In the Money, Out of the EU

Using a Neutral Options Volatility Strategy on the British EU-Referendum



Candidates

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83

84

Number of Words

6973

Executive Summary

In this paper, we use neutral volatility options strategies to capitalize on the inevitable, immediate movements in the market resulting from the outcome of the EU-referendum. The essay introduces the concepts of the two scenarios; Brexit and Bremain, and discusses the impact on the stock market and severity of the consequences in both scenarios. Polling data ahead of the referendum show that the outcome is highly uncertain, indicating a 50 per cent chance of either scenario. As this uncertainty is accounted for in the financial markets ahead of the voting day, one thing remains certain: when the voting results are publicized, the market will move. Using a *straddle*- and a *strangle* options strategy, it is possible to capitalize on high stock volatility in either outcome of the referendum.

The paper analyses sectors and industries in which the referendum will have an impact, and through the process of elimination as well as ad-hoc stock analysis, identifies stocks within these sectors that we believe will prove to be the most volatile.

The banking sector is most affected by possible new EU-regulations and the repercussions of London's loss of status as a financial metropolis. In light of our sector analysis we end up with the following companies to include in our strategy: *Barclays, Lloyd Banking Group* and *Royal Bank of Scotland*.

The airline industry is most affected by the forex-risk, potential changes to airline traffic rights and EU-laws on ownership structure. We pick *Ryanai*r as the stock we believe to be most exposed to these factors, and thus a good fit for the volatility portfolio.

An analysis of the gold price against the VIX-index indicates that the gold price is positively correlated with the level of uncertainty in the markets. As the two outcomes of the referendum will either increase- or reduce the uncertainty in the markets, we expect the gold price to be volatile towards either outcome. By buying stock options on gold companies instead of the commodity we exploit the operational gearing effect in these companies, leading to higher volatility in the straddle. By analysing the operating leverage in several gold companies, we identify *Randgold Resources* as the best stock for the volatility portfolio. In addition, we buy options on a USD/GBP ETF to capitalize on the relative movement of the *GB Pound*.

We buy the options on the 20th of June and exercise the options the day after the referendum. We demonstrate that the straddle portfolio's return with optimal and pessimal execution of the strategy will deviate by 112 per cent. In terms of performance, our strategy yields an 89 per cent return with optimal execution whereas the pessimal execution yields a negative 23 per cent return.

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1. Introduction

This assignment will look at the prospect of making money from a straddle strategy based on the outcome of the British EU-referendum, held June 23rd, 2016. To make the analysis more realistic, and not influenced by our knowledge of what actually happened, we will conduct our analysis as if the referendum has not yet occurred. Our perspective is that we initiate and perform our trading, and pretend that we write this, on the 20th of June 2016.

We will start by explaining the EU-referendum, and highlight the effects a Brexit or a Bremain will have on the different sectors of the British economy. Then we will explain how a straddle strategy is performed using put and call stock options. Following this, we will provide a deeper analysis on how the different sectors of the British economy will be affected by the referendum. This analysis will then serve as the basis of which financial assets we pick, and why. Lastly, we will simulate the execution of the strategy and present the final results from the trading.

2. The British EU-referendum

In an in-out referendum on the 23rd of June, voters in the UK will decide on either remaining a part of the European Union (EU), or leave within few years. Brexit is the most frequently used term for United Kingdom's (UK) prospective withdrawal from the EU, whereas Bremain is the equivalent if they were to stay. The impact and severity of the consequences of both scenarios are heavily debated, and we will describe a selection of these briefly in the following. However, as our paper deals with the dynamics of finance we will continue with topics mainly associated with financial markets, macroeconomics and currency implications.

2.1 Jittery Markets

On June 14th, an IG analyst noted: "There is a Brexit shaped shadow looming over the financial markets" (Mahony, 2016). The same day, the London benchmark index FTSE100 fell under the 6000-level for the first time in months having lost values worth £100bn in just four days. Unarguably, investors are preparing for the worst.

On the one hand, it is reasonable to assume that the aftermath of a potential Brexit could include tremendous effects on the financial sector, as prolonged uncertainty increases

currency volatility, risk-premia on assets and costs and availability of financing. Subsequently, on a more short-term note, a Brexit could turmoil the financial markets in the days succeeding the referendum creating a crash similar to Black Wednesday, where particularly companies in the finance and banking sector experienced severe drops in share price.

On the other hand, since UK has one of the strongest financial services sectors in the EU (Fleming, 2016), if the Brits were to vote in favour of remaining in the EU, one can argue that the market instability evident in the market now will recoil significantly. In conclusion, the expectation is that the British stock market will be volatile towards either outcome of the referendum.

London is one of the world's leading financial centres and the vote to leave the EU has triggered huge uncertainty about the future of its banking sector. The fear of other European economic metropolis such as Frankfurt and Paris dethroning London's 'City' as the Europe's head financial seat is pressing, with large banks as JPMorgan, Deutsche Bank and BNP Paribas already threatening to remove as many as a total of 100.000 jobs from the City (Clarke, 2016).

There are mainly two factors why it is not an unheard-of thought that these threats are realistic. First, it is reasonable to assume that banks' clients prefer to do Euro transactions within the Eurozone. Imagining that the UK through a hard Brexit find themselves outside EU's single market, this would encourage banks to move their main activities to a country still a part of the EU. Secondly, MiFID II, the newly modified EU directive regulating financial market activities, would among other regulations put in place stricter rules on passporting – permission to conduct business and sell services throughout Europe without obtaining a licence or similar in each individual country (EU, 2014).

2.2 Macroeconomic Implications

Chancellor George Osborne, who has been pivotal in the Remain campaign, has several times argued that the macroeconomic consequences of leaving the EU would be grim. The consensus amongst economists is that there will be long-term loss of gross domestic product (GDP) relative to GDP projections whilst still remaining a part of the EU (Begg, 2016).

The factors underlying the negative predictions are based on the uncertainty of restrictions following a Brexit and the impact it can have on for instance productivity growth, job creation and trade. Moreover, the possibility of inflation is evident, and the Bank of England could have to tackle this with higher interest rates (Bateman, 2016). With respect to the housing market, which already is feared to experience plummeting prices in the event of a Brexit, higher interest rates could eventually lead to more negative equity property owners. This would have tremendous effects for many Brits. A common denominator here is the repercussions a Brexit could have on the pound sterling (GBP).

Estimates on the GBP are rather unison in that it will experience a seismic drop in value compared to other major currencies if the referendum results in Brexit. This complies with the prolonged uncertainty of UK's economic future, thus making it unattractive for foreigners to invest in the pound. In the last weeks, safe havens like gold and government bonds have become increasingly more popular for investors, lifting gold prices up by 3-4 % (Ash, 2016). Moreover, a weakened GBP means more costly import of goods from outside the UK and the possibility of inflation inside the British borders.

On the other hand, a weaker pound means that British goods and services become cheaper for foreigners. This would have implications on import and export. Furthermore, there would be consequences for British travel and leisure, as tourists with greater purchasing power would find UK relatively cheaper than earlier, while the Brits would experience more expensive travels abroad.

In light of the obvious uncertainty in the days before the referendum we predict the markets to remain jittery, and that stocks in the sectors most influenced by the abovementioned macroeconomic tendencies will be particularly vulnerable in the case of a Brexit. This is emphasised by recent polls indicating a 50/50 support for each side (Financial Times, 2016), implying that the market will move significantly in one direction depending on the outcome.

3. The Theoretical Foundation for the Paper

Considering the high uncertainty and tight polls regarding the EU-referendum, we will not try to make money by betting on the outcome of the referendum. Instead, we will use a neutral volatility strategy and make our bets on the market volatility caused by the referendum,

regardless of the outcome. A neutral volatility strategy will profit as long as the value of the underlying asset decreases or increases sufficiently. To make our bets on the volatility we will mainly use a long straddle strategy, which is one of the most commonly used volatility strategies. A straddle is when an investor holds both a put- and call option on the same asset, with the same strike price and with the same expiration date.

An option is a financial derivative representing the right, but not the obligation, to buy or sell a specific security or financial asset at an agreed-upon price (strike price) during a certain period of time or at a particular date (exercise date). An option can be either a call option or a put option. A call option provides the right for the option holder to buy the asset at the strike price during the agreed-upon period of time, while a put option provides the right for the option holder to sell the asset at the strike price during the agreed-upon period of time. There are both American and European options, depending on whether the option holder can exercise his right to buy or sell within the period before exercise date, or solely on the exercise date (McMillan, 2012). In this paper, we will only make use of American style options.

Figure illustrates the profit function of a straddle strategy. To conduct a straddle strategy, an investor buys options at-the-money (ATM), which means that the strike price of the options is equal to the share price. Due to higher premiums, straddling is relatively more expensive compared to out-of-the-money (OTM) volatility strategies. OTM options are cheaper than ATM options due to a lower intrinsic value. The value of an option is given by the following equation.

$$Option\ Premium = Intrinsic\ value + Time\ value$$

There are two scenarios in which an investor profit from a straddle: through the put option or through the call option. If the share price drops below *Intersection 1*, the put option will make the straddle profitable. Similarly, if the share price exceeds *Intersection 2,* the call option will generate a net profit. Intuitively, the investor will incur a loss if the share price remains between the two intersection points until the option's expiration date, and is thus considered a bet on absolute volatility.

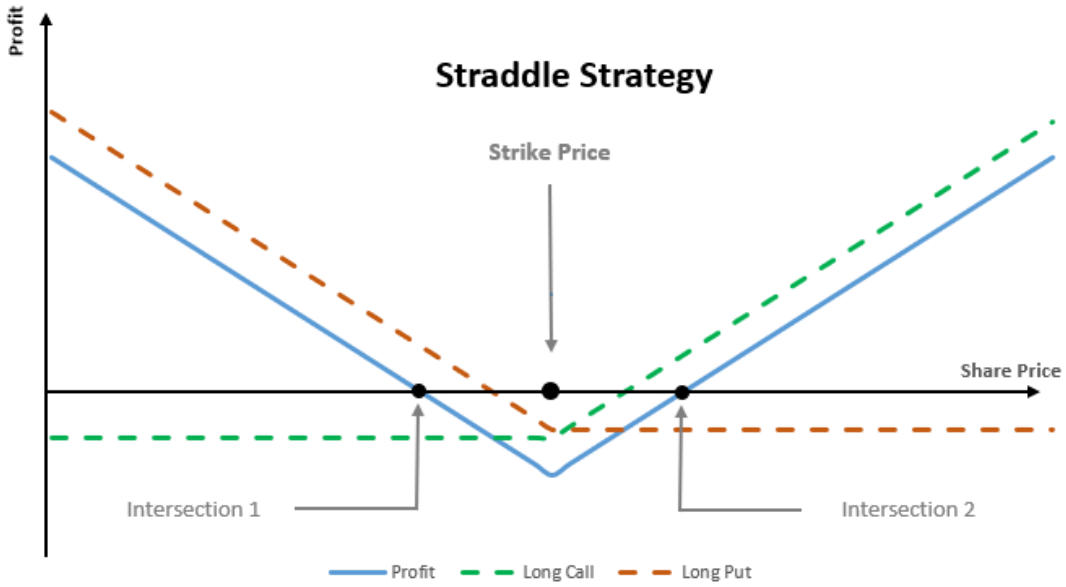


Figure 1- The Straddle Strategy

Profit Equations:

$$Profit_up = Price\ of\ the\ underlying\ asset - the\ strike\ price\ of\ the\ call\ option - net\ premium\ paid$$

$$Profit_down = The\ strike\ price\ of\ the\ put\ option - price\ of\ the\ underlying\ asset - net\ premium\ paid$$

When exercising a long straddle strategy there are three important aspects one need to consider: bid/ask spread, time decay and implied volatility (Cohen, 2016).

The ATM options typically have a tighter spread than OTM and in-the-money (ITM) options (Cohen, 2015). Avoiding wide spreads is crucial to any trading strategy, as high trading costs require a higher level of absolute volatility in the underlying asset to make a profit.

The implied volatility reflects the expected volatility of the underlying asset until the exercise date of the option. The level of implied volatility is positively correlated to higher option premiums and consequently affects the profit of the strategy. A rush in the implied volatility typically occurs when a significant event in relation to the stock is approaching. Moreover,

the implied volatility is often crushed in the aftermath of the event due to increased future certainty. A profit-seeking investor using a straddle strategy will thus aim to acquire the options before the implied volatility has started to build up in anticipation to a significant event.

Time decay implies that the value of an option decreases as a function of time, which can also be seen form the option premium equation. This is because the closer it is to the option's expiration day, the less time value there is left in the option (Cohen, 2016). To hold an option over time reduces its value due to time decay, and is thus an especially relevant factor to consider when using long option strategies.

4. Identification of Volatile Sectors and Assets

With regards to our overall strategy, we will pick the assets we expect to be the most volatile in the immediate aftermath of the referendum. To begin with, we will select specific sectors or industries, and argue why we believe these to be most affected by the outcome of the referendum. We expect the level of the companies' volatility to differ within each sector, and we aim to identify the assets most suitable for the straddle portfolio.

There are two limitations the reader should be aware of in the following analysis:

(I) *There is a limited number of assets on which there are options issued, which place restrictions on assets to include in our straddle portfolio. This is due to the rigorous requirements on size, volume, ownership structure and stock price stability that must be met if there is to be traded options on a stock.*

(II) *Due to the non-perpetual nature of stock options, we have found it extremely difficult to find historical options prices for companies listed on the London Stock Exchange. Therefore, our analysis will be limited to options on stocks listed on American stock exchanges.*

4.1 The Banking Sector

The UK and London unarguably holds the position as Europe's leading international financial centre by holding a 17 per cent international market share in cross-border lending (Gowland, 2016), dominating the wholesale of financial services in addition to being the most prominent centre in the world for trading the Euro. Britain's dominance in financial services has been largely dependent on their free access to the EU single market, which holds approximately 500 million people with an estimated total GDP of €13 trillion (Coiley, 2016). More specifically, it is the EU *passporting rights,* which allows authorised EEA banks to operate in any EU country without needing separate authorisation from each country (Harrison, 2016), the British banks are highly dependent on to retain their current level of operations. Consequently, London's position as Europe's financial hub can largely be accredited to EU law and its passporting rights.

Due to the unknown outcome of any withdrawal agreement between the EU and the UK, the consequences of a potential Brexit are highly uncertain. The ambiguity of whether the banks' passporting rights still will be applicable after a potential Brexit are pressing, and the repercussions of an exclusion from the single market could be severe. Furthermore, with approximately 400,000 European immigrants working in the British financial sector, another concern for the banks would be the laws on immigration from the EU countries (Wickers, 2016). Hence, the uncertainties about the legislative outcome of a Brexit could in a worst-case scenario lead to huge potential losses in both human capital and profits for banks operating in the UK.

As a result, we expect the banks' share price to be highly volatile towards both possible outcomes of the referendum. If the UK decides to stay in the EU, we expect banking stocks to increase considerably due to reduced future uncertainty. On the contrary, in the event of Brexit, we expect the banking stocks to drop severely due to the potential losses and prolonged uncertainty.

4.1.1 Do Investors Pay Attention to the Polls?

By analysing the FTSE 350 banks index versus an average of 15 different polls from the announced vote February 2nd, 2016, we found an interesting correlation which to some extent supports our expectations of volatility in the sector. The chart illustrates how the FTSE 350 Banks index and the polls indicating remain tend to move in the same direction. By conducting a regression analysis on the data, we can test the validity of the correlation. The test gave an R-squared of 0.158 with a p-value < 0.0001 which indicates that the polls can explain *some* of the variation in the stock price.

Description	*R Square*	*P-value*
Correlation of FTSE350 Banks and Polls Indicating Remain	0,15835882	5,9421E-05

Table 1 - Correlation FTSE 350 Banks vs. Polling data

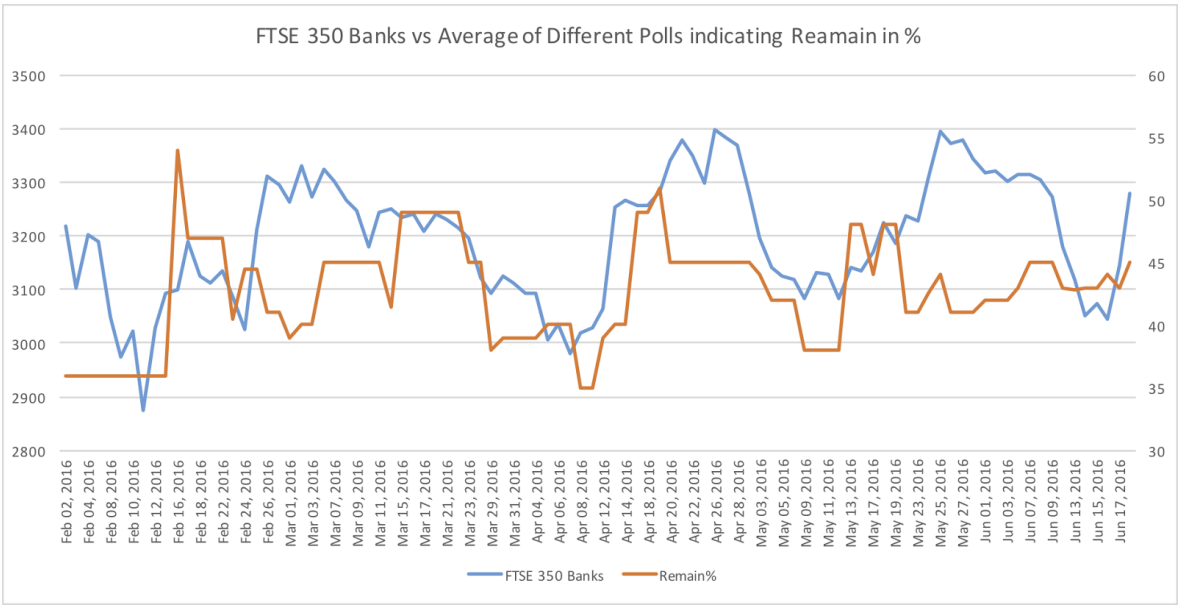


Figure 2 - FTSE350 vs Poll Data

After the referendum, the probability of either Bremain or Brexit will be a 100 per cent, and thus give the remain function a value of either 100- or 0 per cent, respectively. Even though the R square value is fairly low, based on the abovementioned factors a considerable reaction in the FTSE 350 banks index is expected, facilitating a potential gain with a volatility strategy.

4.1.2 Picking the stocks

According to the Bank of England (2016), as of May 2016, there are 156 banks operating in the UK. To categorise the banks according to their sensitivity towards the referendum, we will evaluate to what extent they are exposed to the UK and European market.

Most banks offer financial products worldwide. Due to the uncertainty concerning the passporting rights for British banks, the impact of not being allowed to offer financial products to the Eurozone will be significant. Banks headquartered in the UK will either have to move their headquarters and thus incur large costs, or remain seated in the UK, with a worst-case scenario of being unable to trade European products (Arnold, 2016). Therefore, we expect banks with UK headquarters to be the most volatile in the aftermath of the referendum, and we will thus exclude all banks headquartered outside the UK.

Due to the rigid rules on the issuance of options, there are only five banks with headquarters in the UK with outstanding options on their stocks. Hence, we are left with five banks to consider for our portfolio: HSBC, Lloyds Banking Group, Royal Bank of Scotland Group, Barclays and Standard Chartered.

The next step is to extract the banks with the highest exposure towards the referendum. Based on the sector analysis, we presume banks with a significant portion of their revenue originating from European operations to be the most sensitive to the result of the referendum.

Figure 3 illustrates the geographical distribution of the five banks' sources of revenue. Highlighting, HSBC and Standard Chartered are by far the least reliant on the revenue from the UK and European markets. Moreover, as Asian markets are their main source of revenue, we will exclude them from further evaluation due to their geographical dispersion. We will therefore buy options on Lloyds, Barclays and RBS.

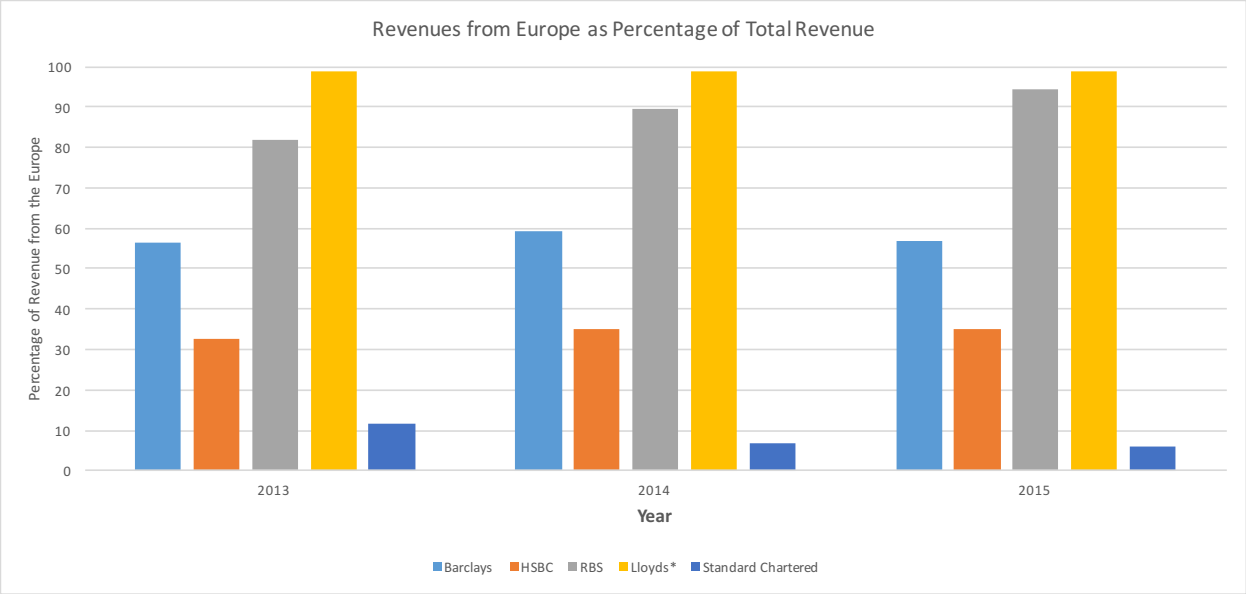


Figure 3 - Banks' Share of Revenue from Europe

4.2 The Airline Industry

The nature of the airline industry makes it sensitive towards either outcome of the referendum. This is largely due to its significant foreign exchange (FX) risk, and its dependency on traffic rights within the EU.

Airlines in general face FX risk over several spectres. Approximately 40 per cent of airlines' operating costs are denominated in US dollars, for example fuel, maintenance and overhaul costs (IATA, 2015). Additionally, all aircraft purchases and lease agreements are usually paid in US dollars. A weaker pound against the US dollar will thus put pressure on the bottom line, and lower expected earnings will have a significant impact on the fair value of the airline companies. Furthermore, another risk associated with a depreciation of the pound is decreased demand for airplane travels from British consumers, as their relative purchasing power would decrease. Inversely, in case of Bremain, the pound is expected to rise against other currencies, which would have the opposite effect on the FX risk and the demand for flights.

As a member of the EU, British owned airlines have access to the European Common Aviation Area (ECAA), which provides access to the intra-EU market. According to CAPA Centre for Aviation (2016), "Any airline owned and controlled by nationals of EU member states is free to operate anywhere within the EU without restrictions on capacity, frequency or pricing" (CAPA, 2016). Considering that 85 per cent of Britain's international air traffic is

between countries with access to the ECAA (Institute for Government, 2016), a fallout from the agreement would be catastrophic for British airlines and is therefore expected to constitute an underlying catalyst for volatility in the industry post-referendum.

On the one hand, in case of a Brexit, it is possible for Britain to renegotiate their access to the ECAA. There are currently 17 non-EU members with access to the ECAA (Institute for Government, 2016), which indicates that this might be a possible outcome. On the other hand, the legislation for the ECAA is enforced by the European Court of Justice, which Theresa May has opposed on several occasions. This agreement is therefore an element of uncertainty in the months leading up to the referendum.

4.2.1 Picking the Stocks

There are currently six airline companies listed on the London Stock Exchange (LSE): Ryanair, International Airlines Group (IAG), easyJet, Flybe, Thomas Cook Airlines and Wizz Air. We will only consider airlines that are listed on the LSE as we believe the abovementioned volatility factors will have the most impact on these stocks.

Due to the rigid rules on the issuance of options, it is only possible to buy options on IAG and Ryanair. Consequently, it is not possible to execute a straddle with any of the other airline companies, and we will turn our focus towards Ryanair and IAG.

Ryanair is an Ireland-based low-cost carrier (LCC) that only offers short-haul flights within Europe and Morocco (Ryanair, 2015). IAG is the Spanish registered parent company of British Airways and the Spanish national airline Iberia. IAG also owns the Irish national airline Aer Lingus and Vuelta, a Spanish LCC. The contributions from British Airways and Iberia accounts for 90% of IAG's total revenue (IAG, 2015), and we will therefore neglect the two other companies owned by IAG for the purpose of this analysis.

Both IAG and Ryanair have significant operations in the UK, and are thus exposed to the GBP/USD risk factor. Consequently, both companies will have individual hedging tactics to avoid large losses due to a depreciation of the pound. It is complicated to estimate which of these two companies that will be the most volatile to a change in the GBP/USD relationship as this would require an assessment of their respective hedging tactics. Therefore, we shift our focus towards their exposure to a possible fallout of the ECAA agreement.

Even though Ryanair is headquartered in Ireland, its ownership structure makes it vulnerable to a potential Brexit. If the Brits vote to leave, the percentage of Ryanair shares owned by EU investors drops well below 50 per cent (Reuters, 2016) and Ryanair will be excluded from the ECAA agreement. Considering that Ryanair only operates within the EU (except for Morocco), all current operations are subject to high uncertainty in the event of Brexit. One possible way around this is to buy back 12 per cent of its total shares to gain 50 per cent EU ownership. However, if Brexit happens and Ryanair alters its ownership structure to be EU owned, post-Brexit UK regulations on airlines could put constraints on Ryanair's operations between the UK and ECAA-countries, which accounted for 37 per cent of Ryanair's operations in 2015 (Ryanair, 2015). Needless to say, a Brexit could have a significant negative impact on Ryanair's operations. On the contrary, in the event of Bremain, we expect Ryanair's share price to soar as some of the uncertainty concerning the outcome of the referendum is likely to be priced in at the current share price.

The situation is different for IAG. IAG is headquartered in London, but is registered in Spain. Their main concern in the event of Brexit would be that their most profitable airline, British Airways, would be subject to UK regulations on foreign ownership for airlines operating in the UK. For example, the maximum percentage of foreign ownership for US airlines is 25 per cent. British Airways are now entirely owned by a EU based company, and a Brexit could therefore imply a possible divestment of British Airlines from IAG if British Airways is to continue be based in London after a potential Brexit. A possible divestment of the highest contributor to revenues would undoubtedly cause volatility in the share price of IAG, and we consider it to be a promising candidate for the straddle strategy.

Both Ryanair and IAG are great candidates for post-referendum share-price volatility. However, due to the aforementioned limitation (II) we only have access to the historical option prices for Ryanair as they are listed on NASDAQ in addition to LSE. Consequently, we can only pick Ryanair.

4.3 The Gold Industry

In general, gold is often perceived as a safe-haven for investors during periods of economic, social or political unrest (Gaffney, 2016). Thus, in pursuit of reduced volatility of their

portfolio, investors flee to gold – raising the price of the metal. Consequently, the price of gold is strongly influenced by uncertainty in financial markets (Li, 2013).

4.3.1 The Gold Price and the VIX Index

The CBOE Volatility Index (VIX Index) is a measurement of expectations on short-term volatility in the financial markets. It computes the expected level of volatility using option premiums as the variable (Chicago Board Options Exchange, 2014). In general, the premium of an option reflects the uncertainty of the underlying asset until the expiration date. Consequently, the VIX Index, which is positively correlated with option premiums, will increase in periods of social and economic uncertainty as the option premiums in the market will be higher.

Figure 4 displays the VIX Index and the gold spot price as a function of time. By plotting the VIX Index and the gold spot price in the same chart, we aim to illustrate the correlation between market uncertainty and development of the gold price. This is exemplified by using the 9/11 terrorist attack, as this caused massive instability in the US markets (Jackson, 2008) and consequently a spike in the VIX Index. Figure 4 illustrates the correlation and Table 2 verifies it.

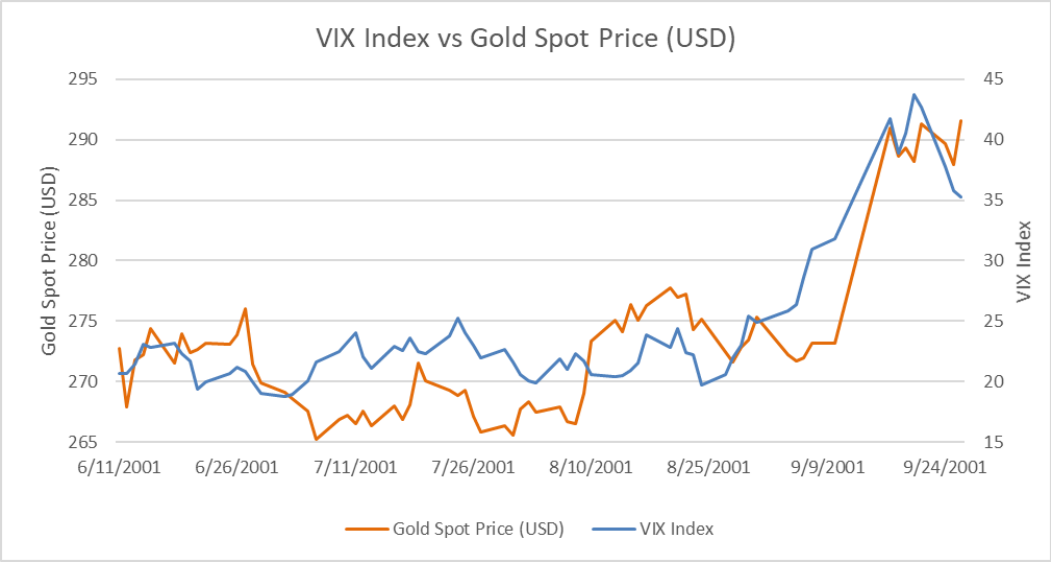


Figure 4 - The CBOE VIX Index vs Gold Spot Price

Description	R Square	P-value
Correlation of the Gold Spot Price and the VIX-index	0,68066944	5,26655E-16

Table 2 - Correlation Analysis on the VIX Index vs Gold Spot Price

The chart shows a steep incline in the VIX Index followed by a surge in the gold price, which is in line with our expectations. Given the unanticipated nature of the 9/11 attacks, we cannot expect a spike of similar magnitude in the VIX Index in the aftermath of the EU-referendum. However, we still believe the referendum will have an impact on the VIX Index for mainly two reasons. Firstly, in the event of Brexit, the actual impact on the British economy would be highly uncertain as the future relationship between the UK and the EU is subject to negotiations. The notion is that this uncertainty would be reflected in a higher VIX index. Secondly, in the event of Bremain, it is business as usual in the UK and the VIX Index is expected to adjust itself to a lower level compared to its level in the tense days leading up to the referendum. Considering the correlation between the VIX Index and the gold spot-price in times of uncertainty, we believe the gold spot-price will be volatile towards either outcome of the referendum.

4.3.2 Futures, Companies or ETFs?

The next question is how we best can incorporate the abovementioned relationship into our straddle portfolio to achieve maximum volatility. There are three different type of assets we can use:

(I) Options on gold future contracts
(II) Options on gold mining companies
(III) Options on ETFs that tracks the gold price.

As it is hard for us to determine which of these possibilities that provides the best option prices for a given amount of expected volatility, we will first exclude the possibility of buying options on gold future contracts. This is partly because if we exercise either of these options, we will have to trade in gold futures, which are extremely expensive. Moreover, if we fail to sell a future contract before it expires we will be the lucky owners of an X-amount troy ounces of gold.

In addition, one can buy a large variety of gold tracking ETFs invested in all sorts of companies and gold futures with different leverage ratios. This makes it complicated for us to pin point the most volatile EFT relative to its option price. We are more experienced with single companies compared to ETFs, and we will consequently concentrate on finding the most volatile gold mining companies and execute the straddle with options on these.

4.3.3 Picking the stocks

With regards to the expected gold price volatility post-referendum, we will try to identify the gold mining companies with the highest share price volatility towards the gold price. A good indicator for this relationship is the companies' respective gearing towards the gold price (Coulson, 2004).

A company with a high degree of operating leverage will be more sensitive towards changes in the gold price. This is what makes certain companies more geared towards the gold price than others. For further clarification, an example including average variable costs of production in Africa and North America is illustrated in Table 3. The most cost-efficient mining companies operate in North America, while the least cost-efficient operates in Africa (EY, 2014). Notably, gearing has the most effect on cost-inefficient companies; the lower the operating profit per ounce, the greater the impact on the bottom line with regards to changes in the gold price. Subsequently, the share price in companies with a relatively low operating profit is most likely to yield the highest volatility towards the gold price. Table 3 further exemplifies that a 1 per cent increase in the price of gold will increase the operating profit by ~3.15 per cent and ~16.47 per cent of an average North American and African mining company, respectively. Consequently, we aim to include companies with low profit per ounce of gold mined in our portfolio.

Original Price	Price/Ounce	Variable Cost/Ounce	Fixed Cost/Ounce	Operating profit/Ounce
North-American Company	1400	598	358	444
African Company	1400	957	358	85
Gold Commodity	1400	0	0	1400

1% increase in Gold Spot Price	Price/Ounce	Variable Cost/Ounce	Fixed Cost/Ounce	Operating profit/Ounce
North-America Company	1414	598	358	458
African Company	1414	957	358	99
Gold Commodity	1414	0	0	1414

Effects on the Companies/Gold Pr	
North-American Company	**3.15%**
African company	**16.47%**
Gold commodity	**1.00%**

Table 3 - The Gearing Effect with an 1% Increase in the Gold Spot Price

Starting with all 245 publicly listed gold mining companies worldwide (EY, 2014), we search for the most cost-inefficient miners. Given the continental differences in average variable costs of production, we expect companies operating in Africa to be the most volatile towards the price of gold. Thus, we exclude all companies without operations in Africa which leaves us with 42 companies. After a more thorough review of the remaining companies, we narrowed it down to the companies exclusively operating in Africa. This leaves us with 25 companies.

Due to the rigid rules of the issuance of options, our array of companies is significantly narrowed. This leaves us with two gold mining companies: Randgold Resources and Semafo Inc.

In terms of cost structure, Semafo Inc. has a lower cost per ounce in production (Els, 2016) compared to Randgold Resources. This leaves Randgold Resources as the most attractive company in terms of gearing towards the gold price, and we will thus pick this company for the straddle portfolio.

4.4 The Pound Sterling

The last asset we expect to be sufficiently volatile, and consequently pick for our portfolio, is the pound. The question is then what currency we will pair it with and what type of asset we will buy the options on.

The optimal currency pair for a straddle portfolio would be the pair that is the most volatile towards either outcome of the referendum. There is broad consensus among analysts (Danske

Bank, 2016) that the EUR/USD pair will decline in case of Brexit, and incline in case of Bremain due to the macroeconomic instability a Brexit would impose on the EU and Eurozone (Samson, 2016). Furthermore, the GBP/USD is expected to fluctuate in a similar pattern, with depreciation in case of Brexit and appreciation in case of Britain towards the dollar. In other words, The EUR and GBP will be positively correlated in either outcome of the referendum. Furthermore, the referendum is expected to have a larger impact on the British economy compared to the whole Eurozone. As a result, we expect the highest volatility currency pair to be GBP/USD.

To incorporate the GBP/USD currency pair in our straddle portfolio, we will buy options on the Guggenheim CurrencyShares British Pound Sterling ETF (FXB), which tracks the USD/GBP currency pair. With USD as the quote currency and GBP as the base currency, the value of the ETF's shares will increase in case of an appreciation of the GBP, or a depreciation of the USD. Conversely, the value of the shares will decrease in case of a depreciation of the GBP or an appreciation of the USD.

5. Execution of the Strategy

In the following section we will simulate the execution of the strategy and provide an evaluation of the outcome. More specifically, we will first provide a section on the initial purchase of the options, and then a section where we execute the strategy and calculate the return. Table 4 provides a summary of the selected assets we will buy options on.

Company Name	Ticker
Randgold Resources	GOLD
Lloyds Bank	LYG
Barclays	BCS
Royal Bank of Scotlan	RBS
Ryanair	RYAAY
FXB	FXB

Table 4 - The Selected Assets

The first thing to consider for the volatility strategy is the date to buy the options. In general, there are mainly two important factors with regards to timing: the time decay and the implied volatility. Regarding our strategy on the EU-referendum, we are faced with a trade-off between buying cheap options with low implied volatility early on when the polls did not

necessarily have much predictive value, or buying more expensive options with higher implied volatility closer to the referendum date. For example, if we had bought options for a straddle on the 20th of February (the announcement date) and the polls in mid-June predict an 80/20 vote to remain, a straddle strategy would be a poor strategy. Therefore, we have to evaluate the polls' predictive value at different dates against the implied volatility and the time decay of the options. On the one hand, with regards to time decay, the option premiums should be cheaper closer to the exercise date. This implies that we should wait as long as possible to buy the options for the strategy, namely buy the options close to the referendum. On the other hand, with regards to implied volatility, when the predictive value of the polls increases, the implied volatility priced in the option premiums is expected to be increasingly higher, which would make the options more expensive the closer it gets to the referendum. This would imply that we should buy the options as soon as we believe the polls have sufficient predictive value to indicate a close vote. As it is imperative to our strategy that the outcome of the referendum is an uncertainty for the markets, we will buy the options on the 20th of June, 4 days before the referendum. Even though the implied volatility will be substantial this close to the referendum, a straddle would be meaningless if the uncertainty is not priced into the market as this is a requirement for volatility in either outcome of the referendum.

The next step is to decide what options to buy on the chosen assets with regards to strike price and expiration date. We will buy the options with the shortest possible time until expiration, which in our case is 25 days. This is because the time decay factor will make options with a longer time until expiration more expensive. Furthermore, as a straddle strategy involves buying the options ATM, the premiums payed for a straddle will be higher compared to volatility strategies using OTM options. It is possible to perform neutral volatility strategies with OTM options, and thus we should evaluate whether we should use a volatility strategy with ATM- or OTM options. Another volatility strategy we could use is called a "strangle". A strangle is effectively the same as a straddle, except for the fact that the options bought are OTM, and consequently the premiums for a strangle will be cheaper (Cohen, 2016). Thus, it is cheaper to enter a strangle than a straddle. An interesting relationship to investigate when deciding between a strangle and a straddle is the required volatility in the share price (% change) to break even on the strategy.

Break-Even Equations:

$$Break\ Even\ Volatility\ (UP) = \frac{(X_{HIGH} + C_0 + P_0 - S_0)}{S_0} * 100\%$$

$$Break\ Even\ Volatility\ (DOWN) = \frac{(X_{LOW} - C_0 - P_0 - S_0)}{S_0} * 100\%$$

$X = Strike\ price$
$C_0 = The\ price\ of\ a\ call\ option\ today$
$S_0 = Price\ of\ underlying\ asset\ today$
$P_0 = The\ price\ of\ a\ put\ option\ today$

Note: In a straddle strategy, the two strike prices (high/low) will be equal.

A break-even volatility analysis of the assets is illustrated in Table 5 & 6. The tables display the required volatility to break even for the different assets when using a strangle and straddle, respectively. Moreover, the tables provide detailed information regarding the price of the options, volatility measures and strike prices. A paragraph on characteristics of the data can be found in the appendix.

Sector	Company Name	Ticker	Share Price Close, 20 June	Strike Price Call	Strike Price Put	Option Premium - Call	Option Premium - Put	Total Premium	Break Even - UP (%)	Break Even - DOWN (%)	Average Absoloute Break Even Volatility
Mining	Randgold Resources	GOLD	$ 95,63	$ 97,50	$ 92,50	$ 3,00	$ 2,55	$ 5,55	7,8 %	-9,1 %	8,4 %
Bank	Lloyds Bank	LYG	$ 4,12	$ 5,00	$ 3,00	0,1	0,1	$ 0,20	26,2 %	-32,0 %	29,1 %
	Barclays	BCS	$ 10,27	$ 11,00	$ 9,00	0,29	0,2	$ 0,49	11,9 %	-17,1 %	14,5 %
	Royal Bank of Scotland	RBS	$ 6,94	$ 8,00	$ 6,00	0,1	0,15	$ 0,25	18,9 %	-17,1 %	18,0 %
Airline	Ryanair	RYAAY	$ 79,74	$ 85,00	$ 75,00	0,55	1,6	$ 2,15	9,3 %	-8,6 %	9,0 %
Currency	GBPUSD	FXB	$ 143,62	$ 145,00	$ 143,00	2,4	3,32	$ 5,72	4,9 %	-4,4 %	4,7 %

Table 5 - Break-Even Volatility Using a Strangle Strategy

Sector	Company Name	Ticker	Share Price Close, 20 June	Strike Price	Option Premium - Call	Option Premium - Put	Total Premium	Break Even - UP (%)	Break Even - DOWN (%)	Average Absoloute Break Even Volatility
Mining	Randgold Resources	GOLD	$ 95,63	$ 95,00	$ 4,31	$ 3,50	$ 7,81	7,5 %	-8,8 %	8,2 %
Bank	Lloyds Bank	LYG	$ 4,12	$ 4,00	$ 0,31	$ 0,20	$ 0,51	9,5 %	-15,3 %	12,4 %
	Barclays	BCS	$ 10,27	$ 10,00	$ 0,75	$ 0,48	$ 1,23	9,3 %	-14,6 %	12,0 %
	Royal Bank of Scotland	RBS	$ 6,94	$ 7,00	$ 0,40	$ 0,45	$ 0,85	13,1 %	-11,4 %	12,2 %
Airline	Ryanair	RYAAY	$ 79,74	$ 80,00	$ 2,20	$ 2,05	$ 4,25	5,7 %	-5,0 %	5,3 %
Currency	GBPUSD	FXB	$ 143,62	$ 144,00	$ 3,10	$ 3,69	$ 6,79	5,0 %	-4,5 %	4,7 %

Table 6 - Break-Even Volatility Using a Straddle Strategy

As highlighted in the figures, the straddle requires a lower break-even volatility compared to the strangle for all assets except for the FXB currency which has equal required volatility. Therefore, we will use the straddle on all assets except for FXB.

To decide which strategy to use for FXB, we will graph the percentage return functions for the asset with the two strategies. This is illustrated in figure 5.

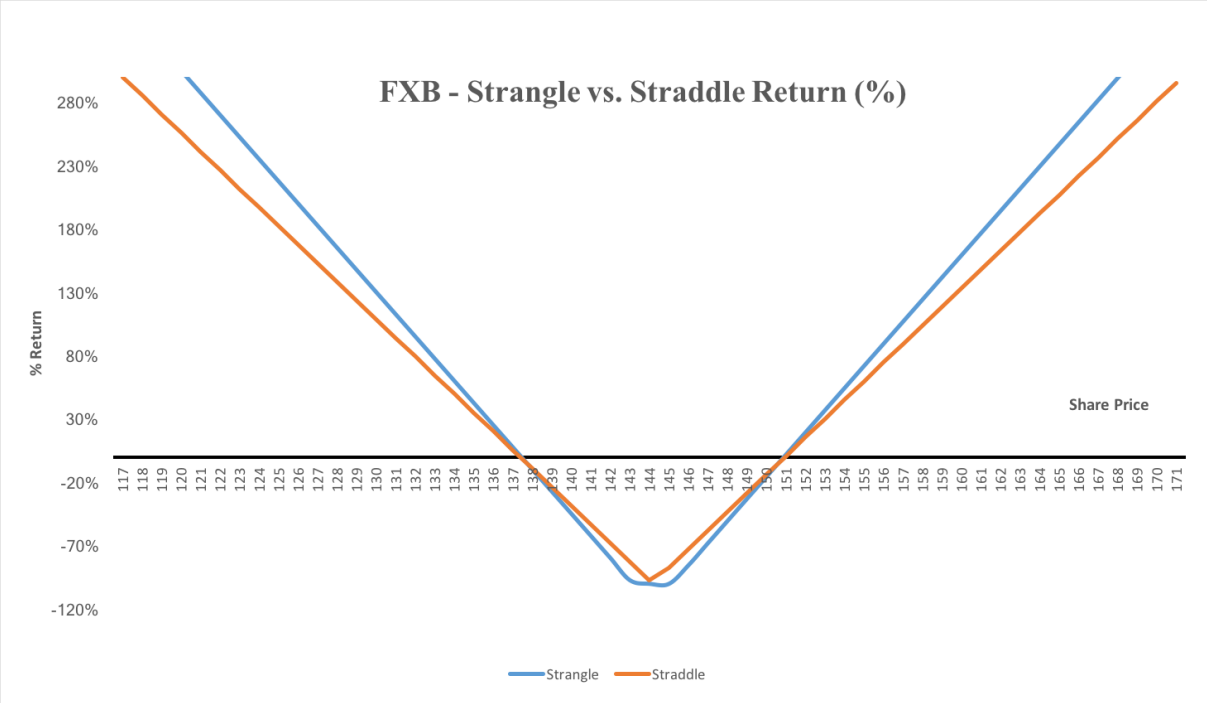


Figure 5 - Return FXB with a Straddle and a Strangle

Figure 5 shows that the strangle will yield a higher profit per change in share price of the underlying asset when the share price is above break-even price. Additionally, the strangle position is cheaper than the straddle which means we can buy more strangles for the same amount of money. Therefore, we will prefer the strangle strategy for FXB.

The last step in implementing the volatility strategies is to buy the selected options at the selected date. Since we are using historical data, we will base our calculations on the close price of the different options. If we had done this in real time, we would have tried to minimize the trading cost by getting in between the best- bid and ask. As a strangle involves buying OTM options in which the spread is usually wider, it is harder to achieve a good price on a strangle compared to a straddle where the options are ATM. A good price on the options will lead to a lower required volatility to break even, and is thus an important aspect of a

volatility strategy that we unfortunately cannot elaborate further in this paper due to the historical data limitation.

5.1 Exercising the Options

We will exercise the options on the 24th of June, which is the day after the referendum. In general, an investor holding a straddle will exercise the options when he believes the underlying asset has reached its maximum or minimum value as this will yield the highest profit. As it is impossible to predict when the top/bottom is reached, we are in no position to make a qualified decision on which day to exercise the options. Additionally, the purpose of this paper is to attempt to make money on the EU-referendum and thus we will try to isolate the effect of the vote by exercising the options the following day.

Another possible execution would be to sell the options in the market rather than exercising them. The decision between exercising or selling the options is an important aspect to consider when using a neutral volatility strategy. However, due to the limitation on number of words in this paper, we unfortunately cannot elaborate further on this decision. Therefore, we will perform the execution by exercising the options.

Table 7 & 8 illustrates the per cent return of the straddle portfolio with optimal and pessimal execution, respectively. Since the execution takes place on the 24th of June, the outcome of the referendum is known. An optimal execution of our portfolio involves exercising the put options and selling the stock at the intraday low for the assets with expected negative volatility post-Brexit, and exercising the call options and selling the stocks at the intraday high for the assets with expected positive volatility post-Brexit. An optimal execution would yield a phenomenal return of 89 per cent over the course of four days.

Conversely, a pessimal execution involves exercising the put options on the intraday high for the assets with expected negative volatility, and exercising the call options on the intraday low for the assets with expected positive volatility. This would yield a negative return of 23 per cent.

Optimal Execution

Company Name	Ticker	Share Price - Best Case	Strike	Total Premium	Profit per straddle	Money invested	# of straddles bought	Total Profit	Δ (%) Share Price vs Strike Price	Return
Randgold Resources	GOLD	105.58	95	7.81	2.77	100000	12804	35467.08	11.14%	35.47%
Lloyds Bank	LYG	3.17	4	0.51	0.32	100000	196078	62744.96	-20.75%	62.74%
Barclays	BCS	Not Applicable	10	1.23	1.82	100000	81300	147966	Not Applicable	147.97%
Royal Bank of Scotland	RBS	5.41	7	0.85	0.74	100000	117647	87058.78	-22.71%	87.06%
Ryanair	RYAAY	71.2	80	4.05	4.75	100000	24691	117282.25	-11.00%	117.28%
FXB	FXB	132.6	143	5.72	4.68	100000	17482	81815.76	-7.27%	81.82%
									Total Return	**89%**

Table 7 – Total Return with an Optimal Execution

Pessimal Execution

Company Name	Ticker	Share Price - Worst case	Strike	Total Premium	Profit per straddle	Money invested	# of straddels bought	Total Profit	Δ (%) Share Price vs Strike Price	Return
Randgold Resources	GOLD	99.33	95	7.81	-3.48	100000	12804	-44557.92	4.56%	-44.56%
Lloyds Bank	LYG	3.4	4	0.51	0.09	100000	196078	17647.02	-15.00%	17.65%
Barclays	BCS	10	10	1.23	-1.23	100000	81300	-99999	0.00%	-100.00%
Royal Bank of Scotland	RBS	6.14	7	0.85	0.01	100000	117647	1176.47	-12.29%	1.18%
Ryanair	RYAAY	77.88	80	4.05	-1.93	100000	24691	-47653.63	-2.65%	-47.65%
FXB	FXB	135.34	143	5.72	1.94	100000	17482	33915.08	-5.36%	33.92%
									Total Return	**-23%**

Table 8 - Total Return with a Pessimal Execution

However, as the share price of Barclays has intraday movements on each side of the strike price, the optimal and pessimal execution on this stock would differ from the abovementioned. The optimal execution on Barclays would be to exercise the call options when the price is on intraday high, and exercise the put options when the price is on intraday low. By optimal execution, the Barclays investment would yield a 148 per cent return. In contrast, the pessimal execution would be to exercise the call- and put option marginally above and below the strike price, respectively. Naturally, this would yield the maximum negative return of ~100 per cent on the investment.

5.2 Trading is a Science and Mastering it is an Art

We believe it would be nearly impossible to execute the trading optimally. However, we hope the pessimal execution would not be a likely scenario either. We would most likely end up somewhere in between the two points of the continuum. Thus, we believe a realistic return would be somewhere close to the average of the two scenarios, which would have yielded a total return of 33 per cent. We find this result more than satisfactory over the course of four days, and we are confident that our approach could prove profitable on similar events in the future.

6. Critique and Limitations

When writing this essay and conducting the straddle strategy, we have found it necessary to adjust our choices and decisions in order to fit limitations and restrictions due to several factors. We will elaborate on the most central of these in the following.

Despite pretending to write this essay on the 20th of June 2016, we must acknowledge that our choices of sectors and companies, and the general analysis of potential outcomes of the referendum, are to some extent biased by what happened.

There are sectors we wished to elaborate further, but due to circumstances like option- or data availability, as well as the requirements of writing this essay, we have not had the chance to do so. For instance, the housing market is obviously something we would have wanted to analyse further, as the influence the Brexit had on companies in this sector was severe. This

also applies to the choice of companies within the industries, such as British Airways and EasyJet.

We have not included the commissions when buying options. This might possibly have affected the choice of companies, and decreased our total profit from the strategy.

A profit from a straddle strategy is mainly dependent on two variables: The price of the options and the share-price volatility. An optimal paper on this subject would have evaluated the price of the options directly towards the expected volatility on the different assets. As it is very hard to quantify the expected volatility, we have not been able to incorporate this relationship thoroughly enough in our paper. This constitutes a weakness in this paper that the reader should be aware of.

The implications of buying data from the Chicago Board Options Exchange (CBOE) website is that it only gives us access to traded options on the CBOE. It is reasonable to expect that options on some of the companies we have chosen, have been traded through other exchanges like NYSE and AMEX, enabling the possibility of us being offered different option premiums, for instance with wider/tighter spreads. This might have affected the profits.

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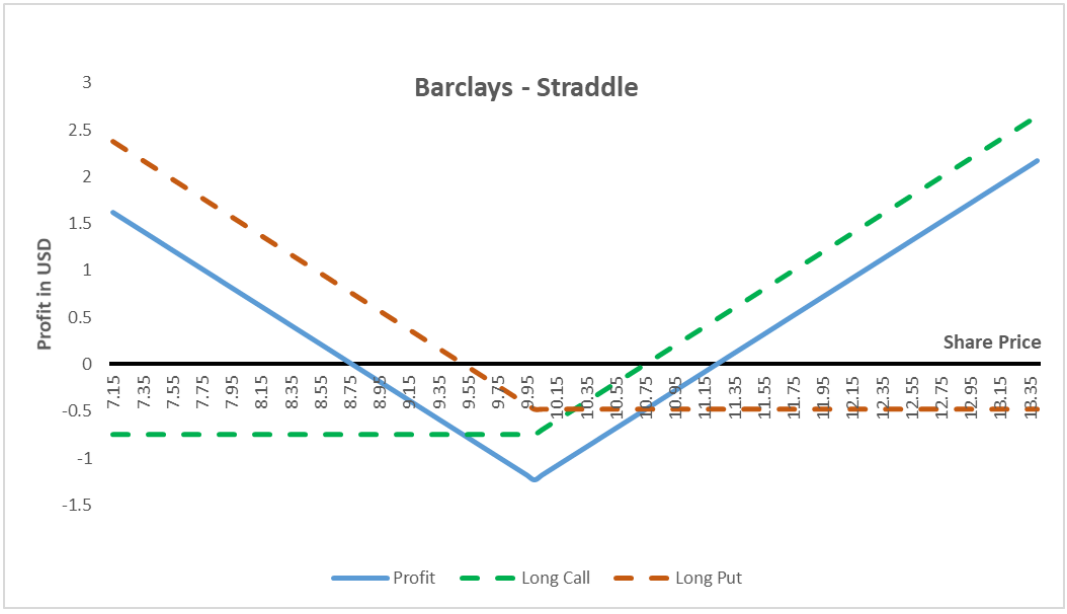
Appendix

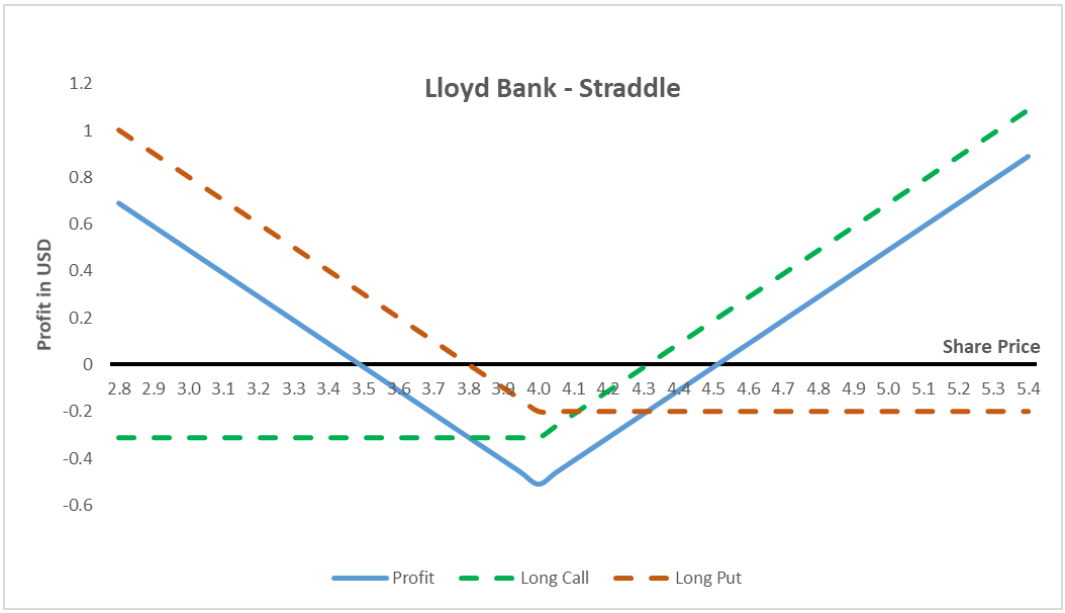
The Data Used in this Paper

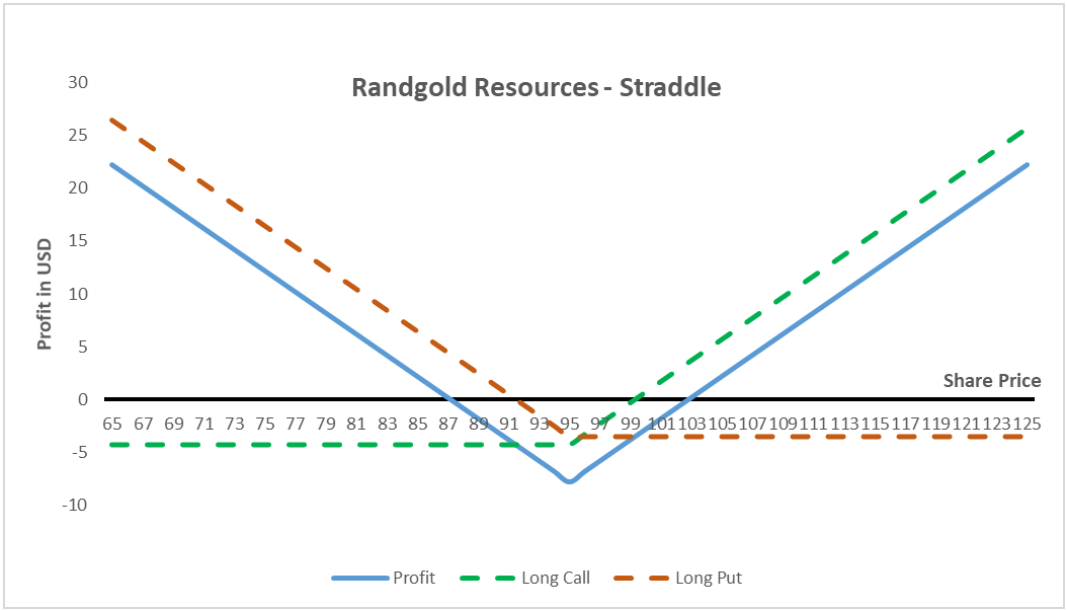
The options data is acquired from Chicago Board Options Exchange (CBOE) LiveVol, which provide historical options data from 2004 to present. CBOE is the world's largest options exchange, providing data on market quote, size, highest and lowest trade and volume traded. A sample of the data set for the FXB asset is provided below.

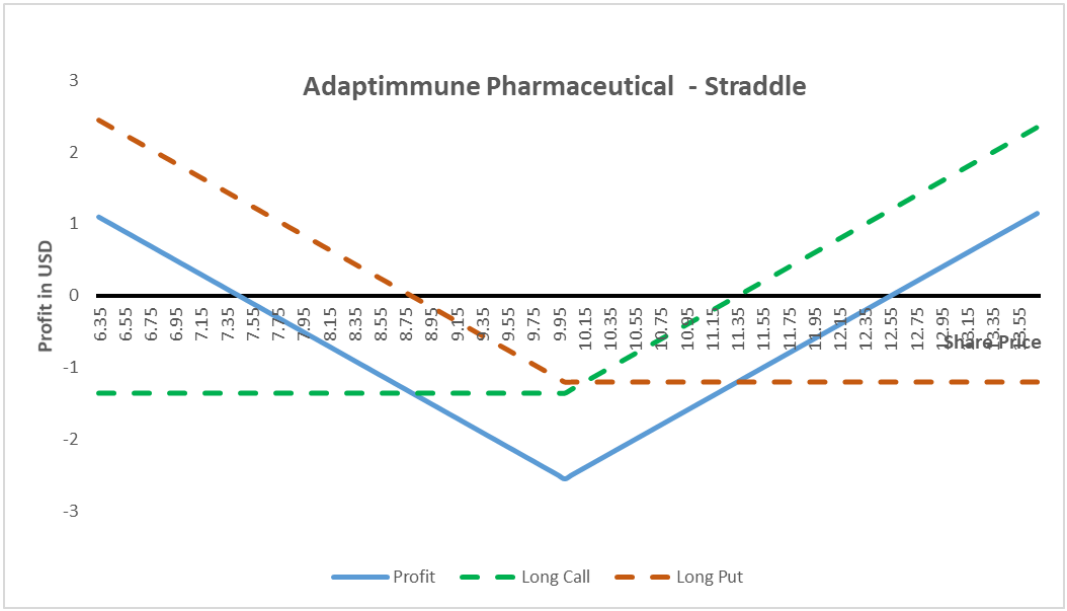
quote_date	root	expiration	strike	option_type	open	high	low	close	trade_volume	bid_size_1545	bid_1545	ask_size_1545	ask_1545	underlying_bid_1545	underlying_ask_1545	bid_size_eod	bid_eod	ask_size_eod	ask_eod	underlying_bid_eod	underlying_ask_eod	vwap
6/20/2016	FXB	7/15/2016	137	p	1.35	2.65	1.35	1.5	76	116	1.35	10	1.55	143.63	143.64	90	1.5	104	1.7	143.58	143.62	1.84
6/20/2016	FXB	7/15/2016	138	c	6.75	6.75	6.75	6.75	1	668	6.3	276	7.6	143.63	143.64	419	6.3	149	7.6	143.58	143.62	6.75
6/20/2016	FXB	7/15/2016	138	p	1.6	1.92	1.6	1.7	46	45	1.6	5	1.75	143.63	143.64	31	1.6	10	1.75	143.58	143.62	1.75
6/20/2016	FXB	7/15/2016	139	c	6	6	6	6	1	666	5.6	21	6.7	143.63	143.64	406	5.6	21	6.7	143.58	143.62	6
6/20/2016	FXB	7/15/2016	139	p	2.2	2.2	1.95	2.05	12	95	1.95	12	2.05	143.63	143.64	32	1.85	21	2.1	143.58	143.62	2
6/20/2016	FXB	7/15/2016	140	c	5.4	5.8	5.2	5.8	67	15	5.7	5	5.8	143.63	143.64	21	5.6	5	5.7	143.58	143.62	5.53
6/20/2016	FXB	7/15/2016	140	p	2.2	2.65	2.2	2.2	82	1	2.15	12	2.3	143.63	143.64	20	2.15	5	2.25	143.58	143.62	2.3
6/20/2016	FXB	7/15/2016	141	c	5.09	5.09	5.09	5.09	1	385	4.7	369	5.4	143.63	143.64	37	4.8	240	5.4	143.58	143.62	5.09
6/20/2016	FXB	7/15/2016	141	p	2.6	2.75	2.6	2.75	19	45	2.4	663	3	143.63	143.64	44	2.4	491	3	143.58	143.62	2.66
6/20/2016	FXB	7/15/2016	142	c	4.2	4.4	4.2	4.4	44	428	4	1	4.4	143.63	143.64	277	4	66	4.6	143.58	143.62	4.25
6/20/2016	FXB	7/15/2016	142	p	2.97	2.97	2.8	2.8	9	387	2.5	579	3.3	143.63	143.64	293	2.5	309	3.3	143.58	143.62	2.95
6/20/2016	FXB	7/15/2016	143	c	3.38	3.8	3.38	3.7	227	10	3.7	2	3.8	143.63	143.64	211	3.5	2	3.8	143.58	143.62	3.59
6/20/2016	FXB	7/15/2016	143	p	3.65	3.65	3.1	3.32	35	176	3	628	3.7	143.63	143.64	213	3	379	3.7	143.58	143.62	3.28
6/20/2016	FXB	7/15/2016	144	c	3.24	3.24	2.9	3.1	232	134	2.95	1	3.1	143.63	143.64	142	2.95	218	3.4	143.58	143.62	3.09
6/20/2016	FXB	7/15/2016	144	p	3.79	3.79	3.6	3.69	8	141	3.4	653	4.2	143.63	143.64	123	3.4	611	4.2	143.58	143.62	3.74
6/20/2016	FXB	7/15/2016	145	c	2.33	2.6	2.2	2.4	42	478	2.3	1	2.65	143.63	143.64	428	2.3	1	2.65	143.58	143.62	2.29
6/20/2016	FXB	7/15/2016	145	p	4.2	4.36	4.1	4.23	46	248	3.8	668	4.8	143.63	143.64	230	3.8	400	4.8	143.58	143.62	4.26
6/20/2016	FXB	7/15/2016	146	c	0	0	0	0	0	652	1.75	21	2.2	143.63	143.64	415	1.75	17	2.2	143.58	143.62	0
6/20/2016	FXB	7/15/2016	146	p	4.2	4.7	4.2	4.51	63	467	4.2	625	5.3	143.63	143.64	279	4.2	316	5.3	143.58	143.62	4.36
6/20/2016	FXB	7/15/2016	147	c	1.61	1.67	1.45	1.53	435	945	1.2	1	1.7	143.63	143.64	335	1.2	1	1.7	143.58	143.62	1.52
6/20/2016	FXB	7/15/2016	147	p	0	0	0	0	0	317	4.8	643	5.9	143.63	143.64	271	4.8	428	5.9	143.58	143.62	0
6/20/2016	FXB	7/15/2016	148	c	1.4	1.4	1.1	1.3	11	773	0.9	12	1.3	143.63	143.64	387	0.95	12	1.3	143.58	143.62	1.29

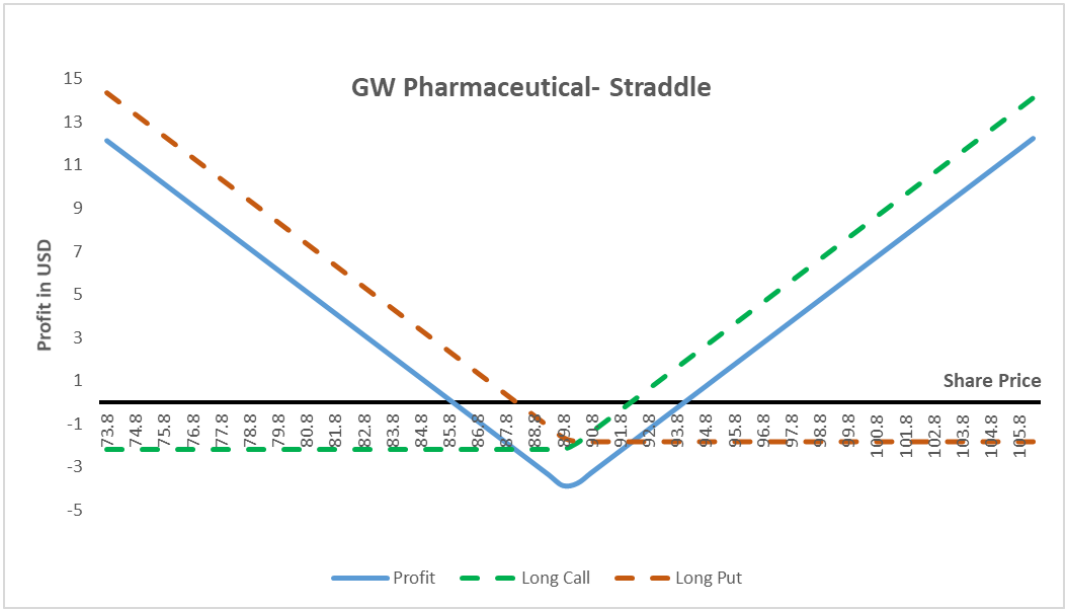
Profit Charts for the Assets

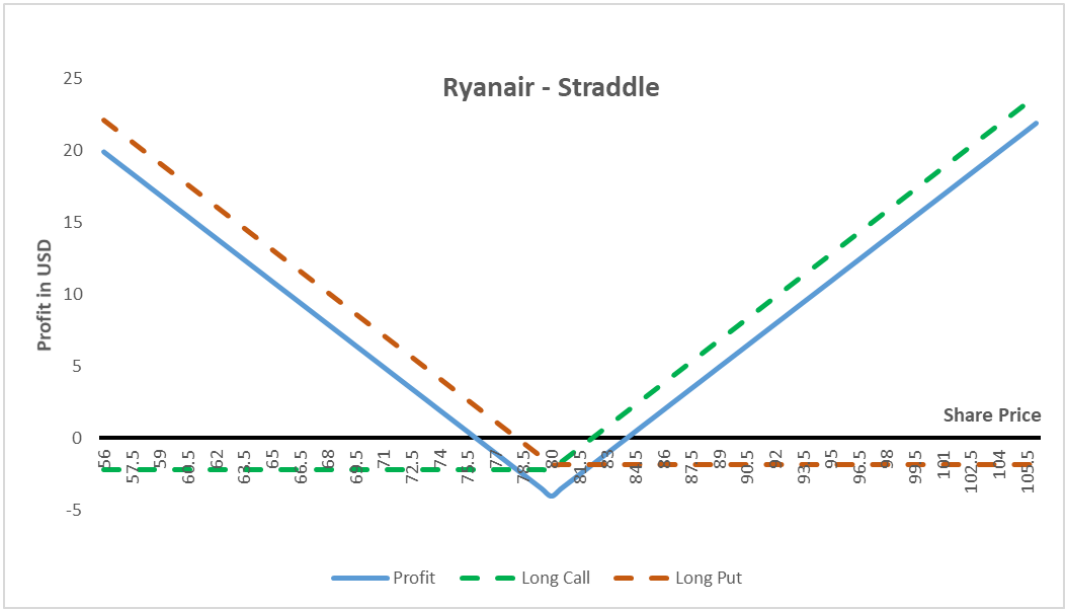


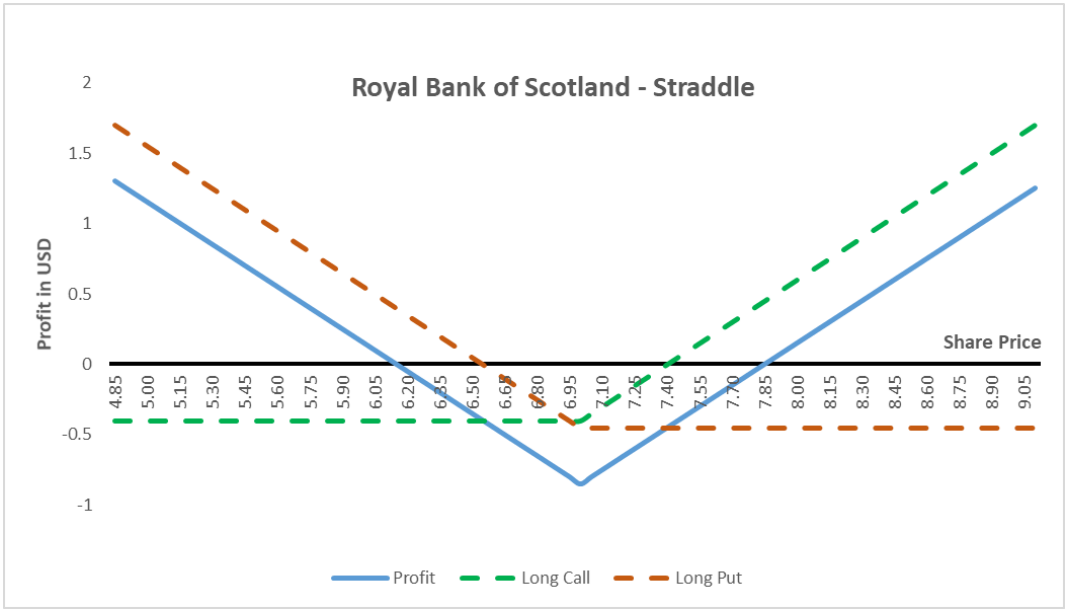


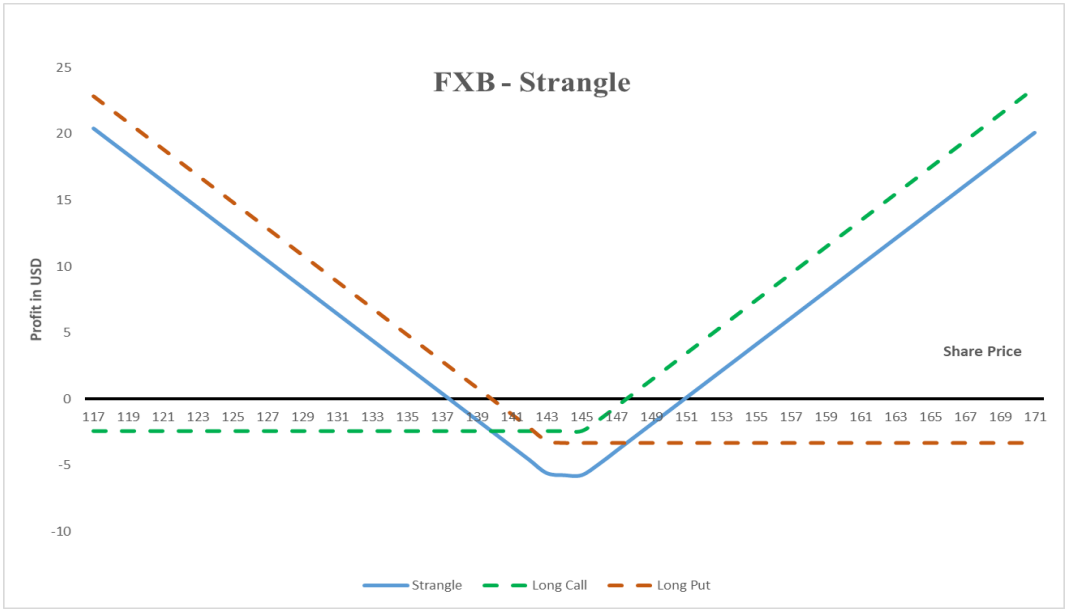

Randgold Resources - Straddle
Profit in USD
Share Price
Profit
Long Call
Long Put


Adaptimmune Pharmaceutical - Straddle
Profit in USD
Share Price
Profit
Long Call
Long Put


GW Pharmaceutical- Straddle
Profit in USD
Share Price
Profit
Long Call
Long Put


Ryanair - Straddle
Profit in USD
Share Price
Profit
Long Call
Long Put


Royal Bank of Scotland - Straddle
Profit in USD
Share Price
Profit
Long Call
Long Put


FXB - Strangle
Profit in USD
Share Price
Strangle
Long Call
Long Put