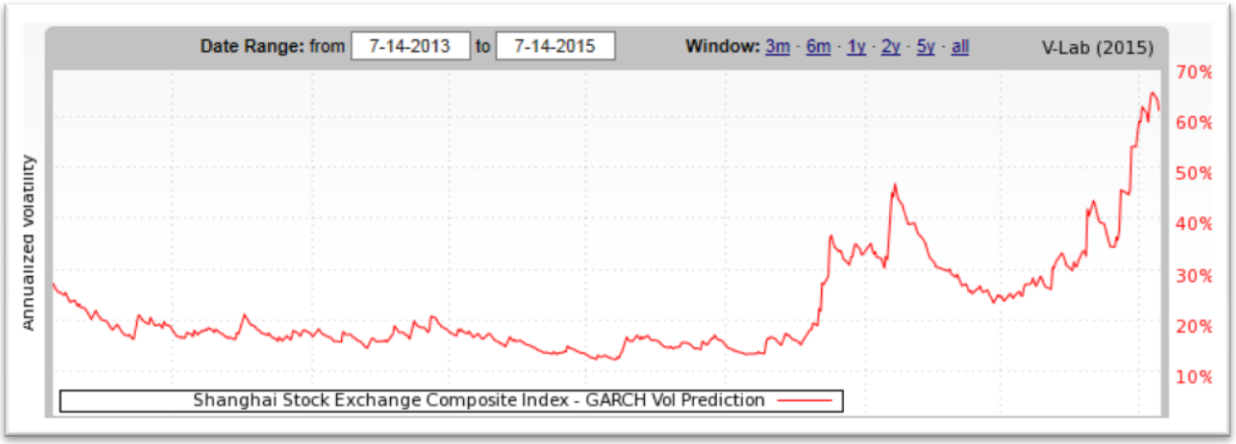

Figure 2: Volatility of the Shanghai Index between July 2014 and July 2015 (V-Lab, 2015)

These market fluctuations in both directions offer opportunities for investors to profit from this. A good way to do so is by means of a so-called Turbo certificate. This financial product magnifies the movements of the underlying asset by a certain factor. A

[2]Measured as a GARCH Volatility Prediction

turbo can be a very lucrative investment, but it also comes with high risk since the movements are being magnified in both positive and negative directions and there is a chance of losing all invested capital, depending on the chosen leveraged product.

The aim of this research is firstly to gain insight into the theory behind leveraged products, especially turbo certificates. This includes the working of the product, how the product is priced and which value drivers affect the price as well as the liquidity. The second aim is to investigate whether there are differences in pricing and liquidity between the various suppliers.

This leads to the following research question:

Are there differences in the pricing and liquidity of Turbo certificates across different suppliers?

The research question will be answered with the help of the following hypotheses:

- Turbo Pricing is fair
- The premium charged for Turbo certificates is positively correlated with the leverage factor
- There is no difference in Turbo pricing between different suppliers
- Liquidity is lower in the opening and closing hours of the day
- Liquidity is different on volatile days
- There is no difference in Turbo liquidity between different suppliers

The thesis will offer a significant contribution in both an academic and practical sense. At the time of writing this thesis there is no literature available which combines turbo certificates with liquidity, much less a comparison between different suppliers. This is where

the relevance is for practical reasons, it is valuable to know which suppliers offer Turbo certificates with higher or lower liquidity so traders can add this to their existing pool of knowledge in order to make better decisions.

The outline of this research is as follows. The introduction contains an overview and the outline of the paper. Section 2 will feature a literate review on leveraged products and liquidity. Section 3 will contain a detailed description of the available leveraged products and Section 4 will explain the pricing mechanism behind turbo certificates. Section 5 will provide an in depth research of liquidity. This includes the basics behind liquidity, a description of different types of risk specifically related to liquidity and an overview of literature regarding measures for liquidity. Section 6 will describe the data and methodology and the results will be presented in section 7. The paper will be concluded in section 8 and section 9 will cover the limitations and suggestions for further study. Section 10 features the bibliography.

2. Literature Overview

Already in 1996, Wasserfallen and Schenk described the use of (then) new structured products in the Swiss equity market for small private investors who want to participate in a rising stock market but cannot afford to take a large downside risk. Swiss banks offered securities in the form of a combination of call options of the Swiss stock market and riskless investments which offered the invested a minimum return plus a participation in the Swiss stock market. Soltes and Soltes (2008) conducted a research on products which investors can use to benefit from in down markets. They pay significant attention to Short Turbo certificates and they show with examples on the DAX Index and Brent Crude Oil that Short Turbo certificates can yield extraordinary returns. This article offers a description of the instrument and its trading mechanisms. Soltes, V. and Rusnakova (2012) study Long Combo strategies using barrier options and their application in hedging strategies. They create a hedging portfolio using one risky asset and barrier options. They find that hedging using Long Combo strategies expand hedging possibilities in different directions and they state that the advantage of hedging against a price drop using the Long Combo strategy with the barrier options is the possibility of its formation at zero initial costs.

Burth, Kraus and Wohlwend (2001) investigate the pricing of structured products in the Swiss equity market. They find evidence which shows a significant bias in favor of the issuing institutions, just like Wilkens, Erner and Röder (2003). They did this by replicating the Turbo certificates as closely as they could by selecting options with comparable properties. Furthermore they distinguish between non-coupon and coupon products and they find that products with a fixed coupon are being traded at a premium and they suggest that this might be because it is being perceived as a bond. Finally they investigate the role of so called ‘co-lead-managers’ which are smaller banks that initiate the launch of a new product.

Products issued by the latter are better priced and show a smaller dispersion of pricing errors. In 2005, Stoimenov and Wilkens find that on the German equity market, banks charge large explicit premiums in the primary market. This is confirmed by Entrop et al. (2009) who find that the price-setting formula of open-end leverage products strongly favor issuers. They also find that issuers can easily hedge these certificates with a semi-static superhedge using spot market instruments. When they sell the product at the Spot price minus the strike price, they can hedge their position by acquiring the underlying asset for the spot price and issue a short term debt for the strike price. This sounds like a good arbitrage opportunity, but it requires financing which is much easier to acquire for banks than for individual investors. Baule et al. (2008) further elaborate on their earlier research. This paper has four important results. First they find that leverage certificates are overpriced. Second they find that the Life Cycle Hypothesis[3] (Stoimenov & Wilkens, 2005) does not only hold for long-term investment certificates but also for short-term investment certificates. Third they find that issuers increase prices in the later trading hours and last they find that issuers' pricing policy is consistent with the customer-driven order flow and the overnight gap risk issuers face. In relation to this, Henderson and Pearson (2011) analyze the pricing of SPARQS[4] which they classify as the most popular listed structured equity product at the time of writing. They find evidence which is consistent with their hypothesis that issuers design and price financial structured products to exploit investors' valuation errors. Further elaborating on investor's valuation errors, Ofir and Wiener (2006) investigate structured products in relation to behavioral biases. They demonstrate that investors tend

[3]Life Cycle Hypothesis = Systematically increasing profits for issuers of the product's lifetime (Entrop et al, 2009)

[4]SPAROQS = Stock Participation Accreting Redemption Quarterly-pay Securities

to be affected by loss aversion[5], the disposition effect[6], herd behavior[7], the ostrich effect[8] and the hindsight bias[9].

Rossetto and van Bommel (2009) conduct a research on OLC's[10]. They use a different terminology than the previously discussed literature where they classify a Turbo as a leveraged product with a pre-determined lifetime (whereas Turbo certificates do not) and they classify an endless leverage certificate as the 'Turbo successor'. They find that issuers face the gap risk in hedging their positions and they document an average mispricing of less than one per cent and that many investors exercise too late. They find that average bid-ask spreads are much smaller than on other derivatives and last but not least they find, with the use of an intraday study on stop-loss terminations and after stop-loss events, the average trading activity increases but the price does not change significantly.

Muck (2006) studies the pricing of exchange traded Turbo certificates and OTC-retail derivatives. He concludes that OTC-derivatives are imperfectly priced due to imperfect competition and limits to arbitrage. His second hypothesis concerned the life-cycle hypothesis (Stoimenov & Wilkens, 2005) and concludes that evidence for this concerning Turbo certificates is weak. He assumes this indicates the existence of additional relevant factors other than the position in the product's life cycle driving issuer's pricing policy for derivatives. Muck (2007) also analyzed the pricing of Turbo certificates in the presence of

[5]Loss aversion = People's tendency to strongly prefer avoiding losses to acquiring gains (Kahneman & Tversky, 1979)
[6]Disposition effect = Investors tend to hold on to their losing assets for too long and sell their winning assets too early (Kahneman & Tversky, 1979)
[7]Herd behavior = Also known as the crowd effect, where agents imitate each other's behavior (Bak et al, 1996)
[8]Ostrich effect = The avoidance of apparently risky financial situations by pretending they do not exist (Galai & Sade, 2006)
[9]Hindsight bias = To see an event as it could have been predicted after it has occurred (Kahneman & Tversky, 1979)
[10]OLC = Open-ended (Endless) Leverage Certificate

stochastic volatility, interest rates and jumps. He found that jump risks have a significant pricing impact. Banks who apply a semi-static hedge with forward contracts face a gap risk.

Baule and Tallau (2011) study the pricing of bonus certificates, which is not equal to Turbo's, they do however fall in the same product category which is why their research is relevant for this study. They explicitly analyze the issuers' profit margins and find that they are relatively large. They vary between 1,98% and 3,50% across the different issuers. They find that margins decrease during the products' lifetime as well as a decreasing function of the moneyness[11]. During the stock market fall in 2008 the average moneyness decreased with it. Average margins then rose from 1%-2% in 2007 to 3%-5% in 2008.

Paik (2013) wrote an extensive thesis about valuation, empirical analysis and optimal exercise of open-end turbo certificates on the German market. His study yields four important results. First he states that an increase in the financing parameter lowers the optimal exercise threshold. Issuers charge financing costs for their products (typically around 2 per cent) and when an investor holds their Turbo certificate for a long time, these costs can chip away a part of the profit (or can make a loss greater) this implies that investors should sell their positions faster. Second, increasing the gap size lowers the optimal exercise threshold as well. Larger caps provide more protection against gap risk for issuers and therefore it is bad for investors. Third, increasing jump intensity raises the optimal exercise threshold. Jumps occur more often and then particularly beneficial jumps for the investor are rendered more likely. Last but not least, increasing the expected downward jump size also causes an increase in the optimal exercise threshold. Then on average jumps reach further downward which makes the situation more beneficial for the

[11]Moneyness = A description of a derivative relating its strike price to the price of its underlying asset (Investopedia, 2015)

investor which in its turn implies that they need to hold on to their Turbo for a longer period of time.

2.1 Liquidity Literature

Yakov Amihud and Haim Mendelson have written a number of different articles concerning liquidity and stock returns. In 1985, Amihud and Mendelsen used the bid-ask spread as a measure for liquidity. This states that investors require a higher expected return if the bid-ask spread is higher to compensate for the higher trading costs. Their evidence states that the spread has a highly significant positive effect on stock returns. The monthly excess return of a stock with a 1,5% spread was 0,45% greater than that of a stock with a 0,5% spread. The higher the spread however, the smaller this effect turned out to be. They also test their results against the Fama and French three factor model and find the factors of this model to be insignificant, whereas the liquidity factor was not insignificant. In contrary to this, Eleswarapu and Reigganum (1993) find a significant size effect even after controlling for spreads and also find that the influence of the bid-ask spreads are not reliably distinguished from zero except in January months where it is significantly positive. Amihud and Mendelson further confirm the liquidity effect in asset pricing in 1991 where they test the effect on Treasury notes and bills.

Amihud and Mendelson (1991) extend their own previous research with respect to investment horizon and portfolio managers. They state that portfolio managers should not only consider the client's risk aversion but also the investment horizon. A short horizon should feature highly liquid assets whereas a long horizon enables the investor to invest in low liquid assets, thus earning higher returns. Public authorities should devise rules that increase liquidity of assets and they should avoid laws and regulations which hurt the

liquidity of assets and capital markets. Amihud and Mendelson also distinguish the different components of the costs of illiquidity.

In 2000, Amihud used a new illiquidity measure. This measure is the average daily ratio of absolute stock return to dollar volume. He concludes that illiquidity has a stronger relationship with small firm stocks, which could be a partial explanation for the changes in the 'small firm effect' over time. He suggests the existence of an illiquidity premium which helps explaining the well-known equity premium puzzle[12].

Pastor and Stambaugh (2001) construct a liquidity measure and relate this to stock performance. Their measure is an OLS-regression with a constant, a stock return factor, a difference between the stock and market return factor, and a Dollar volume factor. They conclude that market-wide liquidity is a variable which is important for pricing common stocks. Stocks which are more sensitive to aggregate liquidity have significantly higher expected returns even after correcting for exposures to market return, size, value and momentum factors. According to their measure, smaller stocks are less liquid and the smallest stocks have high sensitivities to aggregate liquidity.

Huang (2003) studies an equilibrium in which agents face surprise liquidity shocks and invest in liquid and illiquid riskless assets. He concludes that illiquidity can have large effects on asset returns when agents face liquidity shocks and borrowing constraints. He claims that this result can help understand why some securities have high liquidity premia despite having low turnover frequencies.

[12]Equity Premium Puzzle = The phenomenon that observed returns on stocks over the past century are much higher than returns on government bonds (Mehra & Prescott, 1985).

3. Description of a Turbo certificate

Turbo certificates are derivative investment products which track the underlying asset in a linear way. The amount needed to invest in a Turbo certificate in comparison to tracking the underlying asset is considerably less because a large proportion of the certificate is financed by the issuer. This creates a leverage effect which allows the Turbo certificate to generate a higher percentage gain or loss than the underlying asset. Turbo certificates allow for an investor to speculate on either a price increase or a price decrease in the form of a Turbo Long and a Turbo Short. They can also be used to hedge existing portfolios (ABM Amro, 2015).

3.1 Structure

Turbo certificates have become a well-known product in the financial world and its popularity has grown rapidly in the past (Muck, 2007). The Turbo certificate is popular mainly because of its high profit potential, transparent pricing and good liquidity. There is also a broad choice of the different products. A Turbo comes with the risk of losing the biggest part (or even everything) of the initial investment. This is why trading with Turbo certificates is only suited for very experienced and active investors who understand and accept the risks that come with it.

3.2 Leverage Factor

The aspect that makes a Turbo certificate attractive and appealing is the leverage factor. This factor allows the Turbo certificate to change in value (both positive and negative) faster than its underlying asset. The leverage factor tells the investor how much faster the Turbo certificate will react to price movements of the underlying asset. The higher the leverage factor, the faster the Turbo will move in price. When choosing to invest in a Turbo certificate, an investor has a choice between Turbo certificates on the same

underlying asset with different leverage factors. For example, a Turbo Long with a leverage factor of 5 will increase in price with 5% if its underlying asset increases in price with 1%. In the same way, a Turbo Short with a leverage factor of 5 will increase in price with 5% if its underlying asset decreases in price with 1%. The leverage factor can be calculated with the help of the following formulas (Kwakman, 2009):

$$Leverage\ factor\ of\ a\ Turbo\ Long = \frac{\text{Value of underlying asset}}{(\text{Value of underlying asset} - \text{financing level})}$$

$$Leverage\ factor\ of\ a\ Turbo\ Short = \frac{\text{Value of underlying asset}}{(\text{Financing level} - \text{value of underlying asset})}$$

An example: let us assume we have a Turbo Long on the AEX index which has a current value of 498 and the Turbo Long has a financing level[13] of 250. The leverage factor is then $\frac{500}{(500-250)} = 2$. It can be seen that a higher financing level (all else equal) leads to a higher leverage factor and vice versa for a Turbo Short.

3.3 Stop-Loss level

Every Turbo has a certain stop-loss level, also referred to as the barrier. The barrier functions as follows; when the value of the underlying asset goes through the barrier, the Turbo is terminated. For a Turbo Long the barrier is set below the value of the underlying asset, for a Turbo Short the barrier is set above the value of the underlying asset. The investor then receives a small part of the investment in return, or nothing at all, depending on the financing level. The barrier is best to be further clarified with an example. We use the same Turbo Long as mentioned above on the AEX index. The barrier is set at 480 and the financing level remains 250. The value of the AEX now falls to 475. The Turbo Long is terminated and the investor receives the difference between the barrier and the financing

[13]Financing level = The proportion of the underlying asset that is being financed by the issuer of the Turbo certificate

level. Some Turbo products have a barrier set equal to the financing level to create a higher leverage factor, in which case the investor receives nothing of the initial investment when the product is terminated.

$$Amount\ of\ money\ returned\ to\ the\ investor = |\text{financing level} - \text{barrier}|$$

The lifetime of a Turbo certificate is potentially perpetual, as long as the value of the underlying asset remains above the barrier price. This can be expressed in the following formula (Paik, 2013):

$$\tau = \inf\{t: Lt < St\}$$

Where τ denotes the first passage time, *St* is the value of the underlying asset and *Lt* is the barrier price.

3.3.1 Other Barrier options

A Turbo certificate is a form of a knock-out option (Down-and-out); an option which ceases to exist when a barrier is reached and that barrier is set lower than the initial strike price. There are also knock-out options when the option in terminated if a barrier is reached that is set *higher* than the initial strike price (Up-and-out). In this case the lifetime is only perpetual when the value of the underlying asset remains *under* that barrier.

In contradiction to knock-out barrier options, there are also knock-in barrier options. There options only come into existence when a barrier is reached. This barrier can be set below (Down-and-in) or above (Up-and-in) the initial strike price (Hull, 1989).

3.4 Risk

As mentioned above, Turbo certificates and similar products are very risky. There is a significant chance that the investor loses part of the initial investment or even everything. Turbo certificates should only be traded by investors who are experienced and have enough

knowledge to fully understand the workings of the product. The investor should also accept the risk and should own enough capital to be able to incur a possible big loss. An investor faces different types of risks when investing in a turbo, which are described below.

3.4.1 Market Risk

Market risk involves the risk of making a financial loss due to movements in the market price. Market risk involves the sensitivity of the underlying asset to exchange rates, foreign exchange rates, commodity prices, equity prices, managerial skills and exposure from trading and foreign operations (Federal Reserve, 2015). This is closely related to **Stock Price risk**, which is the risk of a change in the value of the underlying asset. Market and Stock Price risk are the same when the underlying asset is a proxy for the market, like the AEX index.

3.4.3 Stop-loss Risk

The stop-loss risk is the risk that the value of the underlying asset reaches the barrier, in which case the Turbo is being terminated. This results in a big loss for the investor and the stop-loss risk is the biggest risk the investor faces (BNP Paribas, 2015).

3.4.4 Leverage Factor Risk

The leverage factor magnifies the Stock Price risk to a degree equal to the leverage factor. The Stock Price, in its turn, also influences the leverage factor as described in section 3.2. Small changes in the stock price of the underlying asset can have a significant effect on the price of the Turbo, both positive and negative. The formula is section 3.2 illustrates that when the value of the underlying asset increases in relation to the financing level, the leverage factor increases too and when the value of the underlying asset decreases, so does the leverage factor. Furthermore, the higher the leverage factor, the more likely it is to reach the stop-loss barrier (BNP Paribas, 2015).

3.4.5 Exchange Rate Risk

If the underlying value is noted in a different currency, the investor also faces exchange rate risk. An appreciation of the foreign currency would have a positive effect on the value of the Turbo and a depreciation of the foreign currency would have a negative effect on the value of the Turbo (BNP Paribas, 2015).

3.4.6 Interest Rate Risk

An investor needs to pay financing costs over the financing level. This will be more thoroughly described in Section 4.3 but in short, most banks apply a standard fee plus the Overnight LIBOR interest rate. So when the interest rate increases or decreases, so does the price of the Turbo (SEC, 2015).

3.4.7 Credit risk

The last type of risk is credit risk, also known as counterparty risk. Since the biggest part of the Turbo certificate is financed by the instance which owns the products, a default of that instance could result in a loss for the investor. According to Global Association of Risk Professionals (2015), credit risk can be defined as: “The potential for loss due to failure of a borrower to meet its contractual obligation to repay a debt in accordance with the agreed terms”. This risk turned out to be quite significant with the collapse of the American bank Lehman Brothers.

3.4.8 Gap Risk

This specific kind of risk is for the issuers. They can semi-statically hedge their position by buying or selling the underlying asset (Tankov, 2008). Gap risk implies that the underlying asset moves through both the financing level and the stop-loss level in one swift motion. When the price of an underlying asset goes through the stop loss, the Turbo is terminated and the issuer sells the underlying asset. When the value of the underlying asset goes through both the financing level and the stop loss (possibly because these two values

are very close together to create a higher leverage factor), there is a realistic chance that the value of the underlying asset lies below the financing level, therefore the issuer makes a loss when it sells the underlying asset. This can happen overnight but also during regular trading hours (BNP Paribas, 2015).

3.5 Payoff

With the knowledge of the abovementioned characteristics of a Turbo product it is possible to construct a payoff diagram. The payoff (g) diagram of a Turbo Long is as follows:

$$g\ (S,t) = \begin{cases} \max(St - Kt), St > Lt \\ Rt \end{cases}$$

Where *St* is the value of the underlying asset, *Kt* is the strike price, Lt is the barrier and *Rt* is the rest value.

It can be seen that for a Turbo Long, whenever the value of the underlying asset (*St*) is above the barrier (*Lt*), the payoff for the investor is equal to the value of the underlying asset (*St*) minus the strike price of the product (*Kt*). Otherwise the payoff is equal to the rest value (*Rt*) of the product. An illustrated payout diagram for a Turbo Long can be seen below. It shows that the profit is in theory endless, as long as the value of the underlying assets keeps increasing. It also shows that when the price of the underlying asset reaches the barrier, the Turbo certificate is terminated and the loss is fixed. The financing level would be anywhere from zero up to and until the value of the barrier.

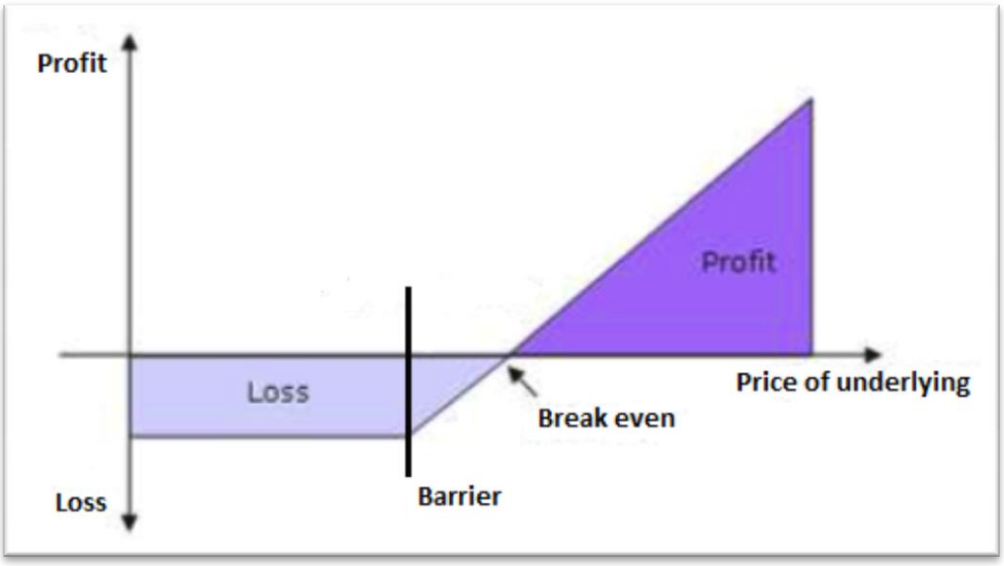

Figure 3: The payoff diagram of a Turbo long

The payoff (h) diagram of a Turbo Short looks like this:

$$h\,(S,t) = \begin{cases} Rt \\ \max(Kt - St), St < Lt \end{cases}$$

For a Turbo Short, whenever the value of the underlying asset (*St*) is below the barrier (*Lt*), the payoff for the investor is equal to strike price of the product (*Kt*) minus the value of the underlying asset (*St*). Otherwise the payoff is equal to the rest value (*Rt*) of the product.

3.6 Costs

Aside from the value drivers, buying a Turbo comes with a variety of different costs.

3.6.1 Financing

The first type of costs is a very obvious one; the financing costs. The concept of the costs will be more thoroughly discussed in Section 4.3 but the essence is that the investor pays a certain amount of money to maintain the financing level. This amount is not universally set and can be determined by the banks themselves.

3.6.2 Bid-Ask Spread

Dealers and market makers quote bid and ask prices and public traders enter orders with limit prices at which they are willing to buy or sell securities. The best price on the sell side (ask) is always higher than the best price on the buy side (bid). The difference is the bid-ask spread. This is a cost for the investor since the investor buys at the ask price and sells at the bid price. As with every traded product, Turbo certificates have a bid-ask spread. This varies a little across different products but usually it is very small like one or two cents. However, since Turbo prices are usually relatively low (due to the financing level structure), a seemingly small bid-ask spread can actually have a significant effect on the price. For example, for a product with a price of €1,00 and a bid-ask spread of only €0,02, there already is a price difference of 2 per cent. The bid-ask spread is a way for issuers to make money, they profit twice, from the buying of the product and from the selling of the product.

3.6.3 Provision and other bank or broker costs

Besides financing costs and the bid-ask spread, buying a product always comes with extra costs. This can be in the form of transaction costs, provision and bank or broker costs. Especially when buying small amounts, one should always take into account the transaction costs since this can be a variable amount or a combination between a fixed and variable amount.

Direct transaction costs include brokerage commissions, exchange fees and transaction taxes. Brokerage commissions are usually higher for stocks than for bonds (Amihud and Mendelson, 1991), exchange fees are different across exchanges and is usually a very small part of the total transaction. Amihud and Mendelson (1991) state that this is between 0,1% and 0,5%. This still holds in 2016 where for example at Binck Bank, a broker

in the Netherlands), transaction costs amount to a fixed starting amount plus 0,10-0,15% of the transaction (Binck Bank, 2016). In 2011, nine members of the European Union proposed enhanced corporation of financial transaction tax with the aim to 'improve functioning in financial markets'. The Netherlands did not partake in this proposal (European Commission, 2012).

3.7 Additional Products

A Turbo or Sprinter is not the most risky leveraged product. Most banks who offer Turbo's or Sprinters also offer products called Turbo BEST, Sprinter BEST or Traders. The term BEST stands for 'Barrier equals Strike'. These products have their barrier set equal to their financing level. This causes the products to have a much higher leverage factor but it also comes with a big risk increase. Firstly, since the leverage factor is higher, the volatility of the product is even higher than a regular Turbo or Sprinter. Secondly, since the barrier is equal to the financing level, once the price of the underlying value moves through the barrier, the investor loses all of the invested capital, instead of only part of their capital which is the case with a regular Turbo or Sprinter.

3.8 Comparison with Options

In a sense, a Turbo is a modified call option. An argument can be made that a Turbo Is actually cheaper than a regular call option that pays no dividends (Wong & Chan, 2008). When looking at the structure of the payoff of a Turbo certificate, the negative spectrum resembles a Down-and-out Call Option (DOC). This is a type of option that is terminated when a barrier is hit. These kind of options are cheaper than regular call options because of the added risk of a barrier (Wong & Chan, 2008). The positive spectrum of the Turbo certificate payoff is similar to a regular call option with an infinite lifetime. A Turbo is thus a

combination of a Down-and-out Call Option and a regular Call Option with an added leverage factor.

4. Pricing of a Turbo Certificate

A major advantage of Turbo certificates is that the pricing is very transparent and quite simple. The formula consists of a few important variables which were taken directly from ABN Amro (2015), BNP Paribas (2015) and Goldman Sachs (2015). They will be described below.

4.1 Value of the underlying asset

Perhaps the most important factor which determines the price is quite obvious; the value of the underlying asset. The risk associated with this variable is described in section 3.4.2 which is the market risk. The value of the underlying asset is equal to the spot price of the asset on which the Turbo certificate is bought.

4.2 Financing level

The financing level is also a major variable which determines the price. As shown in section 3.2, the financing level is a driving factor to determine the leverage factor and the financing level is a major price driver as well. For a Turbo Long holds; the higher the financing level (andthus a higher risk), the lower the price. The opposite is the case for a Turbo Short; the higher the financing level (this a lower risk), the higher the price of the Turbo Short.

4.3 Financing costs

The financing level is not provided for free and this part is where the issuers get their share of the money; the financing costs. The financing costs is set as the percentage which the investors pays to maintain the financing level. These costs are directly incorporated into the price of the Turbo. For example, let us assume the financing level of a certain Turbo Long is equal to 500, and the financing costs are equal to a 2% annual interest rate. The new value a day later will then be $500x0.02^{\left(\frac{1}{365}\right)} = 500{,}027$. Thus the daily increase for this

example is 2,7 cents. For a Turbo Short, the investor receives financing costs if the interest rate exceeds the premium the issuer charges, increasing the value of the Turbo Short over time. The financing costs for investors are negligible if they trade with Turbo certificates on a short time horizon. For issuers however, these financing costs are a way to influence the price and to make money on these certificates. Issuers charge a premium on top of the actual interest rate which results in a strong favor in the pricing for issuers, this has already been discussed in the literature section and will be further addressed in the results.

4.4 Ratio

Depending on the size of the value of the underlying asset, issuers apply a ratio to certain Turbo certificates. A few examples can be seen in table 1 below. To clarify this table, an investor who buys a Turbo on the AEX, invests in $\frac{1}{10}$ of the underlying asset, the AEX index. An investor, who buys a Turbo on the EUR/USD, invests in $\frac{1}{0.01}$ of the underlying asset, thus in 100 times the EUR/USD exchange rate.

Table 1

Turbo certificate ratios on a selection of financial products (ABM Amro, 2015)

Ratio	Underlying Asset
0.01	EUR/USD
0.01	EUR/GBP
1	Brent Oil
1	Philips
10	AEX Index
10	Google
100	Dow Jones Index

4.5 Exchange rate

For Turbo certificates with an underlying asset which is noted in a different currency than the price of the Turbo certificate, the exchange rate is a price driver. This also comes with interest risk as described in Section 3.4.6.

All abovementioned value drivers form the formula to calculate the value of a Turbo Long and/or Short (BNP Paribas, 2015). This formula can be seen below.

$$Intrinsic\ Value\ Turbo\ Long = \frac{Value\ of\ the\ underlying\ asset - financing\ level}{ratio * exchange\ rate}$$

$$Intrinsic\ Value\ Turbo\ Short = \frac{Financing\ level - value\ of\ the\ underlying\ asset}{ratio * exchange\ rate}$$

From the formula we can see that for a Turbo Long, there is a positive correlation between the intrinsic value (price) and the value of the underlying asset. There is a negative correlation between the intrinsic value and the financing level, ratio and the exchange rate. This is the other way around for a Turbo Short where there is a negative correlation between the intrinsic value and the value of the underlying asset, ratio and the exchange rate. There is a positive correlation between the intrinsic value and the financing level.

4.6 Differences between suppliers

The only way in which there can be a difference in pricing across suppliers (in theory) is a difference in the financing costs. Some suppliers state exactly the interest rate they charge, for example ABN Amro charges a fixed premium of 2% plus the overnight LIBOR[14] rate. ING does not specify their financing costs, but on average the charge around 2%, this is also the case for BNP Paribas. The exact premiums which are being charged by the suppliers is being calculated later in this thesis.

[14]LIBOR (London Interbank Offered Rate) = The average interest rate which a selection of London banks charge each other for loans.

5. Liquidity

As seen in the literature overview, liquidity in an important factor concerning prices of assets. This section will first describe the different costs of low liquidity and secondly this section will go over the different volatility measures as described in the literature.

5.1 Costs of low liquidity

The illiquidity of an asset brings several types of costs with it. These types of costs were distinguished by Amihud and Mendelson (1991) and are listed below.

5.1.1 Bid-Ask Spread

Dealers and market makers quote bid and ask prices and public traders enter orders with limit prices at which they are willing to buy or sell securities. The best price on the sell side (ask) is always higher than the best price on the buy side (bid). The difference is the bid-ask spread. This is a cost for the investor since the investor buys at the ask price and sells at the bid price. Illiquid stocks have higher bid-ask spreads than liquid stocks, this spread can amount to between 5 and 10 per cent of the asset's value (Amihud & Mendelson, 1991). It is important to note that such a high bid-ask spread, percentage wise, is only applicable to small assets. Large assets with a price of 100 Euros for example, will never have a bid-ask spread of 5 Euros, whereas a small asset with a price of 1 Euro could very well have a bid-ask spread of 5 cents.

5.1.2 Market Impact Costs

These are the costs that an investor incurs when trading with large quantities. Illiquid stocks do not have many offers against the lowest ask price, so when an investor places a large order, he or she has to buy part of the order against the next lowest ask price (which is higher than the first lowest ask price). The investor thus pays a premium for large orders on illiquid stocks. As an example, it is estimated that market impact costs for small stocks will be double or triple the costs compared to large (more liquid) stocks (Bodurtha & Quinn,

1990). This is closely related to market depth, which is the ability of the market to process large orders (Goldstein & Kavajecz, 2000). In other words, this is the amount that can be bought at the same bid-ask spread (Hachmeister, 2007).

5.1.3 Delay and Search Costs

Delay and search costs are incurred when a trader delays the execution of a transaction hoping to get better trading terms. These costs include the costs of contacting potential trading partners and the risk borne by the investor while doing this. The investor this has the choice between doing the transaction immediately (facing bid-ask spread and market impact costs) or waiting for a better price.

5.2 Other Factors of Liquidity

There are several other market factors which define liquidity. Market breadth measures the number of stocks which are increasing in price and the number of stocks which are decreasing in price. Analysts look at the number of stocks which have realized a 52 week high and the number which have realized a 52 week low. This provides long term information about whether the market is in a positive or a negative trend (Kirkpatrick & Dahlquist, 2010). Another factor is market resilience, which is defined by Hachmeister (2007) as the speed in which prices revert back to their original value after a large order.

5.3 Measures of Liquidity

Amihud (2000)

Amihud introduced the commonly accepted liquidity measure for stocks. He describes the formula for the illiquidity on stock i in year t is as follows;

$$ILLIQ_{iy} = \frac{1}{D_{iy}}$$

$$\sum_{t=1}^{D_{iy}} = \frac{|R_{iyt}|}{VOLD_{iyt}}$$

Where D_{iy} is the number of days that data is available for stock i in year y, $|R_{iyt}|$ is the return for stock i in year y on day t and $VOLD_{iyt}$ is the daily volume in Dollars for stock i in year y on day t.

Amihud also introduces the formula for the ratio of the daily absolute return to the trading volume on that day. This formula is as follows:

$$TURNOVR_{iy} = \frac{1}{D_{iy}}$$

$$\sum_{t=1}^{D_{iy}} = \frac{VOLSHS_{iyt}}{NSHS_{iyt}}$$

Where D_{iy} is the number of days that data is available for stock i and year y, $VOLSHS_{iyt}$is the trading Volume in shares for stock i and year y on day t and $NSHS_{iyt}$ is the number of shares outstanding for stock i and year y on day t.

Lastly he proposes a number of variables to match for correlation with the illiquidity measure. These are the natural logarithm of the Volume in Dollars (lnVOLD), the natural logarithm of the size(lnSIZE), the natural logarithm of the price(lnP) and the turnover measure which is described above (TURNOVR).

Acharya and Pedersen (2005)

Acharya and Pedersen (2005) , as described in the literature section, identified a number of important flaws in the illiquidity measure by Amihud (2000). They improved the illiquidity measure as follows:

$$C_{it} = \min(0{,}25 + 0{,}30 * ILLIQ_{iy} * P_{m,t-1}, 30)$$

Where $P_{m, t-1}$ equals the ratio of capitalizations of the market portfolio at the end of week t-1 and that of the market portfolio at the start date. The factor of 0,3 limits the exposure to extreme outliers which was a problem with the original measure. The factor 30 estimates the costs of illiquidity. This measure was formally accepted by future researchers but modified to make it more practical.

Ruenzi, Ungeheuer and Weigert (2012)

Ruenzi et al changes the illiquidity measure into a liquidity measure, for practical reasons. Since when measuring liquidity, which is better when the value is higher, it is logical to use a measure which results in a positive number. This can be seen below.

$$D_{it} = -C_{it}$$

Where D_{it} measures the liquidity of stock i at time t.

There is one important aspect which has to be changed in the measure though. The traded volume ($VOLD_{iyt}$) is a good indication of liquidity for stocks but not for turbo certificates. With turbo certificates it is possible that there is no trading even though there is sufficient supply given out by the issuer. In this case the turbo is still liquid but the previous measure would falsely document that this is not the case. Therefore a new variable is introduced, $SUPPLY_{it}$, which is the supply for a turbo I at time t. The illiquidity measure is then as follows:

$$ILLIQ_{iy} = \frac{1}{D_{iy}}$$

$$\sum_{t=1}^{D_{iy}} = \frac{|R_{iyt}|}{SUPPLY_{it}}$$

6. Data

The data which has been used for this study was taken directly from the Euronext[15] database. Nine different Turbo certificate products from three different suppliers have been selected. The table below provides an overview of the selection.

Table 2
Overview of selected Turbo certificates

Supplier	ISIN Code	Leverage factor	Stop loss level	Financing level	Price[16]	n
Goldman Sachs	NL0011231717	1,77	€194,40	€190,20	€24,67	29.611
Goldman Sachs	NL0011595418	2,30	€247,66	€247,66	€19,02	5.576
Goldman Sachs	NL0011595400	2,35	€251,69	€251,69	€18,63	5.547
ING	NL0009111004	1,90	€207,00	€202,55	€23,47	22.897
ING	NL0009879477	2,19	€229,00	€224,47	€21,28	39.841
ING	NL0009901925	2,30	€250,00	€245,00	€19,23	39.931
BNP Paribas	NL0009940188	2,09	€233,00	€227,22	€21,17	103.568
BNP Paribas	NL0009940204	2,16	€240,00	€233,84	€20,50	79.305
BNP Paribas	NL0010010476	2,30	€253,00	€246,74	€19,21	77.070

For the Goldman Sachs Turbo certificates NL0011595400 and NL0011595418, only data from 20-01-16 was available. In total the dataset has 403.346 observations.

The data that was used is tick[17] data over the course of six different days, three volatile days and three rather quiet days. All selected products are Turbo certificates with the AEX Index as the underlying asset, they have similar leverage factors and stop loss levels. An overview of the chosen days can be found in the table below, the quotes are of the AEX Index on the given day.

[15] Euronext N.V. = A European stock exchange listed in Amsterdam, Brussels, London, Lisbon and Paris.
[16] Price as of the 7th of March 2016
[17] Tick = A change in the price of a security from trade to trade (Investopedia, 2016)

Table 3
Overview of trading days (IEX, 2016)

Date	Close previous day	Low	High	Close	Return
19-08-15	479,01	468,68	476,87	469,24	-2,04%
24-08-15	442,87	401,87	431,75	419,68	-5,24%
20-01-16	407,68	392,44	400,65	395,72	-2,93%
09-12-15	441,61	437,78	445,02	440,85	-0,17%
24-12-15	443,72	442,32	444,12	444,12	+0,09%
11-01-16	410,82	409,08	415,87	411,31	+0,12%

In order to calculate the intrinsic value of a turbo certificate, data on the underlying asset is needed. Since all selected products have the same underlying asset, tick data on the AEX was gathered and provided by Binck Bank. Unfortunately, they could only provide data for the following three dates: 09-12-15, 24-12-15 and 11-01-16. This leads to the fact that for the calculation of the premium, only the non volatile days can be taken into account. This dataset has a total of 6124 observations.

To test the hypotheses on liquidity, hourly averages were calculated on the return, the bid-ask spread and the Amihud measure. Since tick data was used, the return intervals were very small, this resulted in the values of the Amihud measure to be rather high, but they were not outliers since they were high across the board. Because these values were so high, the Acharya and Pedersen (2005) variant on the measure was not used. In this measure, 0.25 was added to all values and a maximum was set to 30. This does not apply to this data and to change these values would not be based on academic grounds.

After null values in the data were removed, this fortunately was only a very small amount, 396.581 observations were left.

7. Results

This section will answer the hypotheses by empirical data investigation. The first part will focus on the hypotheses regarding Turbo pricing. The second part will focus on the hypotheses regarding liquidity.

7.1 Pricing

The first hypothesis to investigate is whether turbo certificates are fairly priced. Recall from section 4.6 that issuers report a premium of about 2% plus the overnight LIBOR rate. In the period of investigation, the LIBOR rate was only 0,43% (Macrotrends, 2016).

First of all, the data of the turbo certificates was matched with the data of the underlying asset. In order for the data to remain viable, this was done in such a way the data was only matched when the data and time were exactly the same. This is also why the number of observations used in answering this hypothesis is much lower than the number of observations in the whole dataset. Next, the intrinsic value of the turbo certificate was calculated. As stated before, the intrinsic value is simply the difference between the value of the underlying asset minus the financing level, divided by the ratio, which is 10 for Turbo certificates on the AEX. The premium is then calculated as the difference in percentage between the intrinsic value and the ask price. Since two of the Goldman Sachs turbo certificates only had data on one day, they were not incorporated in this section. The results can be seen in the table below.

Table 4

Average premium per Turbo certificate

ISIN	Issuer	Leverage factor	n	Minimum	Maximum	Median	Mean	T-test
NL0009111004	ING	1.90	806	0.0259	0.0543	0.0369	0.0381	0.000 (72.37)
NL0009879477	ING	2.19	759	0.0273	0.0596	0.0403	0.0416	0.000 (75.72)

NL0009 901925	ING	2.30	794	0.0294	0.0659	0.0436	0.0450	0.000 (83.24)
NL0009 940188	BNP Paribas	2.09	143 7	0.0250	0.0577	0.0373	0.0390	0.000 (94.36)
NL0009 940204	BNP Paribas	2.16	149 2	0.0257	0.0596	0.0381	0.0400	0.000 (98.07)
NL0010 010476	BNP Paribas	2.30	145 4	0.0285	0.0639	0.0415	0.0429	0.000 (108.09)
NL0011 231717	Goldman Sachs	1.77	554	0.0192	0.0455	0.0306	0.0317	0.000 (33.79)

According to the issuers, the premium charged is equal to the LIBOR rate plus 2%, thus a maximum of 2,43%. However in practice we see that this is not the case. The minimum premium lies around this mark but it goes up to as high as six per cent. The average premium lies between 3,1% and 4,5%. This is not consistent and not near the 2,43% which they reportedly charge. To confirm this, One Sample t-tests were conducted to test whether the means were different from 2,43%. These results are in the last column, with the probability and the t-statistic in brackets. The null hypothesis of that test is that the means do not differ from 2,43% and this is rejected in all cases.Based on this evidence the first hypothesis (Turbo pricing is fair) is rejected. This outcome supports the conclusion of Entrop et al. (2009) and a number of other studies from the literature section which state that the pricing of open end leverage products strongly favor issuers.

The second hypothesis is that there is a positive correlation between the premium and the leverage factor. At first look this is certainly the case but this needs to be verified. Therefore a regression was done with the premium as the independent variable and the leverage factor as the only dependant variable. The leverage factor was highly significant and accepted at a 99% confidence level. The coefficient was positive at 0.019 which means that for every increase of the leverage factor by one, the premium would increase by 1,9 per cent. The R-squared of almost 19% is high for a regression with only one dependant

variable. To verify that the coefficient is significantly different from zero, a Wald test was conducted. The result was highly significant with an F-Statistic of 1701 and a probability of 0.000, thus rejecting the null hypothesis which was that the coefficient was equal to zero. With this information the abovementioned hypothesis can be accepted.

The next hypothesis is whether there are differences in Turbo pricing across different suppliers. To test this, dummy variables ING and BNP and GS were created which were 1 if the Turbo was from that particular supplier and 0 otherwise. To control for the significant leverage factor effect which was found in answering the previous hypothesis, this coefficient was also added to the regression, the results can be seen in the table below.

Table 5

Average premium per supplier

Independent variable	Coefficient	T-statistic	Probablity
Leverage factor	0.0170	27.63	0.0000***
ING	0.0054	4.08	0.0000***
Goldman Sachs	0.0035	1.40	0.1618
BNP Paribas	0.0016	2.63	0.0085***

It can be seen that all coefficients except the one for Goldman Sachs are highly significant. Based on this evidence, BNP Paribas charges the lowest premium of about 0.16 per cent on top of the leverage factor. ING charges a much higher premium of 0.54 per cent. Unfortunately a conclusion cannot be drawn for Goldman Sachs since the coefficient is not significant. A Wald test for difference in coefficients confirmed that the premiums charged by ING and BNP Paribas are different, on a 99% confidence level. These results allow for the hypothesis (There is no difference in pricing across suppliers) to be rejected.

7.2 Liquidity

This section will test various hypotheses regarding liquidity of turbo certificates.

The first hypothesis to be tested is that liquidity is lower in the opening and closing hours of trading. To test this, dummy variables were added for the times 8.00—9.59 and 18.00-19.59. When tested separately, both the Open and the Close variable were significant on a 10% confidence level with probabilities being 0.0536(-1.94) and 0.0500(-1.97) respectively. The coefficient was negative (where the Amihud measure measures illiquidity) meaning that the liquidity in the opening and closing hours is actually higher. When tested jointly, the result was even more significant which a probability of 0.0156 (-2.43) for opening hours and 0.0146 (-2.45) for closing hours. This is significant on a 95% confidence level. The hypothesis is rejected because liquidity is actually higher in the opening and closing hours.

The second hypothesis to be tested is whether liquidity is different on the days that were classified as volatile. These days are 19-08-2015, 24-08-15 and 20-01-16 as stated in the data section. Values of the underlying asset can change rapidly on volatile days and even more so of turbo certificates due to the leverage factor. Investors would want to turnover their assets quickly after making a decision to do so and therefore high liquidity is desired. To test this hypothesis a dummy variable was created which is 1 on volatile days and 0 otherwise. The result was a positive coefficient, meaning that liquidity is lower, but not significant with a probability of 0.4839(0.70). Thus it cannot be concluded that liquidity is either lower or higher on volatile days. To further verify this result, the same test was conducted on the bid-ask spread which is also regarded as a liquidity indicator. The result was a slightly negative coefficient but also with an insignificant probability of 0.1274(-1.53). The hypothesis that liquidity is different on volatile days is rejected.

The next hypothesis to test is whether there are significant differences in liquidity between suppliers. To do this, dummy variables were created for each supplier which could take the values one and zero. The dependant variable is the Amihud measure, which is a measure for illiquidity and therefore a lower number is desired. The results can be seen in the table below.

Table 6

Average illiquidity per supplier

Independent variable	Coefficient	T-statistic	Probability
ING	1.979.361	0.31	0.7568
Goldman Sachs	524.000.000	59.12	0.0000***
BNP Paribas	172.000.000	30.59	0.0000***

They show that ING has the lowest illiquidity but that number was not significant.BNP Paribas has a higher illiquidity and Goldman Sachs even higher, significant on a 99% confidence level. A Wald test confirmed that the coefficients of Goldman Sachs and BNP Paribas were significantly different with an F-statistic of 33.62.

To further strengthen this result a series of robustness tests were conducted. The first one tests the liquidity of suppliers in the opening and closing hours. The first test in this section tested whether liquidity is different in the opening and closing hours, this one combines this with suppliers. The results are in line with the previous test and can be seen in the table below.

Table 7

Average illiquidity per supplier in opening and closing hours

Independent variable	Coefficient	T-statistic	Probability
ING*OPEN	1.955.661	0.05	0.9631
ING*CLOSE	1.956.129	0.04	0.9688

GS*OPEN	424.000.000	6.84	0.0000***
GS*CLOSE	396.000.000	6.17	0.0000***
BNP*OPEN	143.000.000	3.76	0.0002***
BNP*CLOSE	115.000.000	2.80	0.0053***

The same two tests were then conducted on the bid-ask spread. The bid-ask spread was presented as a negative number, meaning the lower this number, the greater the bid-ask spread is. All variables were highly significant at a 99% confidence interval. Goldman Sachs had the smallest spread, followed by BNP Paribas and ING had the highest spread. A Wald test confirmed that the coefficients were not equal to each other with an F-statistic of 54.55.

Table 8

Average bid-ask spread per supplier

Independent variable	Coefficient	T-statistic	Probability
ING	-0.013	-22.10	0.0000***
Goldman Sachs	-0.003	-3.29	0.0013***
BNP Paribas	-0.011	-20.69	0.0000***

When the open and close dummies were added, the results showed a similar pattern, except for the fact that the coefficients for Goldman Sachs were not significant anymore.

Table 9

Average bid-ask spread per supplier in opening and closing hours

Independent variable	Coefficient	T-statistic	Probability
ING*OPEN	-0.017	-8.80	0.0000***
ING*CLOSE	-0.016	-6.83	0.0000***
GS*OPEN	-0.003	-0.96	0.3364

GS*CLOSE	-0.003	-0.98	0.3281
BNP*OPEN	-0.013	-7.80	0.0000***
BNP*CLOSE	-0.010	-5.33	0.0000***

The evidence presented above leads to the hypothesis of that there is no difference in liquidity amongst suppliers, to be rejected.

Amihud and Mendelsen (1986) conclude that the bid-ask spread has a significant effect on the return of an asset. According to their research (which was done on stocks rather than Turbo certificates) an asset had a higher return when the bid-ask spread was greater. When conducting the same test on Turbo data, the same conclusion was reached. The coefficient for the bid-ask spread was negative with a probability being significant at the 1% confidence level. It was also significantly different from zero with a t-statistic of -11.38. Since the measure for bid-ask spread in this dataset was negative (meaning that a smaller bid-ask spread has a higher coefficient), this result confirms that the average return is lower when the bid-ask spread gets lower, or that the average return is higher when the bid-ask spread gets greater (more negative is this dataset).

In 1991, Amihud and Mendelsen state that over a longer horizon it would be beneficial to invest in low liquid stocks since those would earn higher returns. To verify this, the average return was regressed on the average value of the Amihud measure. A positive coefficient would mean that a higher illiquidity would lead to a higher average return. The result was directly opposite. The coefficient was negative and highly significant at the 99% confidence level and it was also significantly different from zero with a t-statistic of -27.56. This means that a higher illiquidity would lead to a lower average return.

8. Conclusion

The aim of this thesis was to gain insight in the pricing and liquidity of Turbo certificates and to test whether there are significant differences between suppliers. This led to the following research question:

Are there differences in the pricing and liquidity of Turbo certificates across different suppliers?

In order to answer this question, a number of hypotheses were constructed:

- Turbo Pricing is fair
- The premium charged for Turbo certificates is positively correlated with the leverage factor
- There is no difference in Turbo pricing between different suppliers
- Liquidity is lower in the opening and closing hours of the day
- Liquidity is different on volatile days
- There is no difference in Turbo liquidity between different suppliers

It was found that Turbo pricing is not fair and that there is a premium charged by the suppliers which is significantly higher than the reported 2% plus the overnight LIBOR rate and the first hypothesis was rejected. It was also found that there is a positive correlation between the leverage factor and the premium, this hypothesis was accepted. Lastly it was found that the premium charged is different across suppliers. BNP Paribas charges the lowest premium and ING a much higher premium. Unfortunately the coefficient for Goldman Sachs was not significant. These results led to the fact that the third hypothesis was rejected.

For the liquidity part, the first hypothesis that was tested was whether the liquidity is lower in the opening and closing hours of the trading day. This turned out to be not the case

and the liquidity was actually significantly higher in the opening and closing hours of the trading day. This hypothesis was rejected. The next hypothesis was whether liquidity was different on days that were classified as volatile. This was not the case, there was no significant relation. This hypothesis was rejected as well. The last hypothesis was the most important of this part, whether there are differences in liquidity amongst suppliers. ING had the best liquidity but it was not a significant coefficient. BNP Paribas had a better liquidity than Goldman Sachs.

The tests on the bid-ask spread showed a different pattern. Goldman Sachs had the lowest spread, followed by BNP Paribas and ING had the largest spread. A brief overview of all the results can be seen in the table below, ranked from best to worst.

Table 10

Brief summary of the results (= insignificant result)*

#	Premium	Liquidity	Bid-ask Spread
1	BNP Paribas	ING*	Goldman Sachs
2	Goldman Sachs*	BNP Paribas	BNP Paribas
3	ING	Goldman Sachs	ING

The results on the hypotheses give a strong basis to answer the research question. There are differences in both pricing and liquidity amongst the tested suppliers. However, there was no clear ‘winner’. If an investor deems the premium most important it would prefer BNP Paribas over ING and if it deems liquidity most important it would prefer BNP Paribas over Goldman Sachs but if it deems a small bid-ask spread most important it would prefer Goldman Sachs over both BNP Paribas and ING.

9. Limitations and Discussion

Even though this study does take a lot of different factors into account, there are some limitations as to which it can be improved in the future. The data which was used had a lot of different data points, because it was tick data. However it was not over a broad period of time. If one would like to gain results over a longer period of time, an argument can be made to use hourly data or data per minute and then over a longer sample period. For investigating pricing, daily data can even be used but this would not make sense for liquidity research, since it would only give a snapshot of the day.

It could also be good to add more suppliers to the dataset. This study only studied the main suppliers in the Netherlands, but there are other suppliers (just in the Netherlands alone) like Commerzbank and Citi Group.

Another point which could be taken into consideration is to test whether the charged premium differs amongst days which can be classified as volatile. This dataset could not test that but it would make sense. On volatile days, issuers face a larger gap risk (which is the risk that the value of the underlying asset moves through both the barrier and the financing level). This could lead to a higher charged premium to cover this extra risk.

Lastly this study finds that there is a significant positive relation between the leverage factor and the premium. It would be interesting to test if this also holds for Turbo certificates with a higher leverage factor. It does not seem reasonable to assume that the premium increases with 2 per cent for every increase of one in the leverage factor.

The discussion that arises from the results in this thesis is what aspect of a Turbo certificate is preferred. A cheaper price allows for a greater profit (or a smaller loss) but if this is paired with a lower liquidity, this could hurt the return when the investor tries to sell

the asset on a volatile day, or any day in general. The bid-ask spread can be viewed from both a pricing and a liquidity perspective. A smaller spread means lower costs when undertaking the transaction and a smaller spread is generally regarded as to the asset being more liquid. BNP Paribas would have the lowest premium and the best liquidity. Goldman Sachs would have the lowest bid-ask spread, but in the results it was also found that a greater bid-ask spread leads to a higher return and ING has the highest bid-ask spread. An argument can be made for all suppliers in one way or another. In the end it comes down to the preferences of the investor and if he or she is willing to take on extra risk to be able to realize extra returns.

I believe that this thesis provides a valuable contribution to the field of finance by linking pricing and liquidity of Turbo certificates which had not been done before. I think a lot more research can be done in this part of the field and I hope that this thesis provides a basis and a starting point to do so.

10.Bibliography

ABM Amro. (2015). *Turbo Brochure.*

ABN Amro. (2015). *Trader Brochure.*

Acharya, V., & Pedersen, L. H. (2005). Asset Pricing with liquidity Risk. *Journal of Financial Economics*, 375-410.

Amihud, Y. (2002). Illiquidity and Stock Returns: Cross-Section and Time-Series Effects. *Journal of Financial Markets* .

Amihud, Y., & Mendelson, H. (1986). Asset Pricing and the Bid-Ask Spread. *Journal of Financial Economics*, 223249.

Amihud, Y., & Mendelson, H. (1988). Liquidity and Asset Prices: Financial Management Implications. *Financial Management*, 5-15.

Amihud, Y., & Mendelson, H. (1986). Liquidity and Stock Returns. *Financial Analysts Journal*, 43-48.

Amihud, Y., & Mendelson, H. (1991). Liquidity, Asset Pricing and FInancial Policy. *Financial Analysts Journal*, 56-66.

Amihud, Y., & Mendelson, H. (1991). Liquidity, Maturity, and the Yields on U.S. Treasury Securities. *The Journal of Finance*, 1411-1425.

Amihud, Y., & Mendelson, H. (2000). The Liquidity Route to a Lower Cost of Capital. *Journal of Applied Corporate Finance*, 8-26.

Anderson, J. (2006, September 23). Better the House and Losing Big. *The New York Times* .

Ang, A., Chen, J., & Xing, Y. (2006). Downside Risk. *Review of Financial Studies* .

Bak, P., Paczuski, M., & Shubik, M. (1996). Price Variations in a Stock Market with Many Agents. *Elsevier* .

Baule, R. E., & Wilkens, M. (2008). Credit Risk and Bank Margins in Structured Financial Products: Evidence from the German Secondary Market for Discount Certificates. *Journal of Futures Markets*, 376-397.

Baule, R., & Tallau, C. (2011). The Pricing of Path-Dependent Structured Financial Retail Products: The Case of Bonus Certificates. *Journal of Derivatives* .

Bawa, V. S. (1975). Optimal Rules for Ordering Uncertain Prospects. *Journal of Financial Economics*, 95-121.

Bawa, V. S., & Linderberg, E. B. (1977). Capital Market Equilibrium in a Mean-lower Partial Moment Framework. *Journal of Financial Economics*, 189-200.

Bernstein, P. (1987). Liquidity, Stock Markets and Market Makers. *Journal of Financial Management*, 54-62.

Binck Bank. (2016, November 9). *Tarievenoverzicht*. Retrieved November 9, 2016, from https://www.binck.nl/zelf-beleggen/tarievenoverzicht

Black, F., & Scholes, M. (1973). The Pricing of Options and Corporate Liabilities. *Journal of Political Economy*, 637-654.

BNP Paribas. (2015). *Turbo Brochure.*

Bodurtha, S., & Quinn, T. (1990). Does Patient Program Trading Really Pay? *Financial Analysts Journal*, 23-34.

Burth, S., Kraus, T., & Wohlwend, H. (2001). The Pricing of Structured Products in the Swiss Market. *The Journal of Derivatives* .

Centraal Bureau voor de Statistiek. (2015, June 3). *Beleggingen van institutionele beleggers.* Retrieved March 16, 2016, from Statline: http://statline.cbs.nl/StatWeb/publication/?VW=T&DM=SLNL&PA=82824NED&LA=NL

Commerzbank. (2015). *Turbo Brochure.*

Eleswarapu, V., & Reinganum, M. (1993). The seasonal behaviour of the liquidity premium in asset pricing. *Journal of Financial Economics*, 373-386.

Entrop, O., Schober, A., & Wilkens, M. (2011). The pricing policy of banks of the German secondary market for leverage certificates: Interday and Intraday Effects. *Die Betriebswirtschaft 65*, 521.525.

Entrop, O., Scholz, H., & Wilkens, M. (2009). The Price-setting Behaviour of Banks: An Analysis of Open-end Leverage Certificates on the German Market. *Journal of Banking and Finance*, 874-882.

European Commission. (2012, October 23). *Commission proposes green light for enhanced cooperation on financial transaction tax*. Retrieved November 9, 2016, from http://europa.eu/rapid/press-release_IP-12-1138_en.htm

Fama, E., & French, K. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, 3-56.

Federal Reserve. (2015, May 27). *FRB: Market Risk Management*. Retrieved from Federal Reserve: http://www.federalreserve.gov/bankinforeg/topics/market_risk_mgmt.htm

Fishburn, P. C. (1977). Mean-Risk Analysis with Risk Associated with Below-Target Returns. *The American Economic Review,* 116-126.

Galai, D., & Sade, O. (2006). The "Ostrich Effect" and the Relationship between the Liquidity and the Yields of Financial Assets. *Journal of business*, 79.

Global Association of Risk Professionals. (2015). *Credit Risk Management.*

Goldman Sachs. (2015). *Turbo Brochure.*

Goldstein, M., & Kavajecz, K. (2000). Eighths, sixteenths, and market depth: changes in tick size and liquidity provision on the NYSE. *Journal of Financial Economics*, 125-149.

Hachmeister, A. (2007). *Informed Traders as Liquidity Providers: Evidence from the German Equity Market.* Wiesbaden: DUV.

Harlow, W. V. (1991). Asset Allocation in a Downside-Risk Framework. *Financial Analysts Journal*, 28-40.

Hasan, H. (2012, May 11). *Top 10 Biggest Trading Losses in History*. Retrieved April 6, 2016, from TIME: http://newsfeed.time.com/2012/05/11/top-10-biggest-trading-losses-in-history/

Henderson, B., & Pearson, N. (2011). The Dark Side of Financial Innovation: A Case Study of the Pricing of a Retail Financial Product. *Journal of Financial Economics* , 227-247.

Huang, M. (2003). Liquidity Shocks and Equilibrium Liquidity Premia. *Journal of Economic Theory*, 104-129.

Hull, J. (1989). Options, Futures and other Derivatives. *Boston* , Prentice Hall.

IEX. (2016, November 12). *AEX Volatility Index.* Retrieved November 12, 2016, from http://www.iex.nl/Index-Koers/247504/AEX-Volatility-Index.aspx

IEX. (2016). *Historische koersen AEX*. Retrieved March 8, 2016, from IEX: http://www.iex.nl/Index-Koers/12272/AEX/historische-koersen.aspx?

ING Bank. (2015). *Sprinter BEST Brochure.*

ING Bank. (2015). *Sprinter Brochure.*

Investing Answers. (2015, May 27). *Price Risk*. Retrieved May 27, 2015, from Investing Answers: http://www.investinganswers.com/financial-dictionary/stock-market/price-risk-3182

Investopedia. (2015, May 29). *Moneyness*. Retrieved May 29, 2015, from Investopedia: http://www.investopedia.com/terms/m/moneyness.asp

Investopedia. (2016). *Tick definition*. Retrieved March 8, 2016, from Investopedia: http://www.investopedia.com/terms/t/tick.asp

Kahneman, D., & Tversky, A. (1979). Prospect Theory: An analysis of Decision Under Risk. *Econometrica*, 263-291.

Kamp, A. J. (2015, May 29). *China de Gekste*. Retrieved from IEX: http://www.iex.nl/Column/155579/China-de-gekste.aspx

Kirkpatrick, C., & Dahlquist, J. (2010). *Technical Analysis.*

Kwakman, J. T. (2009). Turbo's, a good substitute for futures when hedging currency risk?

Macrotrends. (2016). *Historical LIBOR Rates Chart*. Retrieved June 14, 2016, from http://www.macrotrends.net/1433/historical-libor-rates-chart

Markowitz, H. M. (1959). *Portfolio Selection: Efficient Diversification of Investments.* New York: John Wiley & Sons, Inc.

Mehra, R., & Prescott, E. (1985). The Equity Premium. *Journal of Monetary Economics*, 145-161.

Muck, M. (2007). Pricing Turbo Certificates in the Presence of Stochastic Jumps, Interest Rates, and Volatility. *Die Betriebswirtschaft 77*, 224-240.

Muck, M. (2006). Where should you buy your options? The pricing of exchange-traded certificates and OTC derivatives in Germany. *Journal of Derivatives 14*, 82-96.

Nawrocki, D. N. (1999). A Brief History of Downside Risk Measures. *The Journal of Investing*, 9-25.

Nawrocki, D. N. (1991). Optimal Algorithms and Lower Partial Moment: Ex Post Results. *Applied Economics*, 465-470.

Nawrocki, D. N. (1992). The Characteristics of Portfolios Selected by n-Degree Lower Partial Moment. *International Review of Financial Analysis*, 195-209.

Norris, F. (1994, December 8). Orange County's Bankrupcy: The Overview; Orange County Crisis Jolts Bond Market. *The New York Times* .

Ofir, M., & Wiener, Z. (2006). Investment in Financial Structured Products from Rational and Behavioral Choice Perspectives.

Ong, S. E., & Sing, T. F. (1994). Asset Allocation in a Downside Risk Framework. *Journal of Real Estate Portfolio Management*, 213-223.

Paik, S. (2013). Valuation, Emperical Analysis, and Optimal Exercise of Open-End Turbo Certificates. *University of Bamberg Press* .

Pastor, L., & Stambaugh, R. (2001). Liquidity Risk and Expected Stock Returns.

Rossetto, S., & van Bommel, J. (2009). Endless Leverage Certificates. *Journal of Banking & Finance* .

Ruenzi, S., Ungeheuer, M., & Weigert, F. (2012). Extreme Downside Liquidity Risk.

Rusnáková, M., & Younis, A. M. (2012). The Utilization of Exotic Options in the Formation of Structured Products. *Journal of Modern Accounting and Auditing*, 1814-1822.

Schenk, C., & Wasserfallen, W. (1996). Portfolio Insurance for the Small Investor in Switserland. *Journal of Derivatives*, 37-43.

SEC. (2015). *Interest Rate Risk - When Interest Rates Go Up, Prcis of Fixed-Rate Bonds Fail.* Securities and Exchange Commission.

Šoltés, M. (2010). Crude Oil Trading Using Turbo Certificates. *Acta Montanistica Slovaca*, 1-4.

Šoltés, V., & Rusnáková, M. (2012). Long Combo strategy using barrier options and its application in hedging against a price drop. *Acta Montanistica Slovaca*, 17-32.

Šoltés, V., & Šoltés, M. (2008). Various Innovating Instruments of Financial Markets, Recommended in Case of a Fall in the Underlying Asset Price. *Financial System Integration of Balkan COuntries in the European Financial System*, 189-195.

Stallinga, R. (2015, April 29). *China ziet ze vliegen*. Retrieved from IEX: http://www.iex.nl/Column/154540/China-ziet-ze-vliegen.aspx

Stoimenov, P., & Wilkens, S. (2005). Are structured products 'fairly priced? An analysis of the German market for equity-linked instruments. *Journal of Banking and Finance*, 2971-2993.

Tankov, P. (2008). Pricing and Hedging Gap Risk.

The MatchWorks, Inc. (2015, July 27). *Sample and Expected Lower Partial Moments*. Retrieved July 27, 2015, from MathWorks: http://nl.mathworks.com/help/finance/sample-and-expected-lower-partial-moments.html

Thomas Jr, L. (2007, November 8). Morgan Stanley Takes a Hit on Mortgages. *The New York Times* .

Unser, M. (1998). Lower Partial Moments as Measures of Perceived Risk - An Experimental Study.

V-Lab. (2015, July 14). *Shanghai Stock Exchange Composite Index GARCH Volatility Graph*. Retrieved December 12, 2015, from V-Lab: http://vlab.stern.nyu.edu/analysis/VOL.SHCOMP%3AIND-R.GARCH

Wilkens, S., Erner, C., & Röder, K. (2003). The Pricing of Structured Products - An Emperical Investigation of the German Market. *Journal of Derivatives*, 55-69.

Witt, R., & Waibel, H. (2009). Lower Partial Moments as a Measure of Vulnerability to Poverty in Cameroon.

Wojt, A. (2010). Portfolio Selection and Lower Partial Moments.

Wong, H. J., & Chan, C. M. (2008). Turbo warrants under stochastic volatility. *Quantitative finance* .