UNIVERSITY OF LJUBLJANA

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MASTER'S THESIS

EXCHANGE RATE RISK PROTECTION: CREATING A MODEL FOR A SELECTED COMPANY

Ljubljana, February 2017 TIMO GRANDOVEC, 19522771

AUTHORSHIP STATEMENT

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INTRODUCTION

Today's highly modernized and technologically advanced world offers integration never seen before. Businesses today are finding out, that in order to be successful, domestic market is not enough and that in order to grow, companies must expand to foreign markets. Expanding to foreign markets is not easy: one must deal with foreign regulatory forms, foreign culture and many times also foreign currency. Being exposed to making business in foreign currency may cause a lot of difficulties and instability for a company. Where one currency will depreciate, the other may be in a better position because suddenly those products and services will be cheaper and therefore more competitive. The opposite applies in the other direction. This situation of instability and uncertainty makes it hard for top management's planning of strategy and cash flows, taking care for a firm's certain liquidity. Due to today's uncertain political situation in the East Europe, regarding Russia as a large exporting market for European firms, with depreciating rouble significantly cutting down their revenues, this topic is especially relative to all top managements looking for opportunities in the East. Euro, having problems with debt crisis, makes this topic even more interesting, with a simple question asked: "How can a firm isolate itself from currency volatility turmoil?"

There are several modern techniques that enable us to hedge against currency volatility and therefore effectively plan our future cash flows. However, those instruments also cause certain costs. Those costs are not limited only to actual costs of instruments, that the company must pay to the intermediary for carried out service, they include also opportunity costs of missed profits for the favourable dynamics of currency to the firm, as firm can benefit strongly also from domestic currency depreciation.

Given that today's companies operate using efficient and powerful informational systems, which give insight and traceability also to actions in the past, it would be wise to analyse past transactions and execute some form of hypothetical simulation of past actions. This method can give a reliable result of what would happen in what-if scenario with no harm to the present reality with no additional costs. On the other side, we can also use a proven method, such as Value-at-Risk for 5% (hereinafter: VAR5) simulation, to connect with the real-time data. With those two tools we can look more deeply into what would happen in case of hedged and non-hedged scenario.

The purpose of this master thesis is exactly that – first, I will carry out an analysis of hedged cash flows based on real transactions in the past; I will compare each transactions in hedged and non-hedged scenario. With this method, I will analyse the behaviour of the instruments and the behaviour of the results – which markets performed best and we actually made profit on hedging, and also which markets didn't perform well. Second, I will carry out a VAR5 simulation for all observed markets and try to look for parallels between both methods in search of the common conclusions.

The entire thesis on the subsequent pages is trying to be as applicable as possible, as it is based on the real-life example of Company X. Company X is a real Slovenian company, however, all the data are codified in order to protect the true identity of the company. The thesis will describe Company X's situation, its problems and connect them with the theoretical part of the thesis. The theoretical part will describe the basic theory of forwards and futures contracts, what applies for the currency hedging with the following part of the research. Research part represents the core of this thesis – it will present 2 methods, analysis of real-life historical data and VAR5 simulation, the empirical development, the final results and the correlation links of simulation with the real-life factors and of course the common conclusions of both methods.

The purpose of the first method is to compare two scenarios under the assumption, that in order to add more flexibility to sales process, all the contracts are now not made in euros, but in a foreign currency. In the first scenario, we would not hedge the turnover, while in the second scenario we would hedge it. The result will be the positive/negative difference between the two. Markets will be compared and at the end conclusions will be drawn.

The second method will be basically the analysis of VAR5 simulation between the examined markets. Two VAR5 simulations will be carried out for each market, one for simulated Earning before taxes (hereinafter: EBIT) of non-hedged cash flows and one for simulated EBIT of hedged cash flows. I will try to prove, that hedged cash flows simulation gives us a better and a more stable distribution of expected result. Basically, this method will compare VAR5 and standard deviation result of hedged and non-hedged simulation.

The third part of the research will be to connect the first and second method. As already stated, the first method is a historical analysis of real cash flows in Company X, while the second method is a simulation of future results, based on the volatility of past foreign currency movements. The third part will therefore look for the common conclusions in order to give this thesis a red line ending.

In the first part of the thesis, the general situation of Company X will be presented: its financial results and financial exposure to foreign currency, the simple correlation presentation of the rise/fall of sales with currency dynamics and also the future prediction of the cash flows on the markets with foreign currency. Next, the thesis will move to the theoretical part. Transaction, translation and economic risk of currency exposure will be presented, together with the measurement of the exchange rate risk. Next, (as the whole simulation and analysis is also based on) the forwards and future contracts will be presented: how they work and what is their purpose. Lastly, the thesis will move to the simulation part with the methodology already shortly described in the last paragraph.

1 COMPANY X'S SITUATION

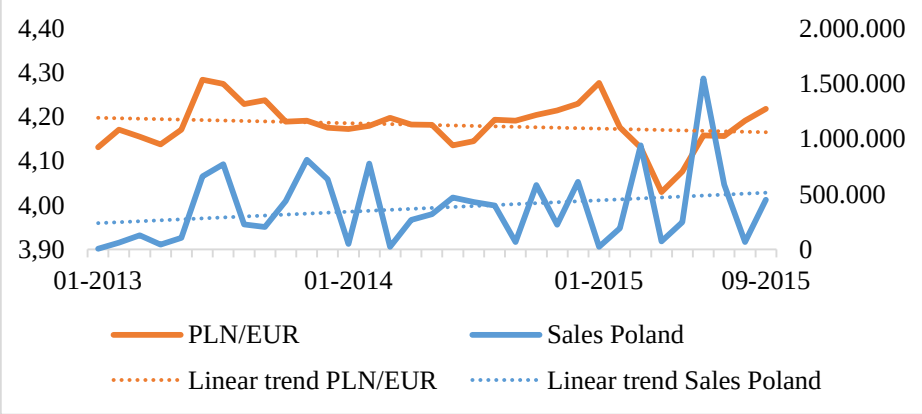
1.1 Financial results and financial exposure to foreign currency

The true data of Company X cannot be revealed, and also all of the projected data in the master thesis will be codified for the interest of the company. Although I cannot reveal Company X's real name or area of industry, I can unveil series of (codified) financial data and events, which will present the troubles all euro-zone companies are facing, when doing business in other currency markets. In this chapter I will describe Company X in allowed frames, and present a simple forecast on the foreign currency markets delivered by company's area managers and management board.

The industry that Company X operates in is very investment sensitive. As soon as there is a glimpse of economic crisis, investments shutter and the impact on business results is significant. The other aspect that we must consider is the product type, which Company X produces. Produced products are standardized and homogenized and regulated with industry standards. That means that there is not much room for product differentiation and we can also speak about a perfect competition. The biggest factor leading to sales is the price. That means that sales process should be as flexible as possible in order to attract customers and adapt to their conditions. As the price is the biggest factor of sales, we must also consider the price movement that happens because of currency dynamics: as domestic currency depreciates, it is easier to sell in markets with foreign currency, as suddenly your products are cheaper. Exchange rate dynamics can have a huge impact on acompany's cash flows and market value (Doehring, 2008).

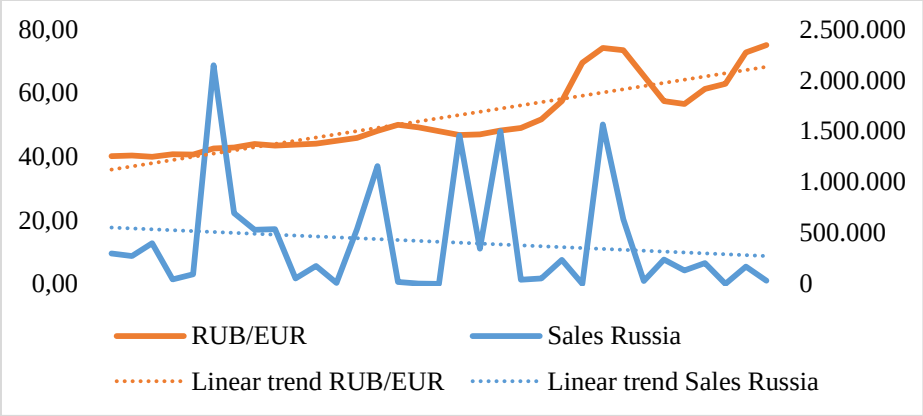
Below we can find a simple correlation Figures for markets of Poland, Russia, Sweden and United Kingdom (hereinafter: UK) Switzerland's data of orders was not available), where sales trends are shown together with spot rate dynamics. Figures show real-life dynamics of sales, invoiced in €, correlated with the dynamics of foreign currency.

Figure 1. Sales and exchange rate dynamics – Poland



Source: Company X, *Internal Data*, 2016; Oanda.com, *Historical rates database*, 2016.

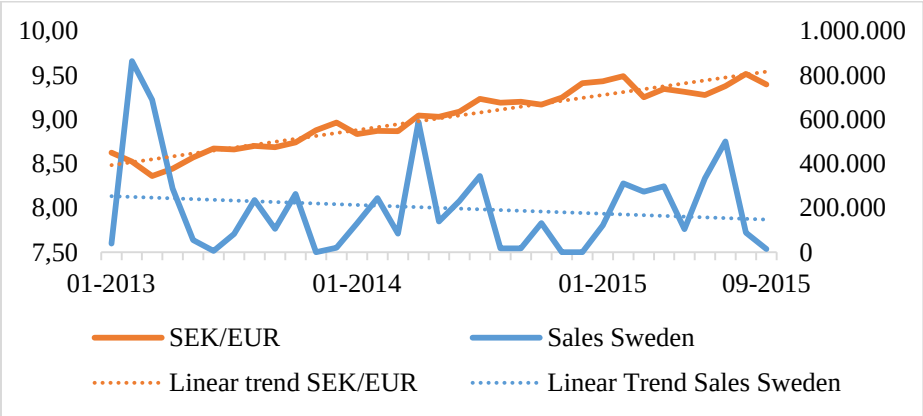
Figure 2. Sales and exchange rate dynamics – Russia



Source: Company X, *Internal Data*, 2016; Oanda.com, *Historical rates database*, 2016.

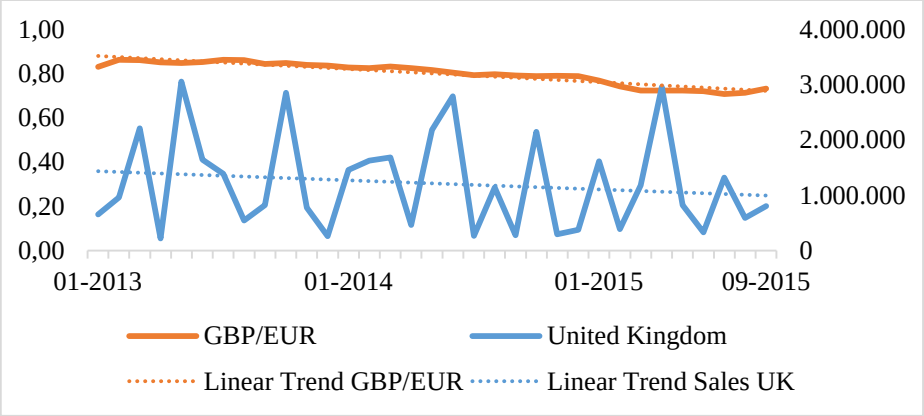
Figures 1, 2, 3 and 4 show interesting observations. Mostly we can see that exchange rate has an inverse influence on new sales orders. In the cases of Sweden, Russia and Poland, this observation fits – euro appreciation or depreciation had an inverse effect on sales. If euro had appreciated, like in the cases of Sweden and Russia, sales had dropped. If euro had depreciated, like in the case of Poland, sales went up. The Figures clearly show a clear correlation between currency and sales dynamics. Therefore, we can conclude that we would stabilize our sales, if we started making all of the contracts in foreign currency in order to adapt to the conditions of the customers in order to stop linking sales with currency dynamics as exchange rate dynamics have a connection with end earnings (Chang, Hsin, & Shiah-Hou, 2012) and stock prices ((Hsin, Shiah-Hou, & Chang, 2007).

Figure 3. Sales and exchange rate dynamics – Sweden



Source: Company X, *Internal Data*, 2016; Oanda.com, *Historical rates database*, 2016.

Figure 4. Sales and exchange rate dynamics – United Kingdom



Source: Company X, *Internal Data*, 2016; Oanda.com, *Historical rates database*, 2016.

Forecasting of exchange rate is proven to be extremely difficult – so hedging of our foreign cash flows can be a logic idea (Nikolopoulos, Litsa, Petropolous, Bougiokos, & Khammash, 2014). Making that (start making contracts in foreign currency) will therefore also be my assumption in deriving the simulation: what would happen, if we hedged all our orders in foreign currency, versus what would happen, when we wouldn't hedge all our orders in foreign currency, as that would help Company X to reduce costs, increase revenues and reduce risk (Kosarev, Nepp, Domnikov, Olga, & Campbell, 2012).

1.2 Simple forecast of future cash flows of foreign currency

Company X has recently issued a new 5-year plan with sales forecast until 2020 in euros. The plan was drawn up by the management board, signed and approved by the sales directors of regional areas. Plan was prepared under the assumption of complete reorganization of the company, targeting a bigger market share in the specific region. Below we can see the sales forecast on the markets with foreign currency.

Table 1. Sales forecast on markets with foreign currency

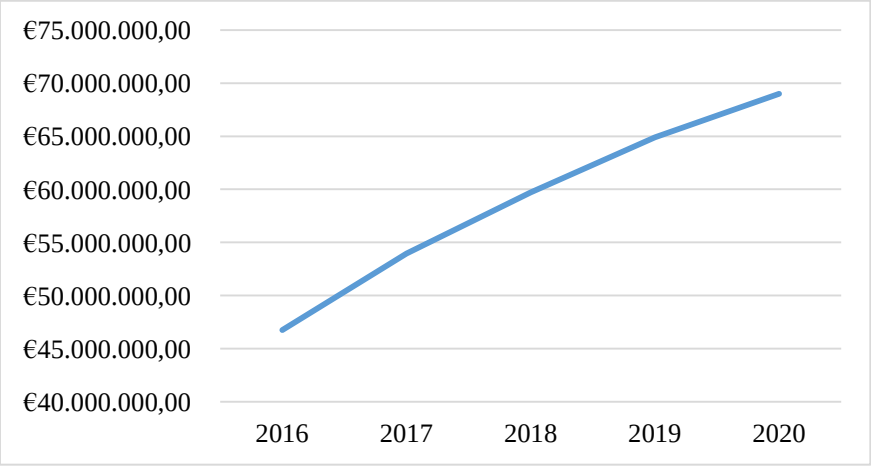
Sales forecast in € million	**2016**	**2017**	**2018**	**2019**	**2020**
United Kingdom	22,0	23,5	25,7	27,4	30,5
Poland	7,5	8,0	8,5	8,9	8,7
Russia	5,1	7,3	8,2	9,6	9,9
Sweden	5,8	7,2	7,1	7,8	7,9
UAE	1,6	2,6	3,3	3,9	3,8
Singapore	1,6	2,5	3,2	3,4	4,0
Saudi Arabia	2,2	1,5	2,1	2,2	2,3
Qatar	0,4	0,7	0,9	1,1	1,2
MENA other	0,7	0,8	0,8	0,8	0,7
Total in € million	**46,8**	**54,0**	**59,7**	**64,9**	**69,0**

Source: Company X, *Internal Data*, 2016.

As we can see in Table 1 and Figure 5, Company X is forecasting sales in a total of € 69 million on the markets with foreign currencies, with a steady annual average growth of 12%. Eventhough the plan is made in euros, we can see the ambition of Company X to increase sales. This ambition, however, would require certain measures to come closer to the customer, and issuing invoices in foreign currency can be one of them.

The largest share of sales represent Russia, Poland, Sweden and United Kingdom. Poland and Sweden's currencies are pegged to the euro and are recognised as fairly stable. Pound sterling is in a free floating rate compared to euro and is thus already a little bit more riskier. However, as we compare those three currencies with Russian rouble, they are proven to be far more stable as the latter. Also, as evidence shows, markets from former eastern block are more sensitive to macroeconomic news, than the west (Egert & Kočenda, 2012).

Figure 5. Total sales forecast on markets with foreign currency



Source: Company X, *Internal Data*, 2016.

Figure 5 shows that an annual growth of 12% is planned on markets with foreign currency and as already written at the end of chapter 2.1, one must take certain measures in order to achieve such growth. One of them is to start making contracts in foreign currency instead of in euros.

This thesis will analyse the exposure and a simulation of the company to foreign currencies, when Company X would start with such a policy: making deals in foreign currencies and therefore also issuing invoices in foreign currencies. In the next chapter the exposure to foreign currency on the 5 main foreign currency markets will be analysed.

1.3 Company X's foreign currency exposure

Big companies are more vulnerable to exchange rate risk (Lan, Chen, & Chuang, 2014)) and as fairly big Slovenian company, Company X surely goes into that class. Company X has 5 main foreign currency markets: United Kingdom, Sweden, Switzerland, Poland and

Russia. Each of them has its own characteristics – season peaks, invoice volume, total sales etc. On the other side we must also consider the currency volatility in each individual market.

Data descriptives will be analysed for each individual market. I will further divide each market data descriptives into two parts, analysis of invoice distribution and currency dynamics. Each market will be analysed by the number of invoices issued, sum of turnover, mean of invoice sum, standard deviation of invoice sum and average time to payment. Average time to payment is an important indicator, as it gives us a glimpse of which forward contract will be used the most. Also an important indicator of country's foreign currency risk is an average exposure. Average exposure tells us an open account of receivables to the country with foreign currency, i.e. how much money averagely am I owed from the market with foreign currency.

1.3.1 United Kingdom

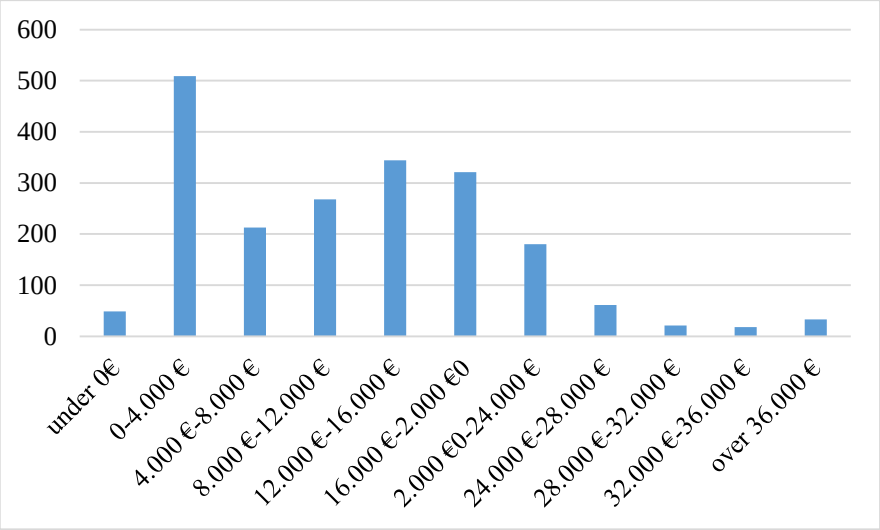
1.3.1.1 Invoice statistics

Table 2. Descriptive statistics of UK invoice database

# OF INVOICES	2.017,00
SUM (€)	27.968.424,40
MEAN (€)	13.866,35
STANDARD DEVIATION (€)	51.430,95
HIGHEST INVOICE (€)	1.327.408,01
LOWEST INVOICE (€)	- 535.492,00
AVERAGE TIME TO PAYMENT (in days)	65,04
AVERAGE SPOT RATE (GBP/€)	0,81
AVERAGE WEEKLY EXPOSURE – IN GBP	1.759.488,63
AVERAGE WEEKLY EXPOSURE – IN €	2.164.997,30

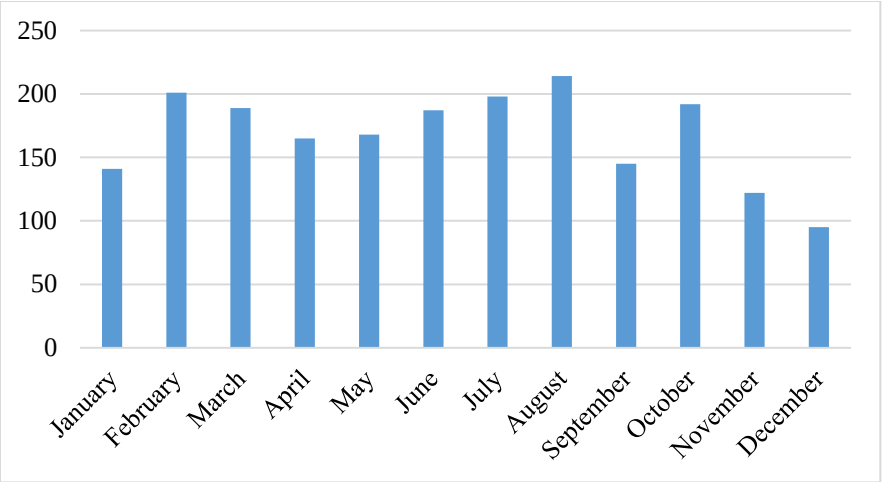
Source: Company X, *Internal Data*, 2016.

Figure 6. Frequency of invoices issued on UK Market



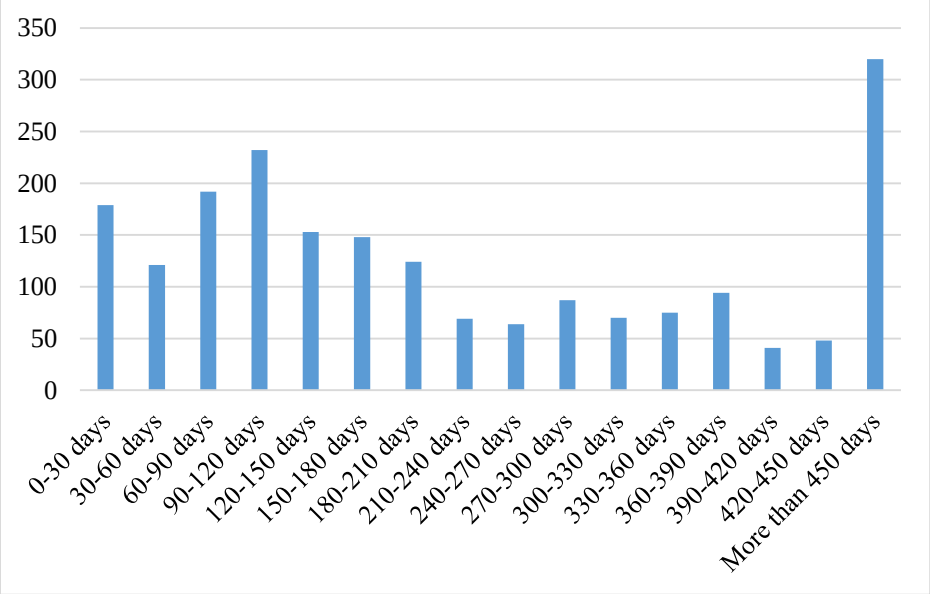
Source: Company X, *Internal Data*, 2016.

Figure 7. Yearly distribution of issued invoices on UK Market



Source: Company X, *Internal Data*, 2016.

Figure 8. Frequency distribution of the difference between order and invoice issue (in days)



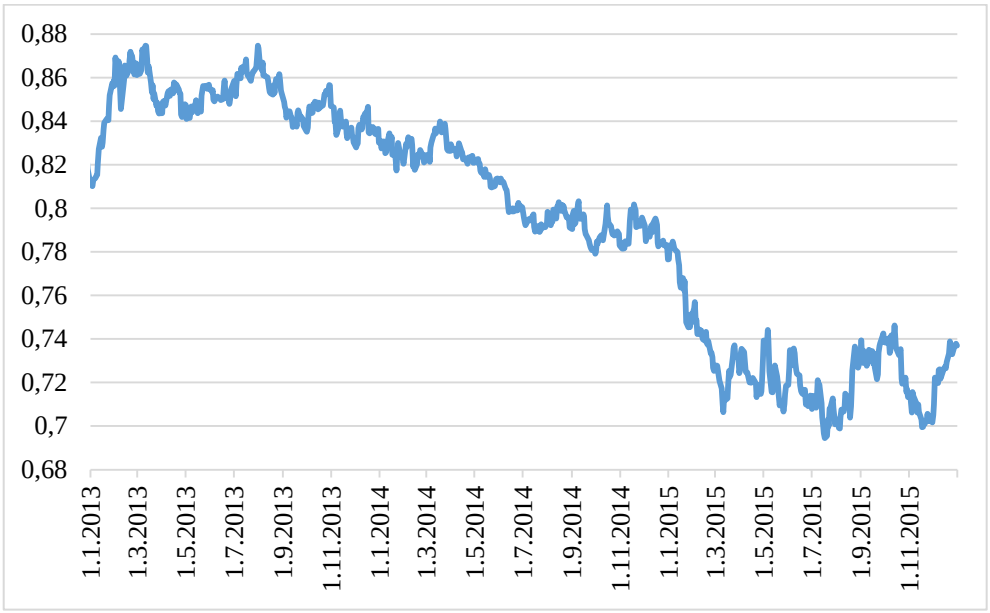
Source: Company X, *Internal Data*, 2016.

Table 2 and Figures 6, 7 and 8 show that the UK Market is the largest of all markets with foreign currency in Company X's portfolio. The virtue of the UK Market is a constant demand, as we can see that issued invoices don't have distinct peaks and the top of the season (start of spring and autumn). The most issued invoices have the amount of 4.000€, whereas total sum of the invoices issued amounts to 27.968.424,40 €. Most invoices are due in 60–90 days, where the average time of payment is 65 days. Average weekly

exposure amounted to 1.759.488,63 GBP, which amounted to 2.164.997,30 € by average spot rate of 0,81 €/GBP.

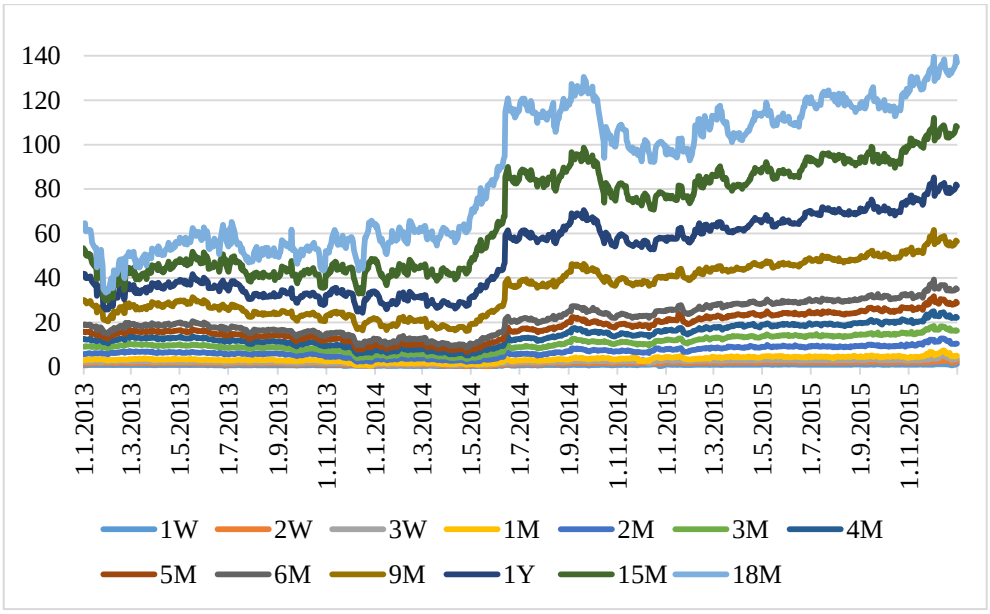
1.3.1.2 Currency statistics

Figure 9. EURGBP Spot rate



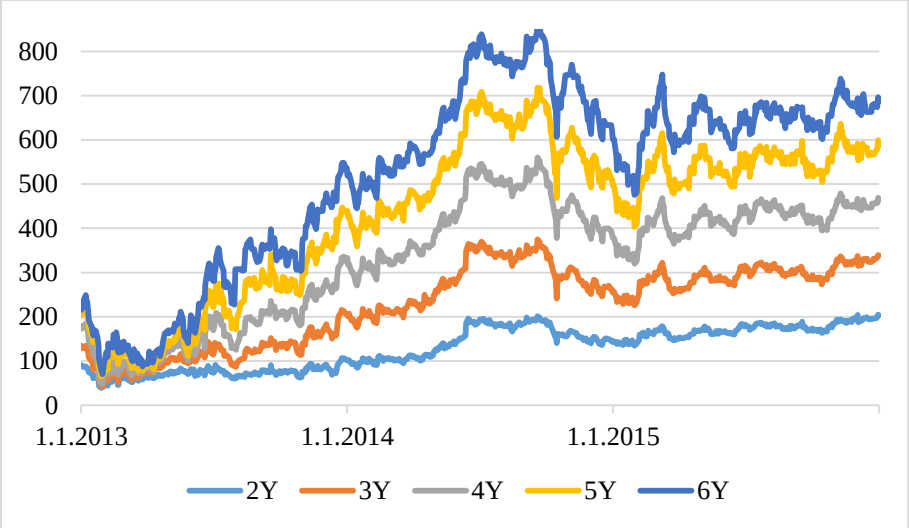
Source: Bloomberg, *Financial database*, 2016.

Figure 10. EURGBP forward contracts in points addition to the spot rate (1W-18M)



Source: Bloomberg, *Financial database*, 2016.

Figure 11. EURGBP forward contracts in points addition to the spot rate (2Y-6Y)



Source: Bloomberg, *Financial database*, 2016.

Figures 9, 10 and 11 show that EURGBP spot rate dropped in the analysed period of 2013–2015. That means that euro became worth less than pound sterling, which made Company X's products more favourable. Although there was a clear downfall of the spot rate, market still expected the rise of euro as we look at the forward contracts from 1W to 6Y. In any given moment between 2013–2015 there was never a situation where the market predicted a further downfall of euro against the pound sterling. What would that mean in our case? If Company X went into the policy of securing every invoice issued, it would actually secure itself from euro appreciation, whereas in reality, euro would still fall. If Company X took no kind of hedging from the forward contracts, it would profit from currency dynamics massively, as I will also try to show in the end analysis. We can observe a normal future curve, a contango phenomenon, as also explained in Chapter 4.1.1. Since future prices have a positive premium, that means future prices are more expensive as the spot price.

1.3.2 Sweden

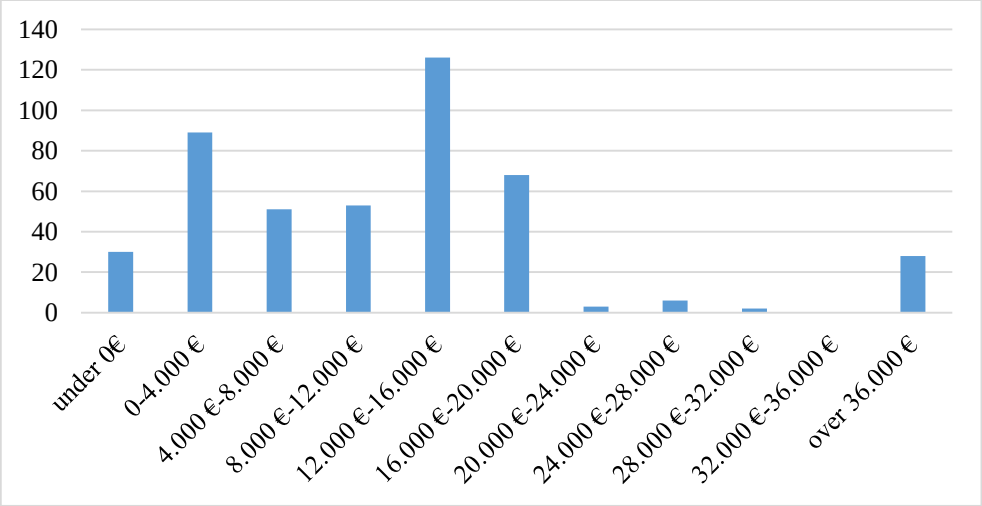
1.3.2.1 Invoice statistics

Table 3. Descriptive statistics of Swedish invoice database

# OF INVOICES	456,00
SUM (€)	6.602.627,25
MEAN (€)	14.479,45
STANDARD DEVIATION (€)	40.150,11
HIGHEST INVOICE (€)	352.703,00
LOWEST INVOICE (€)	- 303.511,93
AVERAGE TIME TO PAYMENT (in days)	26,15
AVERAGE SPOT RATE (SEK/€)	8,98
AVERAGE WEEKLY EXPOSURE – IN SEK	1.890.594,41
AVERAGE WEEKLY EXPOSURE – IN €	210.466,84

Source: Company X, *Internal Data*, 2016.

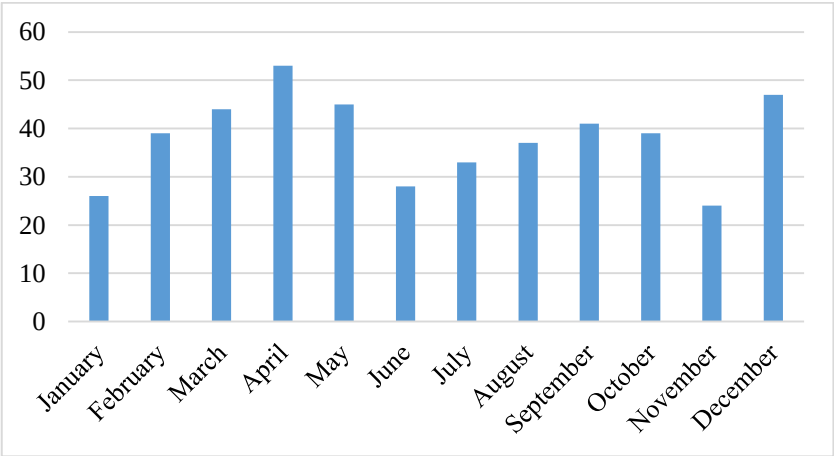
Figure 12. Frequency of invoices issued on Swedish Market



Source: Company X, *Internal Data*, 2016.

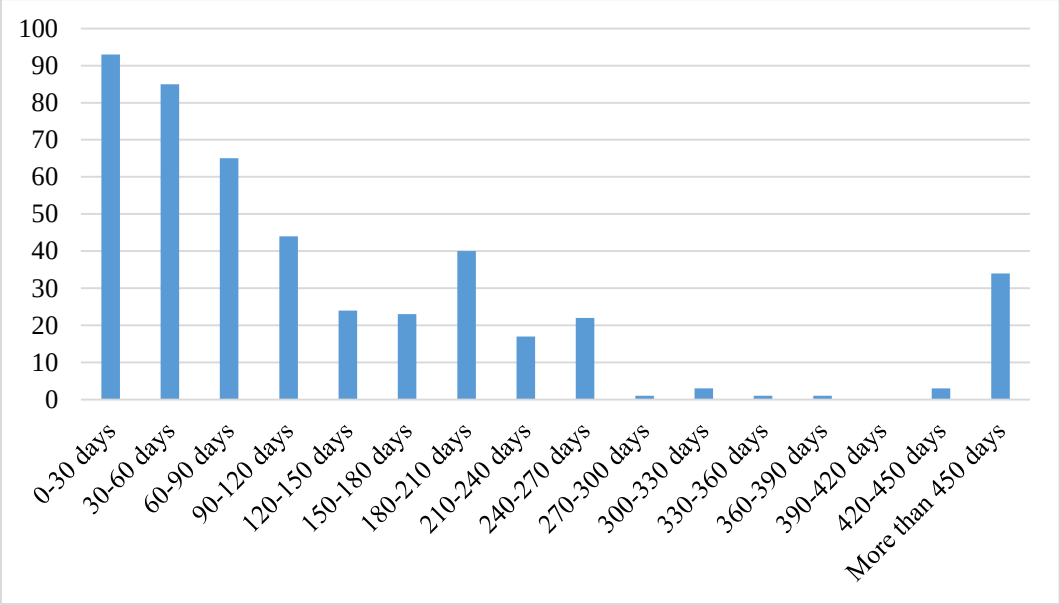
Situation in Sweden is different than in the UK Market. Most of the invoices amount from 12.000€–16.000€, and average due date is 26 days, as shown in Table 3 and Figures 12, 13, 14. That would mean that the most used forward contract here would be 2 months contracts. As the average sum of invoices is bigger, it would also take less time to coordinate with the bank, as it would need to tie just 0,60 of invoice per working day to expected turnover. Market of Sweden amounted to 6.602.627,25 € with highest peaks in April and December. Average weekly exposure amounted to 1.890.594,41 SEK, which amounted to 210.466,84 € by average spot rate of 8,98 SEK/€.

Figure 13. Yearly distribution of issued invoices on Swedish Market



Source: Company X, *Internal Data*, 2016.

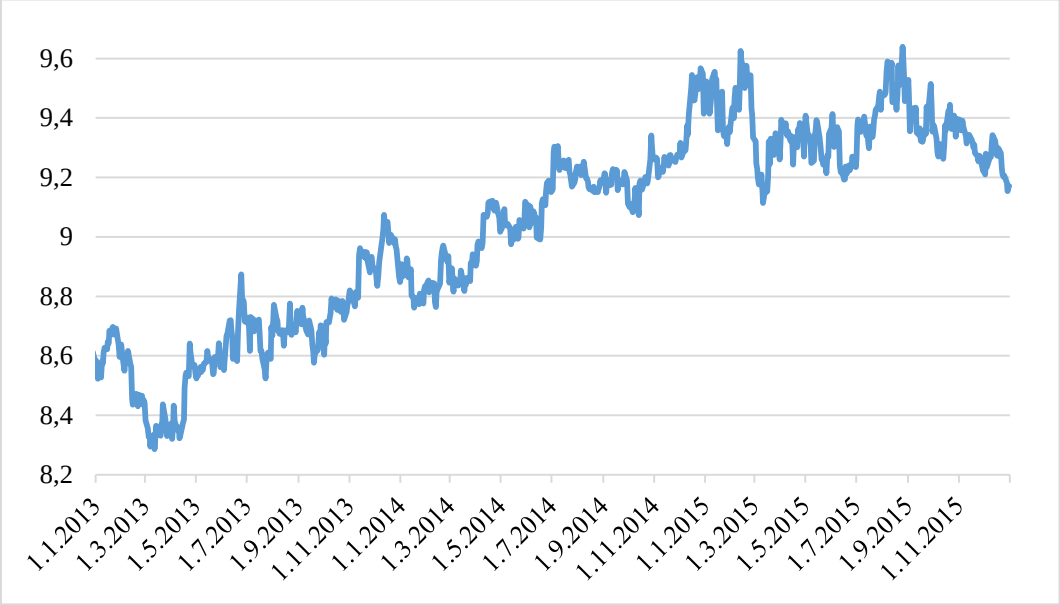
Figure 14. Frequency distribution of the difference between order and invoice issue (in days)



Source: Company X, *Internal Data*, 2016.

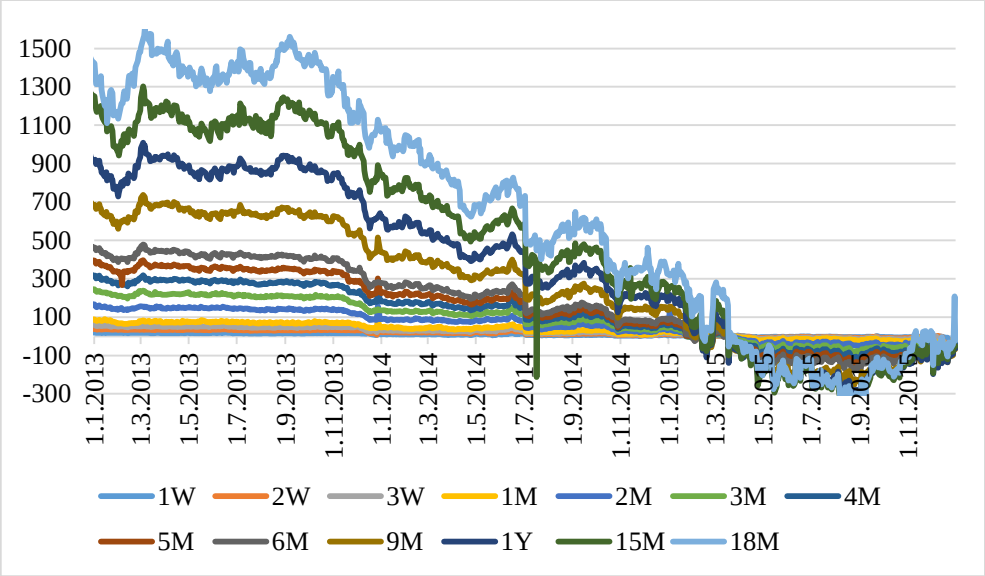
1.3.2.2 Currency statistics

Figure 15. EURSEK Spot rate



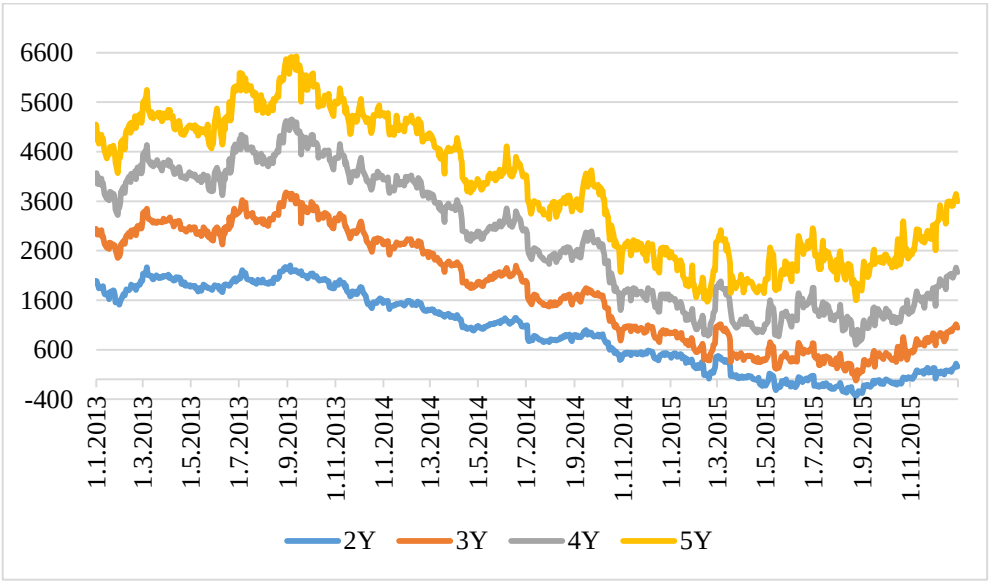
Source: Bloomberg, *Financial database*, 2016.

Figure 16. EURSEK forward contracts in points addition to the spot rate (1W-18M)



Source: Bloomberg, *Financial database*, 2016.

Figure 17. EURSEK forward contracts in points addition to the spot rate (2Y-6Y)



Source: Bloomberg, *Financial database*, 2016.

Figures 15, 16 and 17 show a steady rise of euro compared to the Swedish krona. However, markets here started to expect a fall of euro from the mid of 2014, as we can observe a negative addition of points to the spot rate. That means that forward rate is expected to be lower than the spot rate. We can expect that Company X would lose severely in the case of no hedging, while it would also gain a lot in case of hedging because of negative addition of forward rates. The future prices of EURSEK forward rates were always in contango, which means that they had a positive premium. However, Figures 15, 16 and 17 show that in the start of 2015, prices went into normal

backwardation, that means they had a negative premium – future prices were cheaper than today's spot prices.

1.3.3 Switzerland

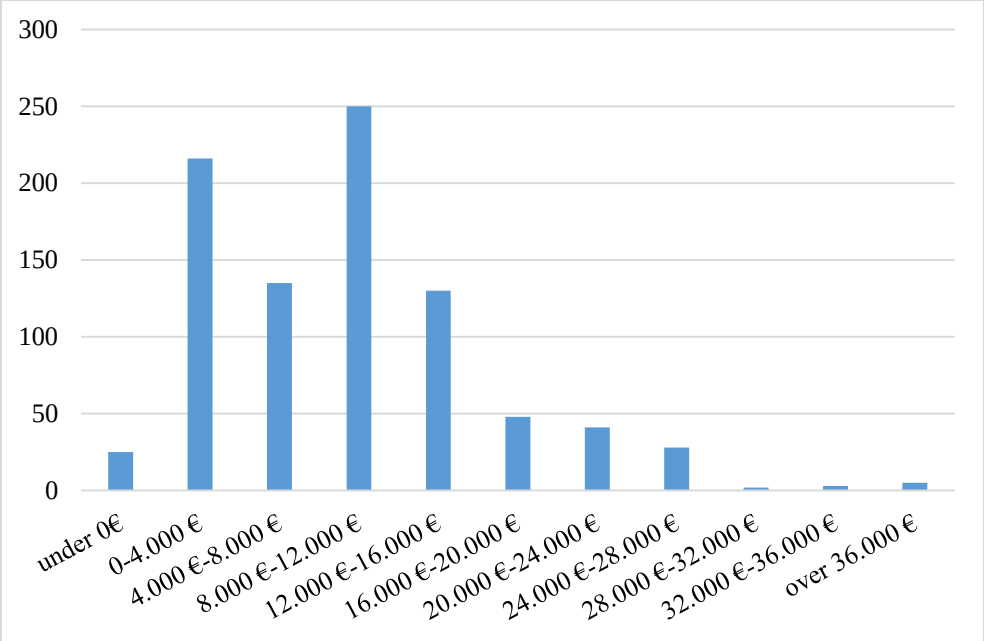
1.3.3.1 Invoice statistics

Table 4. Descriptive statistics of Swiss invoice database

# OF INVOICES	883,00
SUM (€)	8.076.518,54
MEAN (€)	9.146,68
STANDARD DEVIATION (€)	8.126,74
HIGHEST INVOICE (€)	59.800,00
LOWEST INVOICE (€)	- 82.133,44
AVERAGE TIME TO PAYMENT (in days)	31,82
AVERAGE SPOT RATE (CHF/€)	1,19
AVERAGE WEEKLY EXPOSURE – IN CHF	274.834,92
AVERAGE WEEKLY EXPOSURE – IN €	230.915,06

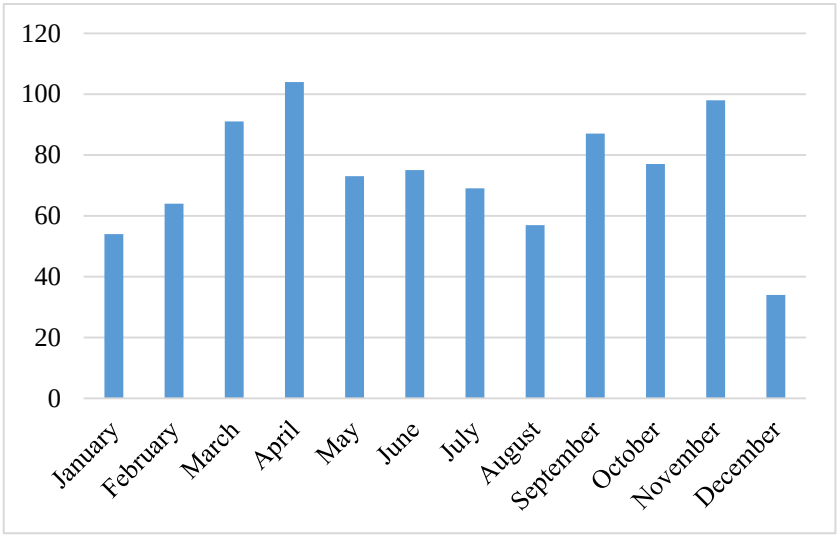
Source: Company X, *Internal Data*, 2016.

Figure 18. Frequency of invoices issued on Swiss Market



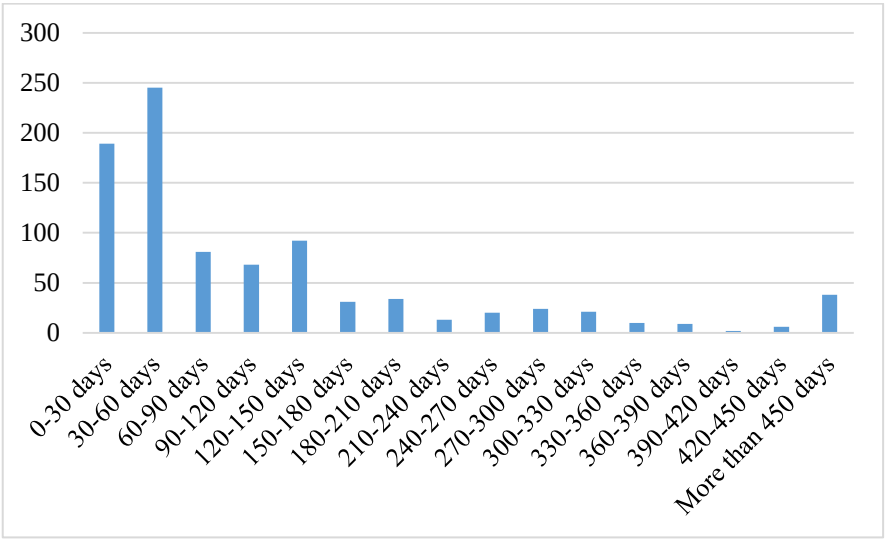
Source: Company X, *Internal Data*, 2016.

Figure 19. Yearly distribution of issued invoices on Swiss Market



Source: Company X, *Internal Data*, 2016.

Figure 20. Frequency distribution of the difference between order and invoice issue (in days)

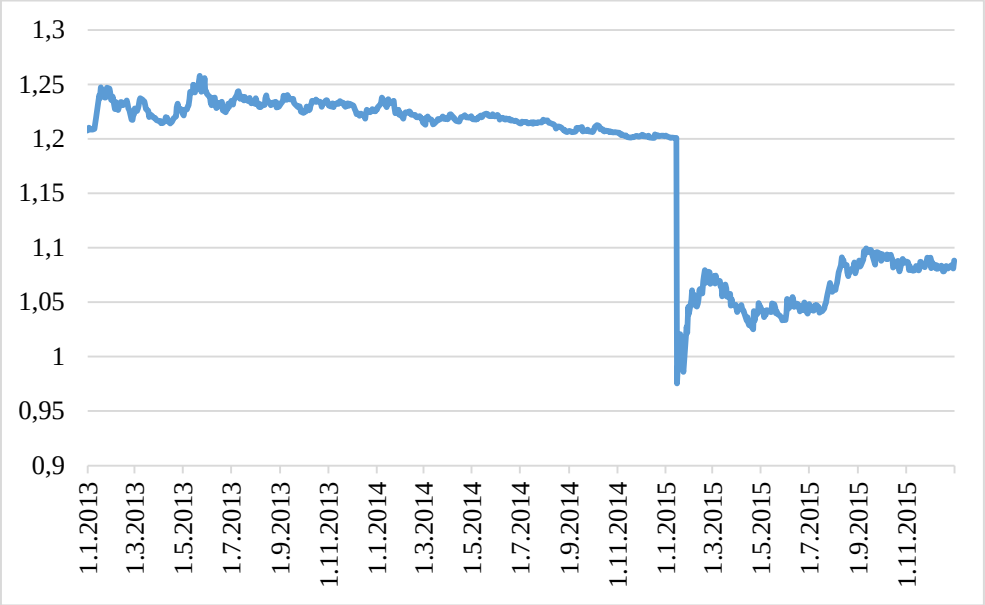


Source: Company X, *Internal Data*, 2016.

Table 4 and Figures 18, 19, 20 show the main statistics of Swiss market, where situation is similar to Sweden. Most of the invoices range from 8.000€ to 12.000€, where the most issued invoices come from April and end of the year. Average time to payment is 32 days and most invoices fall into a range of due date from 30–60 days. That means that mostly forward contracts of 1 and 2 months would be used. Total sum of invoices amounts to 8.076.518,54 € and on average 1,17 invoices per working day were issued. Average weekly exposure amounted to 274.834,92 CHF, which amounted to 230.915,06 € by average spot rate of 1,19 CHF/€.

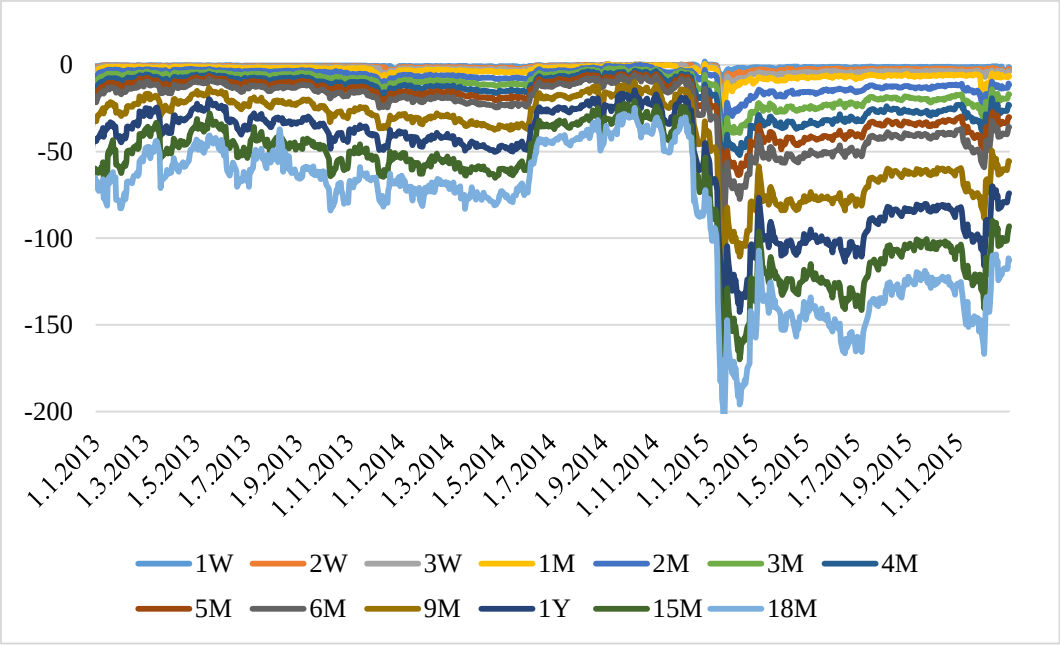
1.3.3.2 Currency statistics

Figure 21. EURCHF Spot rate



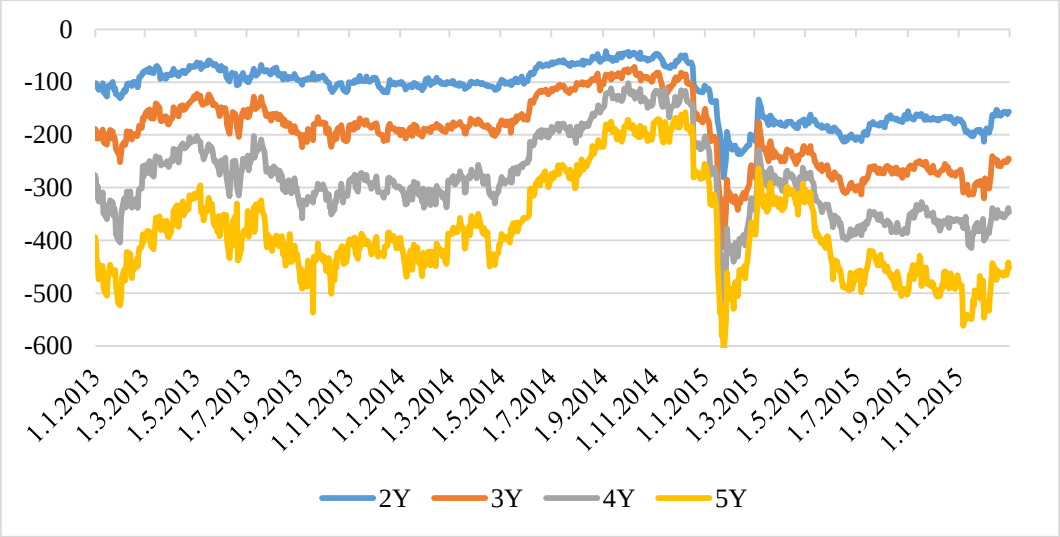
Source: Bloomberg, *Financial database*, 2016.

Figure 22. EURCHF forward contracts in points addition to the spot rate (1W-18M)



Source: Bloomberg, *Financial database*, 2016.

Figure 23. EURCHF forward contracts in points addition to the spot rate (2Y-5Y)



Source: Bloomberg, *Financial database*, 2016.

Looking at the dynamics of Swiss franc compared to euro is very unpredictable. Franc was stable at the rate of 1,2 € for franc till January 2015, when Swiss central bank released the fixed franc rate, which then all of a sudden appreciated (eventhough the franc traditionally appreciates against many currencies when measures of global risk increase and financial stress (Grisse & Nitschka, 2013), this was a big surprise). However, since the franc sudden rise, which has also harmed all franc borrowers, we can observe its steady fall. This phenomenom also shows the shock that can happen by fix exchange rate (Craighead & Tien, 2015). Also the markets were in the right position here, as forward contracts always carried negative addition points, as franc was expected to fall. Here an analysis of pre- and post-franc rise (January 2015) should be made. Looking also at future prices, they all had a negative premium, which means they were cheaper than spot prices – a phenomenon of backwardation.

1.3.4 Poland

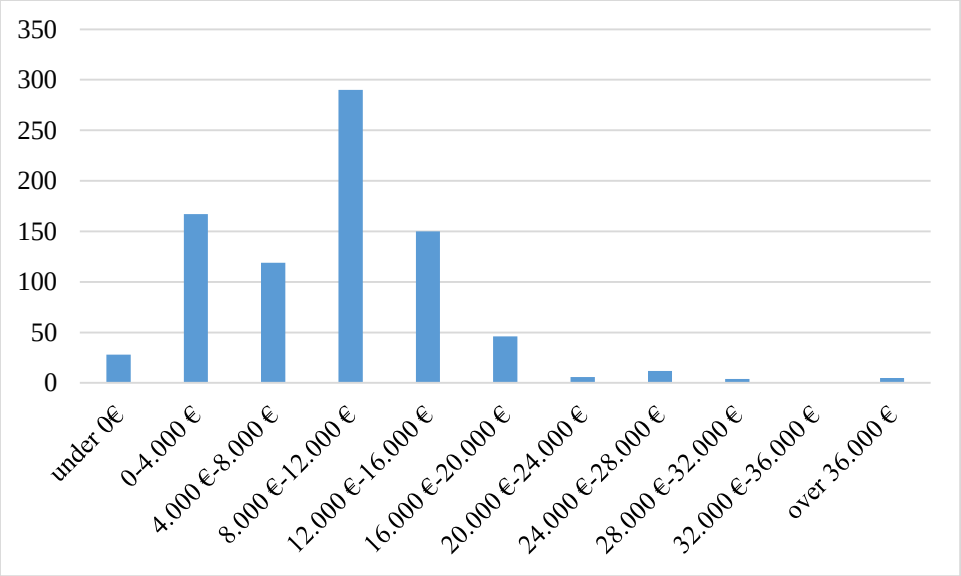
1.3.4.1 Invoice statistics

Table 5. Descriptive statistics of Polish invoice database

# OF INVOICES	827,00
SUM (€)	7.466.899,29
MEAN (€)	9.028,90
STANDARD DEVIATION (€)	7.518,37
HIGHEST INVOICE (€)	71.653,11
LOWEST INVOICE (€)	- 23.400,00
AVERAGE TIME TO PAYMENT (in days)	41,34
AVERAGE SPOT RATE (PLN/€)	4,18
AVERAGE WEEKLY EXPOSURE – IN PLN	1.325.629,80
AVERAGE WEEKLY EXPOSURE – IN €	317.334,19

Source: Company X, *Internal Data*, 2016.

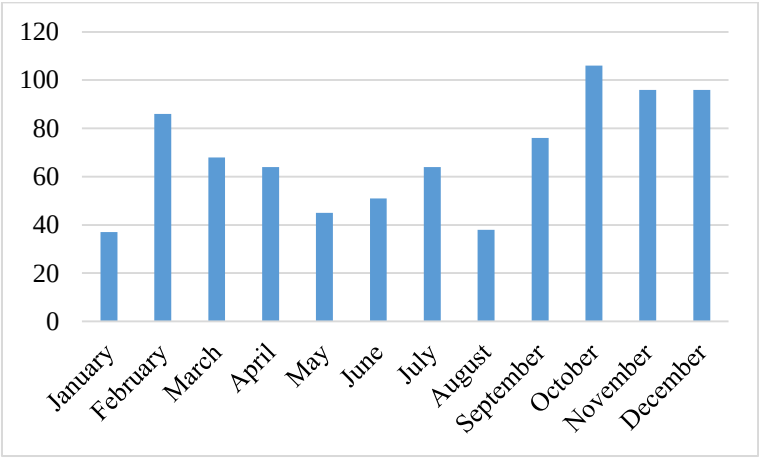
Figure 24. Frequency of invoices issued on Polish Market



Source: Company X, *Internal Data*, 2016.

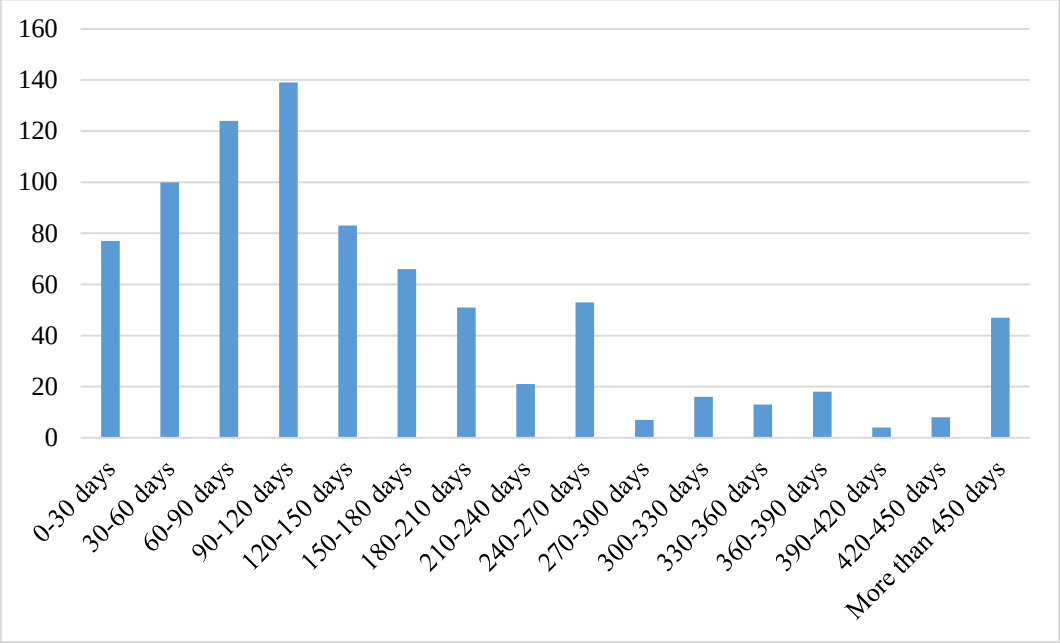
As we can observe in Table 5 and Figures 24, 25 and 26, Poland too is a market similar to Sweden and Switzerland. Most of the invoices amount from 8.000 € to 12.000 €, however, most invoices are issued at the end of the year with a due date of 90–120 days. That means that most of the contracts used would be 3 or 4 months. With a total sum of 7.466.899,29 €, less coordination with the bank would be needed, as just 1,1 invoices per day would be secured. Average weekly exposure amounted to 1.325.629,80 PLN, which amounted to 317.334,19 € by average spot rate of 4,18 PLN/€.

Figure 25. Yearly distribution of issued invoices on Polish Market



Source: Company X, *Internal Data*, 2016.

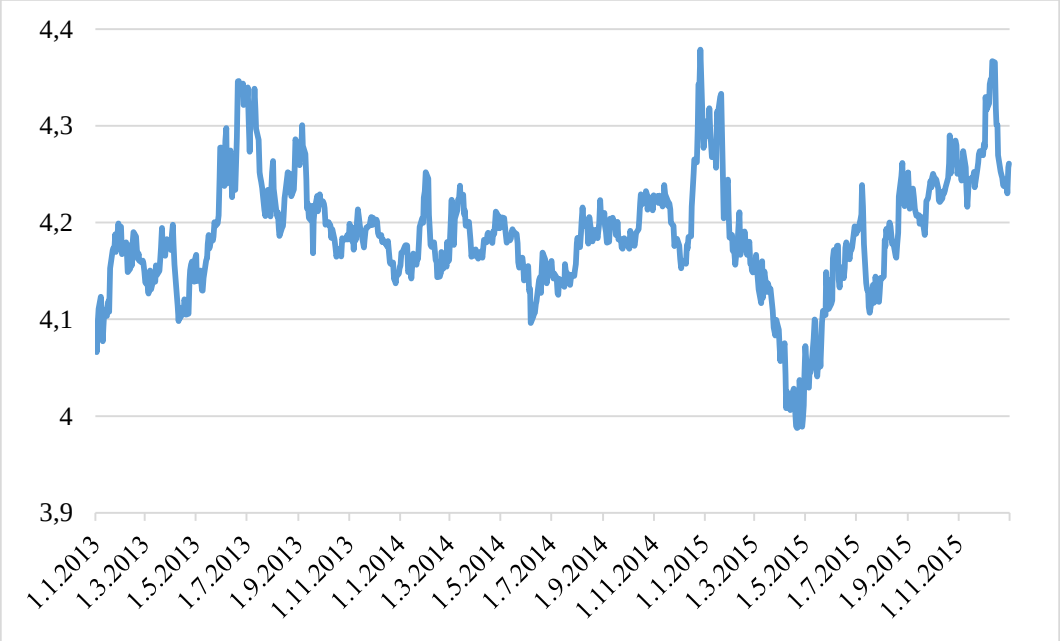
Figure 26. Frequency distribution of the difference between order and invoice issue (in days)



Source: Company X, *Internal Data*, 2016.

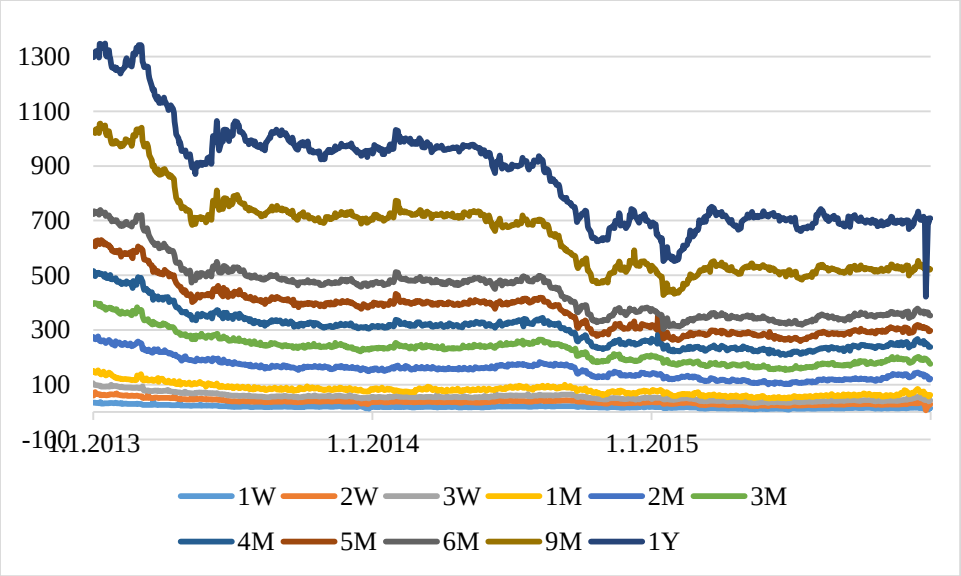
1.3.4.2 Currency statistics

Figure 27. EURPLN Spot rate



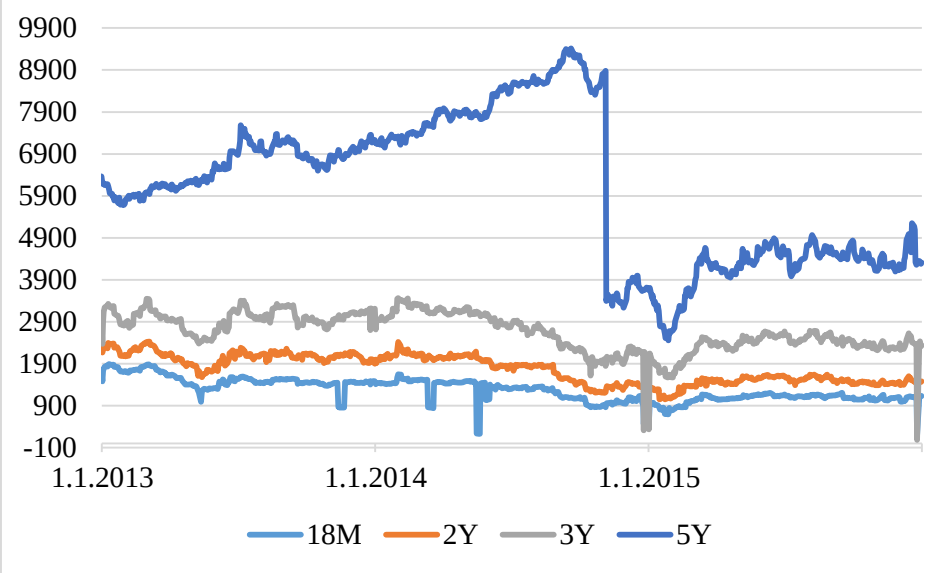
Source: Bloomberg, *Financial database*, 2016.

Figure 28. EURPLN forward contracts in points addition to the spot rate (1W-1Y)



Source: Bloomberg, *Financial database*, 2016.

Figure 29. EURPLN forward contracts in points addition to the spot rate (18M-5Y)



Source: Bloomberg, *Financial database*, 2016.

EURPLN exchange rate dynamics are very unstable. We can observe somewhat of a stable rate with two peaks in spring of 2013 and start of 2015. If we compare spot rate dynamics with forward rates, we can see that markets all the time expected a depreciation of the zloty, however there is no clear indication of that in real life. To forecast the result of the analysis would be unwise, however it will be a good indication of what to do on markets like Poland. Future prices had a positive premium, i.e. they were in contango movement.

1.3.5 Russia

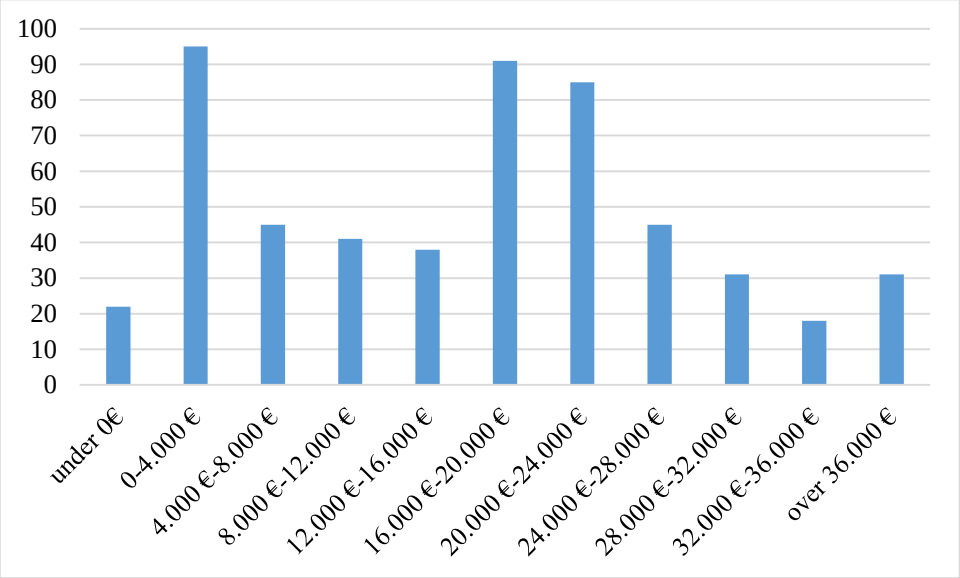
1.3.5.1 Invoice statistics

Table 6. Descriptive statistics of Russian invoice database

# OF INVOICES	542,00
SUM (€)	9.581.779,92
MEAN (€)	17.678,56
STANDARD DEVIATION (€)	23.689,78
HIGHEST INVOICE (€)	346.380,00
LOWEST INVOICE (€)	- 57.850,00
AVERAGE TIME TO PAYMENT (in days)	16,72
AVERAGE SPOT RATE (RUB/€)	49,86
AVERAGE WEEKLY EXPOSURE – IN RUB	7.478.659,07
AVERAGE WEEKLY EXPOSURE – IN €	150.004,09

Source: Company X, *Internal Data*, 2016.

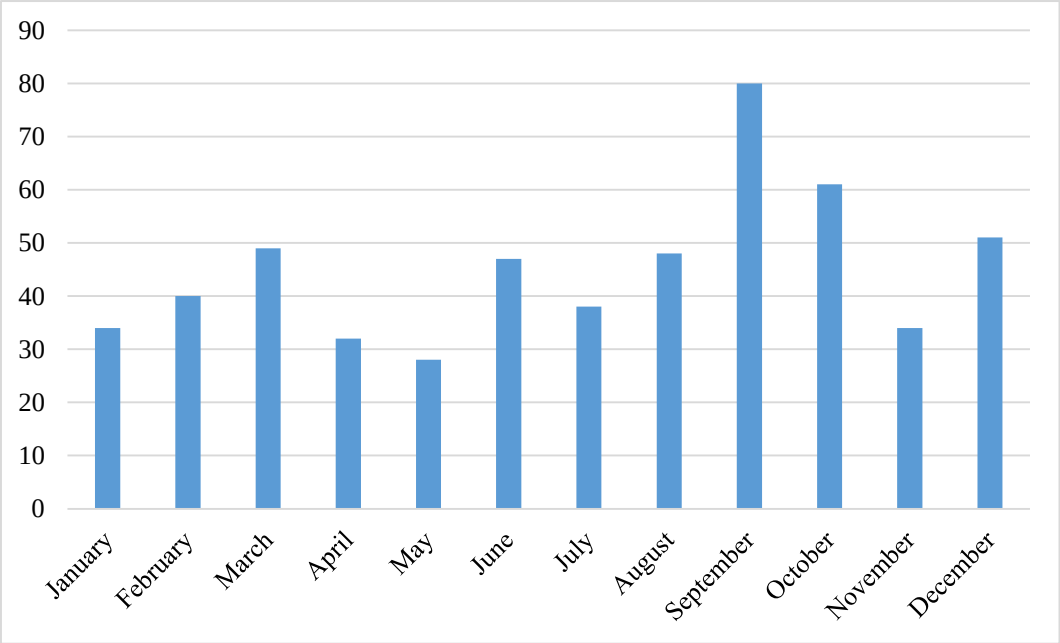
Figure 30. Frequency of invoices issued on Russian Market



Source: Company X, *Internal Data*, 2016.

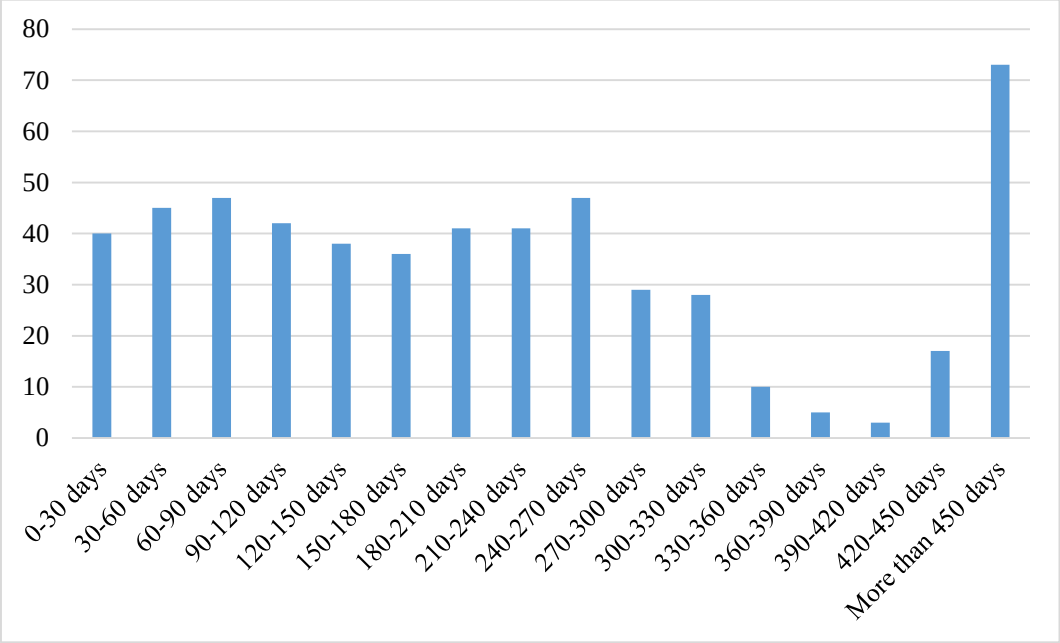
Russia is the most special example among the chosen five, with a total amount of invoices issued with a sum of 9.581.779,92 €. Here, most of the invoices sum fall into the range between 0€–4.000€ and 16.000€–24.000€. With an average amount of 17.578,56€, this is the market with the highest average of the issued invoice. That means also a lot less bank coordinating as only 0,73 invoices per day would have to be secured to expected turnover. Average weekly exposure amounted to 7.478.659,07 RUB, which amounted to 150.004,09 € by average spot rate of 49,86 RUB/€.

Figure 31. Yearly distribution of issued invoices on Russian Market



Source: Company X, *Internal Data*, 2016.

Figure 32. Frequency distribution of the difference between order and invoice issue (in days)



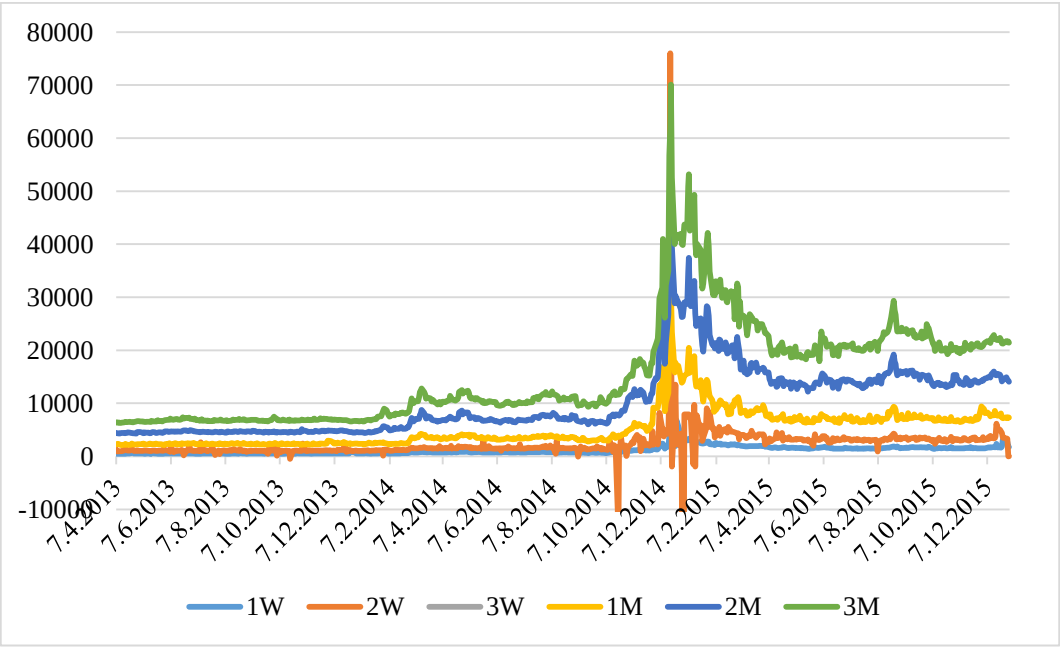
Source: Company X, *Internal Data*, 2016.

1.3.5.2 Currency statistics

Figure 33. EURRUB Spot rate

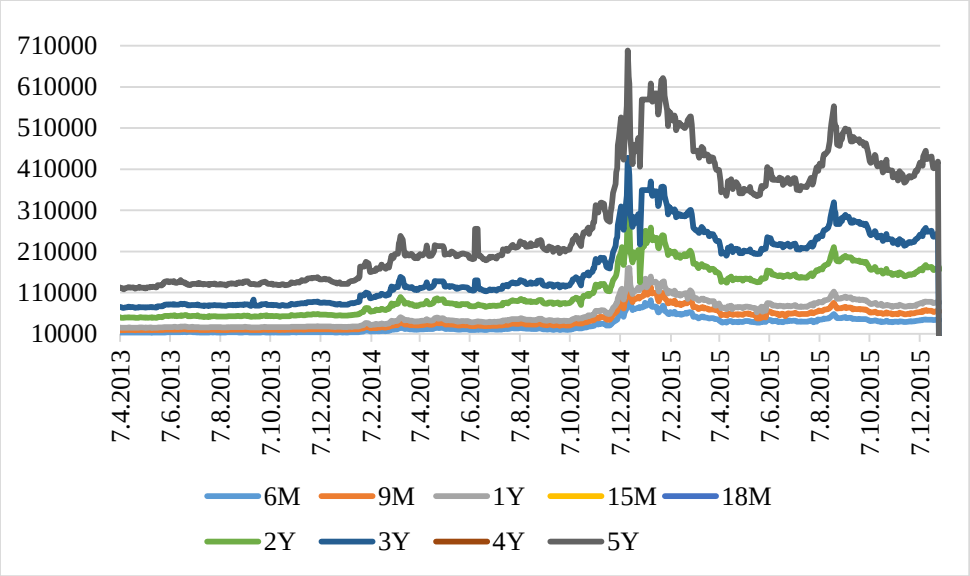
Source: Bloomberg, *Financial database*, 2016.

Figure 34. EURRUB forward contracts in points addition to the spot rate (1W-3M)



Source: Bloomberg, *Financial database*, 2016.

Figure 35. EURRUB forward contracts in points addition to the spot rate (6M-5Y)



Source: Bloomberg, *Financial database*, 2016.

Situation in Russia is the most representative example of how unstable an exchange rate can be and how it can harm company's sales. In winter of 2015, because of the Ukrainian crisis and subsequent downfall of trade with Russia, as Russia is also dependtant on oil prices ((Bouoiyour, Selmi, Tiwari, & Shahbaz, 2014)) rouble depreciated subsequently, which harmed the purchasing power of Company X's customers on a large scale. Also, falling prices of oil caused further harm and made the matter worse. Looking at those facts, it is normal that future price had a big positive premium.

1.4 Company X's foreign currency exposure conclusion

Looking at the data descriptives, we can see that on one hand we have 5 different markets: markets with different size, different distribution of seasonal invoice issuance, and also different spot rate dynamics. On EURGBP market we can observe a steady appreciation of pound sterling, (which would profit Company X), EURSEK and EURPLN market enjoys a steady appreciation of euro, which indicates urgency of hedging, EURCHF market surprised everyone with a sudden unpeg of franc to euro, which caused a massive disturbance on the market, while EURRUB market is a clear example of how currency volatility can harm firm's sales on the market. Looking at the future prices, pound, zloty and rouble enjoyed a positive premium, while franc and krona enjoyed a negative premium. It can therefore be expected that negative premiums should be used in order to profit from the foreign currency appreciation.

These 5 markets clearly scoop enough of diverse information for a concrete and credible analysis of the simulation. What would happen, if Company X started issuing invoices on markets like UK, Sweden, Poland, Switzerland and Russia? What would happen, if we hedged the turnover and what if we didn't?

In order to derive a model, we must first present a theoretical part of the thesis, with a presentation of currency risks and forward contracts, and by using them I will derive the final model for simulation.

Table 7. Summary of countries researched by exposure

	Average currency (FC/€)	Average exposure (in foreign currency)	Average exposure (in €)
UK (in GBP)	0,81	1.759.488,63	2.164.997,30
Poland (in PLN)	4,18	1.325.629,80	317.334,19
Switzerland (in CHF)	1,19	274.834,92	230.915,06
Sweden (in SEK)	8,98	1.890.594,41	210.466,84
Russia (in RUB)	49,86	7.478.659,07	150.004,09

Source: Company X, *Internal Data*, 2016

As we observe in Table 7, it also shows an interesting summary of countries exposures. By far the most exposed country is United Kingdom. However, even though Russia is second in turnover, it results the last in exposure. Why? Average day of payment in Russia was just 16 days, consequentially that also results in the lowest exposure to foreign currency between the countries.

2 EXCHANGE RATE RISK

A common definition of exchange rate risk relates to the effect of unexpected exchange rate changes on the value of the firm. In particular, it is defined as the possible direct loss (as a result of an unhedged exposure) or indirect loss in the firm's cash flows, assets and liabilities, net profit and in turn, its stock values from an exchange rate move. To manage the exchange rate risk inherent in multinational firm's operations, a firm needs to determine the specific type of currency risk exposure, the hedging strategy and the available instruments to deal with these currency risks (Papaioannou, 2006). Exchange rate risk could rise due to both domestic and international factors, like lower domestic growth and higher fiscal deficits (Gadanecz, Miyajima, & Shu, 2014).

The three main types of exchange rate risk that I will examine in this thesis are transaction risk, translation risk and economic risk – I will theoretically describe them and try to fit them into real examples of Company X. The thesis solely focuses on the transaction risk, however in order to fully understand all of the order sides of currency risk, I will also present translation and economic risk.

2.1 Transaction risk

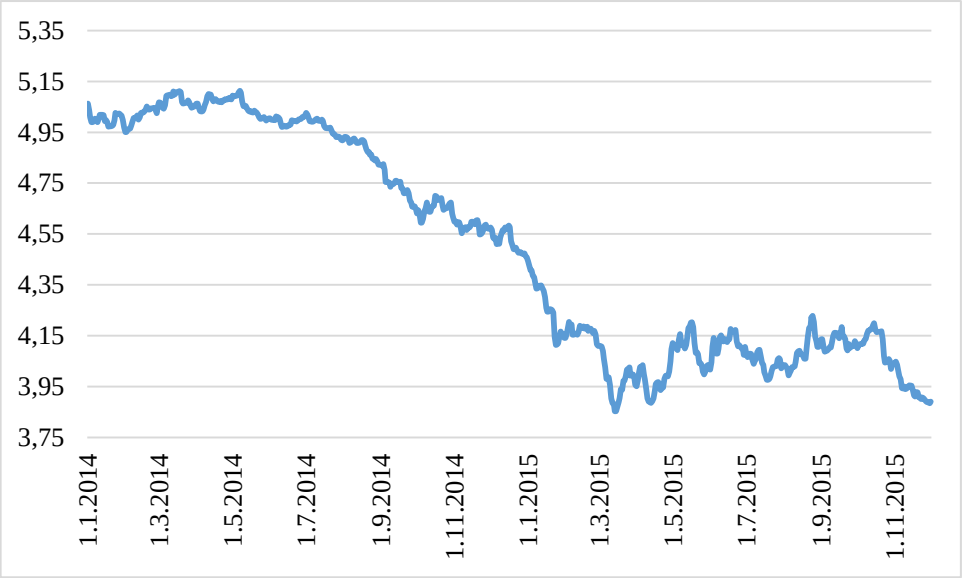
Transaction risk, which is basically cash flow risk and deals with the effect of exchange rate moves on transactional account exposure related to receivables (export contracts), payables (import contracts) or repatriation of dividends. An exchange rate change in the currency of denomination of any such contract will result in a direct transaction exchange

rate risk to the firm (Papaioannou, 2006). Usually the time frame for committed transactions (in the time between contracting and payment) is relatively short. However, it can in some cases reach several years, where deliveries are committed a long time in advance (Doehring, 2008).

2.1.1 Mini case study – Abu Dhabi

As described in previous sections, Company X's policy is to make contracts in euro and therefore also issue all of the invoices in euros. That however was not the case with the company from United Arab Emirates, we can call it Company Abu Dhabi. Company Abu Dhabi is one of the key accounts of Company X and represents a strong link to the Middle East market of Company X. To keep such a strong customer, one must also adapt and that is why Company X left its policy of making all the contracts and invoices in euros. Consequentially, for (let's call it) Project Big Emir, all the invoices were issued in AED, which is pegged to dollar. Contract was made in May 2014, invoices were issued from May 2014 till April 2015.

Figure 36. EUR/AED exchange rate



Source: Oanda.com, *Historical exchange rates database*, 2016.

In this case, Company X didn't hedge itself against currency risks. Looking back, we can say it was the right decision, as it captured more than 20% of the deal just on currency movements. Still, this phenomenon just shows, how unpredictable currency movements are, as it could easily be the other way around.

Transaction risk will therefore be analysed also in this thesis. We will see, how hedge results will differ themselves under the assumption that we issue invoices in other currency, if we hedge them or if we don't.

2.2 Translation risk

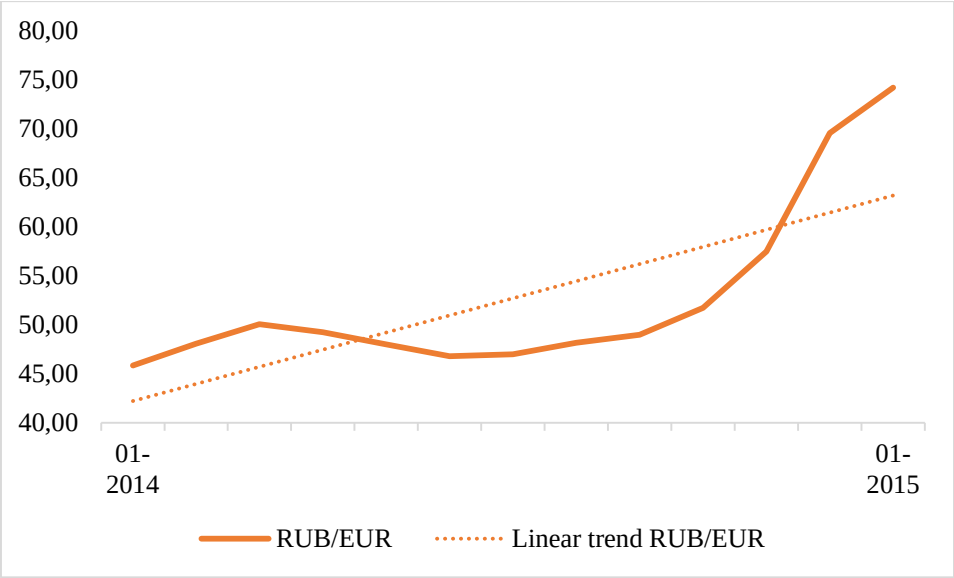
Translation risk refers to the impact of exchange rate changes on the valuation of foreign assets (mainly foreign subsidiaries) and liabilities on a multinational company's consolidated balance sheet. Usually, translation risk is measured in net terms, i.e. net foreign assets minus net foreign liabilities (Doehring, 2008). In consolidating financial statements, the translation could be done either at the end-of-the period exchange rate or at the average exchange rate of the period, depending on the accounting regulations affecting the parent company. Thus, while income statements are usually translated at the average exchange rate over the period, balance sheet exposures of foreign subsidiaries are often translated at the prevailing current exchange rate at the time of consolidation (Papaioannou, 2006).

2.2.1 Mini case study – Russian subsidiary

Company X is not just a parent company. It operates also with subsidiaries on specific markets. These foreign subsidiaries are own legal entities with own balance sheets. Therefore, they also comprise a balance sheet of a parent company in a process of consolidation. That means that foreign subsidiaries are exposed to exchange rate volatility as in a given moment company's subsidiary assets and obligations can be worth more or less.

The best example for this case study is Company X's Russian subsidiary – let's call it Company RUS. Perfect examples are December 2013 and December 2014 RUB/EUR exchange rates, when we had the following situation:

Figure 37. RUB/EUR exchange rate in year 2014



Source: Oanda.com, *Historical exchange rates database*, 2016.

As we can observe in Figure 37, the exchange rate in December 2013 was 45,02 RUB/EUR, whereas in December 2014 it was 74,16. That is more than 60% increase. Over the year Company RUS's assets and obligations were worth less. Following is a representation of how Company RUS's balance sheet (where both assets and obligations are originally set in roubles) looked like in euros and roubles at the end of 2013 and 2014, when usually also end consolidation is made:

Table 8. Balance sheet of Company RUS in years 2013 and 2014 (in 000s)

Exchange rate: 45,02 EUR/RUB					
Assets	RUB	EUR	**Obligations**	RUB	EUR
Long-term assets	47.362	1.052	Equity	13.225	294
Inventory	14.317	318	Long-term debt	36.193	804
Cash	7.924	176	Short-term debt	20.183	448
Total	**69.601**	1.546	**Total**	**69.601**	**1.546**
Exchange rate: 74,16EUR/RUB					
Assets	RUB	EUR	**Obligations**	RUB	EUR
Long-term assets	47.362	639	Equity	13.225	178
Inventory	14.317	193	Long-term debt	36.193	488
Cash	7.924	107	Short-term debt	20.183	272
Total	**69.601**	939	**Total**	**69.601**	**939**

Source: Company X, *Internal Data*, 2016.

For the sake of presentation both annual balance sheets, denominated in roubles, are equal, except the exchange rate, which is over 60% higher at the end of 2014. The most interesting part is, that while the value of assets and obligations stayed the same in roubles,

it fell dramatically in euros. Value of balance sheet fell from €1.546.000 to just €939.000, while equity value fell from €294.000 to €178.000. All these decreases amount to 40% which has an enormous impact on the parent company.

Like the upper case study shows, exchange rates can also have an enormous impact on company's balance sheet. Changes in subsidiaries effect consolidated statements. In the upper case, Company X's consolidated balance sheet would therefore show less equity, which also shows different debt-to-equity ratio. We are not talking about cash flows, and therefore not about liquidity problems, but one can argue, that exchange rate volatility can also affect company's credit ratio.

2.3 Economic risk

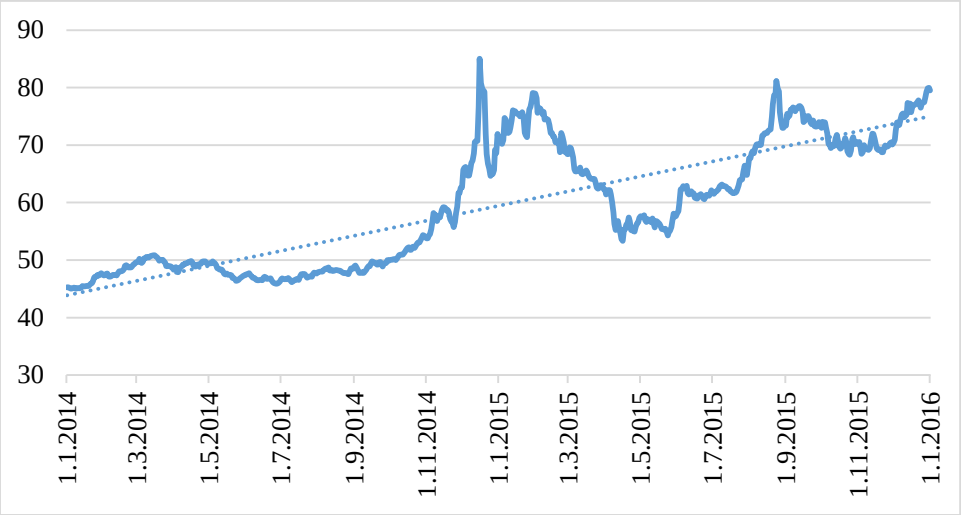
Economic risk reflects the risk to the firm's present value of future operating cash flows from exchange rate movements. In essence, economic risk concerns the effect of exchange rate changes on revenues (domestic sales and exports) and operating expenses (cost of domestic inputs and imports). Economic risk is usually applied to the present value of future cash flows operations of a firm's parent company and foreign subsidiaries. Identification of various types of currency risk along with their measurement is essential to develop a strategy for managing currency risk (Papaioannou, 2006). In short, it refers to the impact of exchange rate changes on the present value of uncertain future cash flows. It comprises the impact of exchange rate variation on future revenues and expenses through both variations in price and volume (Doehring, 2008).

To understand the difference between transaction and economic risk, we can take the example of Company X. Transaction risk would refer only to the order received today for shipments of products payable in three months. The quantity and the foreign currency price are already known today, so the transaction risk only concerns the euro value of the foreign currency payment in the next three months. On the other side, economic risk talks about adjustment of demand to exchange rate variations, which have a direct impact on the price. We can say that transaction risk is more of a short-term phenomenon, while economic risk is more of a long-term phenomenon. We can also hedge ourselves against transaction risk, while we can not influence on economic risk of exchange rate movements.

2.3.1 Mini case study – natural hedge

Russia is an important market for Company X as Company X owns a subsidiary there (100% ownership) and a production facility (51% ownership). Subsidiary's job is to sell Company X's premium products, shipped from Slovenia, while a production facility's job is to produce and sell company's base products. Russia represents Company X's biggest foreign market.

Figure 38. EUR/RUB historical exchange rates



Source: Oanda.com, *Historical exchange rates database*, 2016.

For the last year and a half we are witnessing a steady fall of Russian rouble, as it has fallen for 65% over the euro. This fall makes it really hard to sell the product and it is a great representation of economic risk as the demand adjusts on such a rise in prices. There is no way to hedge ourselves over such a long-term and steady fall. What was Company X's reaction? After a fall in sales, which was already described in previous sections, Company X decided to focus more on the sales of base products, which are already produced in production facilities in Russia. That is a kind of natural hedging. Still, problem appears with dividends payout from Russia as payout is not as big as it was supposed to be.

2.4 Measurement of exchange rate risk

Measuring currency risk may prove difficult, at least with regards to translation and economic risk. Currently, widely used method is the value-at-risk model (VaR), which will also be used as the second part of research. VaR methodology can be used to measure a variety of types of risk, helping firms in their risk management. VaR measure of exchange rate risk is used by firms to estimate the riskiness of a foreign exchange position, resulting from firm's activities, including the foreign exchange position of its treasury, over a certain period of time under normal conditions (Habibnia, 2013).

VaR is an estimate of the worst possible loss that could happen over a time horizon, under normal market conditions (defined by a given level of confidence). If the reported daily VaR (at 5% probability or 95% confidence) is €5 million, then the maximum amount I expect to lose on any one day, in 19 out of the next 20 days, is €5 million (Habibnia, 2013).

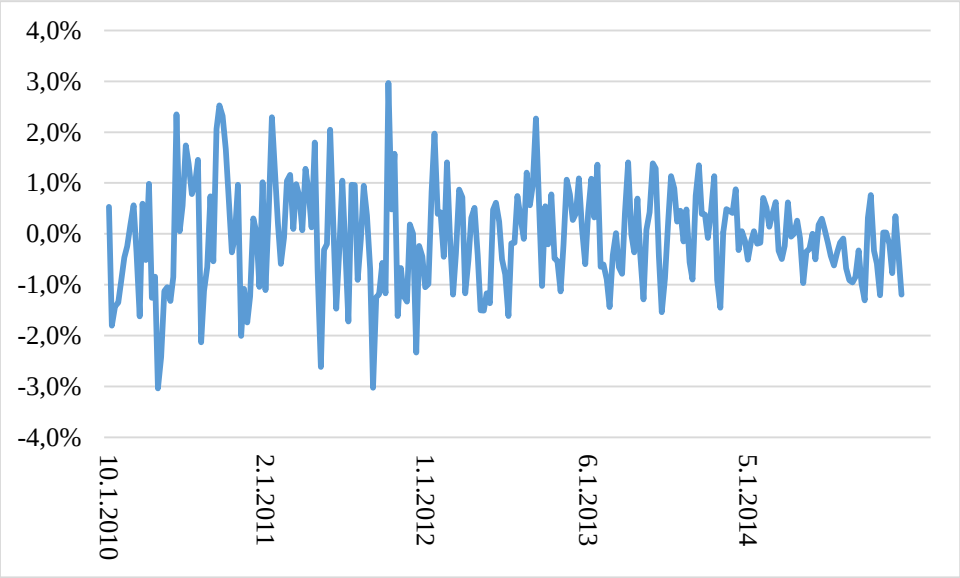
The VaR calculation depends on 3 parameters: the holding period (the length of time over which the foreign exchange is planned to be held – typical holding period is 1 day), the confidence level (at which estimate is planned to be made, usual confidence levels are 99 percent and 95 percent) and the unit of currency (currency that is used to be denomination of the VaR) (Habibnia, 2013).

According to types of losses we can define expected loss (statistical estimate of losses mean), unexpected loss (maximum loss at a specified tolerance) and extra loss (somewhat higher than the maximum loss with very low probability). Value at risk is the unexpected loss and tolerance level is the probability of loss occurrence that is more than the maximum of predicted losses. Therefore, to obtain VaR it can be appropriate to focus at the highest loss over a certain period of time at a given confidence level (which depends on risk aversion level of individuals involved with the issue).

2.4.1 Mini case study – VAR Calculation

Company X acquired a big project in the Middle East region, however there was a condition of the customer, that a contract must be signed in USD. Size of contract was $13 million and the span of the project was from February 2013 till October 2014, therefore a total span of 20 months. As we know from past experience, a lot can happen in 20 months and Company X could suffer a lot of damages when it wouldn't hedge itself. We can calculate a total currency exposure with VaR parametric method.

Figure 39. EUR/USD historical exchange rate



Source: Oanda.com, *Historical exchange rates database*, 2016.

Even though the span of the project lasted just 20 months (February 2013 – October 2014), Figure 39 shows EUR/USD dynamics for a longer period of 5 years. Second thing is, growth rates of the exchange rate are presented and not absolute values. By using growth rates, one can calculate standard deviation from the mean, which in this case amounts to 0,994%. Mean growth rate in observed time is -0,064%, which is a favourable information for Company X, as that means they were getting more € for $ from signing the contract, as the buyer was worse off. How to calculate a VaR value for the given project? As we want 5% certainty, the z-score for 5% certainty is 1.64. Multiplying z-score with standard deviation gives us the value, where our growth rate becomes negative for Company X, which is 1,63%. Multiplying that with the contract worth means that Company X was negatively exposed in this project by €114.000.

3 FINANCIAL INSTRUMENTS

Companies need a risk management process. At its simplest, it requires them to examine their operations in the broadest sense in order to recognize the risks that can affect the firm's future cash flows. This involves identifying the risks, their assessments or evaluation, the selection of the risk management techniques, their implementation and keeping the programme under review (Moles, Parrino, & Kidwell, 2011). Looking again at the question we are raising in this thesis: What is the difference between non-hedged and hedged transactions? To build this simulation, a model must be built and this process can be broken down into a number of logical steps. These would typically include (Moles, Parrino, & Kidwell, 2011):

- Identification – this would involve the financial manager in surveying the various business units and determining the profile of the business risks involved. Exposures can be simply classified according to the way they could affect the firm's operations.
- Evaluation – wherever possible, the impact of the risk is quantified in monetary terms. This helps in ranking the risks according to the severity of their effect. When combined with estimates of their frequency, this provides a way of scoring the result.
- Management – the final element is a clear framework for managing the risks once they have been identified and evaluated. Here a key criterion is whether they have the capacity to derail the firm's strategy. The management of risks is therefore integrated into the company's strategic goals. At the operational level, the company will establish procedures and assign responsibility to oversee the management of these unacceptable risks. Hence, it is often the function of the financial manager to use financial techniques or source instruments to mitigate the risks. For instance, by buying insurance cover against specific risks.
- Review – the final step is to repeat the process and keep the risks under review, since conditions change and firms evolve over time.

Companies can protect themselves against the currency risk in various ways, either by operational hedge or various financial strategies. As this is a thesis about using financial derivatives, we will focus on the latter. In this section forwards, futures, and swaps will be explained, since I will use them in my simulation. As the red line of this master thesis is to stick to applicable aspect, I will try to synthesize the derivatives theoretical description together with a concrete situation of Company X as an exporter getting paid in foreign currencies. In this sense, the use of exchange rate derivatives is an attempt to mitigate currency risk, and hedging firms are successful to the extent that their market and financial performance is nearly indistinguishable from non-hedging firms during the crisis (Allayannis, Brown, & Leora, 2001).

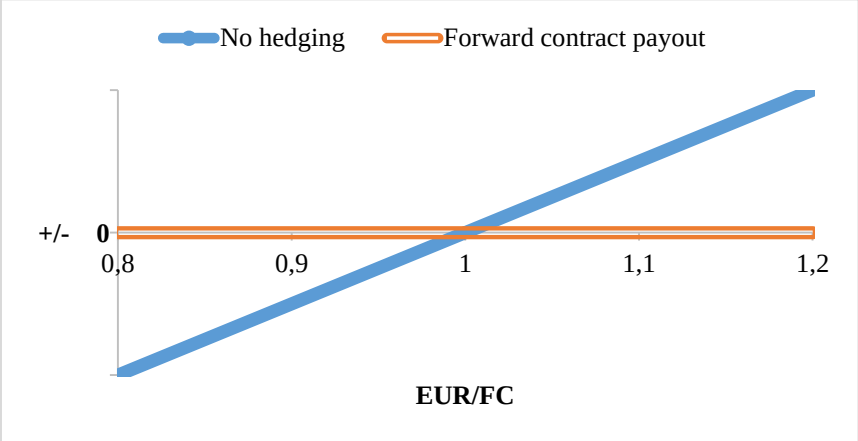
3.1 Forward and futures contracts

Forward contracts allow a company to set the exchange rate at which it will buy or sell a given quantity of foreign currency in the future (on either a fixed date or during a fixed period of time). They are flexible instruments that can easily match future transaction exposures. By entering into this forward contracts, the company will have eliminated all or most of the transaction exposure it faces (EDC, 2009). By buying a forward contract, company enters into a contractual commitment to deliver to (or purchase from) a bank or foreign exchange broker a fixed quantity of foreign exchange at a future date (EDC, 2009).

The equivalent to forward contracts in function, although they differ in several important features, are futures contracts. Futures contracts are exchange traded and therefore have standardized and limited contract sizes, maturity dates, initial collateral and several other features. Given that futures contracts are available in only certain sizes, maturities and currencies, it is generally not possible to get an exactly offsetting position to totally eliminate the exposure. The futures contracts, unlike forward contracts, are traded on an exchange and have a liquid secondary market which make them easier to unwind or close out in case the contract timing does not match the exposure timing (Bodnar, 2016).

Company X as an exporter gets an order of 1 million of foreign currency (FC). Company X will issue invoices in the range of the next year, every three months. Company X can plan the incoming cash flows, coming from those projects and can therefore financially hedge itself, by buying a simple FC/EUR forward contract. With this contract, company will buy euros by selling FC at the predetermined rate on a predetermined date.

Figure 40. Forward contract payout



For the simple presentation we can assume that Company X has just received an order for FC 1 million. All the price calculations in the offer phase were calculated at FC1=€1. That means that if Company X does not go into hedging, it is thrown to the uncertainty and volatility of international financial markets. That means that if the spot rate on the date of

receiving payment is more than 1,0 FC/EUR, Company X will record a profit on the exchange rate movement. However, exchange rate can also slip under 1,0 FC/EUR and in that case Company X will report a loss. With profit margins already very slim, it is very risky to receive unhedged payments in a foreign currency. Forward contract gives us a chance to hedge our future cash flows and plan them with stability. Because of its simplicity and easy-to-use application, it is perfect to conduct an analysis of hedged vs. non-hedged cash flows.

We can choose from a big portfolio of forward and futures contract maturities, as they span from 1 week to 6 years. Mostly, we can choose through the following contract lengths: 1W, 2W, 3W, 1M, 2M, 3M, 4M, 5M, 6M, 9M, 1Y, 15M, 18M, 2Y, 3Y, 4Y.[1]

Contracts are always valued in forward points. Forward points are the number of basic points (bps) added to or subtracted from the current spot rate of a currency to determine the forward rate for delivery on a specific value date. When points are added to the spot rate, this is called a forward premium; when points are subtracted from the spot rate, the currency trades at a forward discount. For example, if euro can be bought vs. the dollar at the rate of 1.1350 for spot, and the forward points on the offer side for a given date are +13, the outright forward rate is 1.1363 (Investopedia.com, 2016).

3.1.1 (Normal) Contango vs. (normal) backwardation

A lot of different theories are used by evaluating the right position of today's price of future derivative. If today's future price gives the best forecast of the future spot price, it satisfies the **expectation hypothesis,** which can be written as

$$F_t = E_t [S_t] \quad (1)$$

The reason this relationship may hold is as follows. Say the one-year EURGDP future price is F=1,1. If the markets forecast that the EURGDP in one year will be at 1,2, one could make a profit by buying a futures contracts at 1,1, waiting a year, then buying a EURGDP at a rate of 1,1 and then resell it at higher price of 1,2. In other words, deviations from this relationship imply speculative profits, for which we could say that the expectation hypothesis may hold its ground (Jorion, 2005).

For financial assets for which the arbitrage between cash and futures is easy, the futures or forward rate is solely determined by the cash-and-carry relationship. However, at commodity market we also face other factors, such as storage cost, which also request a certain premium/discount (Jorion, 2005).

We can show 4 examples of relationship between future prices, spot prices and expected spot prices: **backwardation, normal backwardation, contango and normal contango.**

[1] W= week, M=month, Y=year

Table 9. Contango vs Backwardation

1. Contango vs Backwardation	
Contango	**Backwardation**
current spot price < futures price	current spot price > futures price

A market is said to be in **contango,** when the futures price trades at a premium, relative to the spot price. A market is said to be in **backwardation**, when forward prices trade at a discount to spot prices (Jorion, 2005).

Figure 41. Contango vs. backwardation, forward prices in FC/€

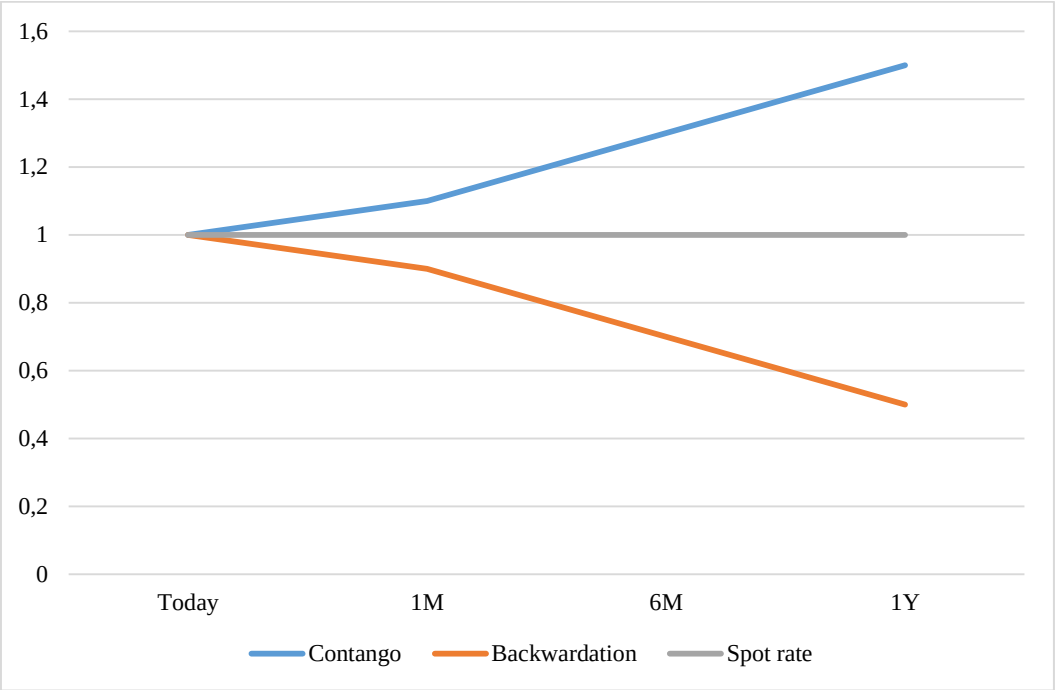
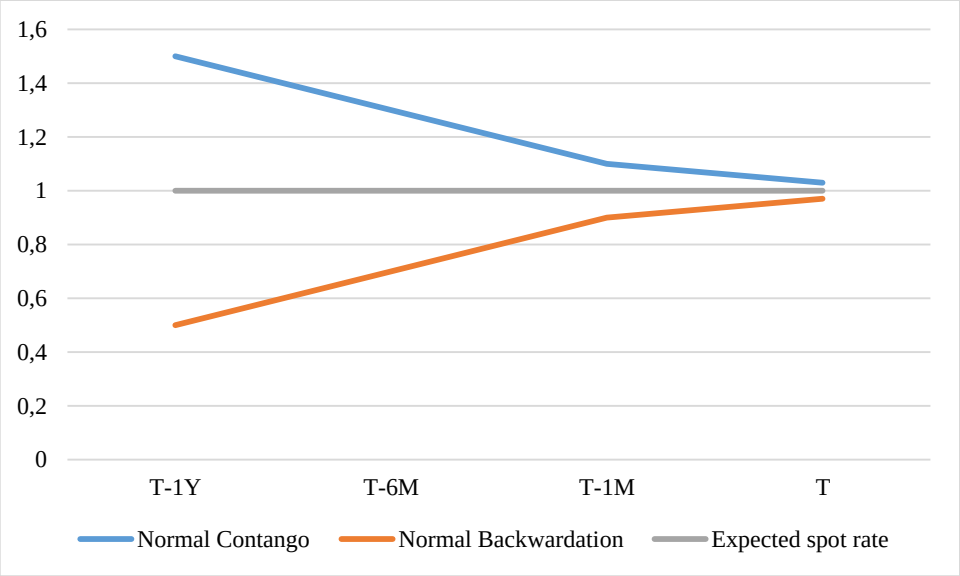


Table 10. Contango vs Backwardation

2. Normal Contango vs Normal Backwardation	
Normal Contango	**Normal Backwardation**
expected spot price < futures price	expected spot price > futures price

A market is said to be in **normal contango,** when the expected spot price is lower than the futures price, as also the market is said to be in **normal backwardation**, when the expected spot rate is higher than futures price.

Figure 42. Normal Contango vs normal backwardation, forward prices in FC/€



A few fundamental factors inform supply/demand for the commodity, which ultimately determines the shape of the futures curve. If we want to be precise, we could say that fundamentals like storage cost, financing cost (cost to carry) and convenience yield inform supply and demand. Supply meets demand where market participants are willing to agree about the expected future spot price. Their consensus view sets the futures price. And that is why a futures price changes over time: market participants update their views about the future expected spot price. The traditional crude oil futures curve, for example, is typically humped: it is normal in the short-term, but gives way to an inverted market for longer maturities (Harper, 2015).

That is why we should distinguish between two things when talking about (normal) contango and (normal) backwardation by financial derivatives and commodities. By financial derivatives we basically don't have any subsequent costs like storage cost, while by commodities we have. That is why premium or discount by financial derivatives like currency forwards are determined by plain risk premium and basic evaluation of where the currency is headed. We can conclude that expectation hypothesis is more suitable for financial derivatives price evaluation.

3.1.2 Optimal Hedge Ratio

The optimal hedge ratio may be defined as the quantities of the spot instrument and the hedging instrument that ensure that the total value of the hedged portfolio does not change (Hatemi-J & Roca, 2006). Hedge ratio is defined as:

$$h = \frac{\Delta SPOT\ PRICE}{\Delta FUTURE\ PRICE} \quad (2)$$

With a further expansion of upper formula, optimal hedge ratio can be derived as follows:

$$h = correlation\ factor \times \frac{\sigma_{Spot\ price}}{\sigma_{future\ price}}$$

(3)

By calculating hedge ratio, we can see, in which size we can hedge a desired transaction in order to be fully hedged.

3.1.3 Mini case study

Company X wants to hedge their weekly income of 1.000.000 € (denominated in FC) sales, however, they fear that future FC prices will depreciate, making their result in euros lesser. Standard deviation of EURFC σ_{future} prices amounts to 1% (calculated on weekly growth rates), while standard deviation of EURFC σ_{spot} prices amounts to 0,8%. Correlation factor between future and spot prices is 90%. Based on this information we can calculate an optimal hedge ratio, which amounts to 72%.

The contract size of EURFC is usually 125.000€. Thus, if we want to make a perfect hedge, we would need to buy 8 contracts (1.000.000€/125.000€). However, since this is not a perfect hedge, we need to buy just 72% of perfect hedge's contracts. Further calculated, that means 6 contracts (72% x 8 contracts).

3.2 Swaps

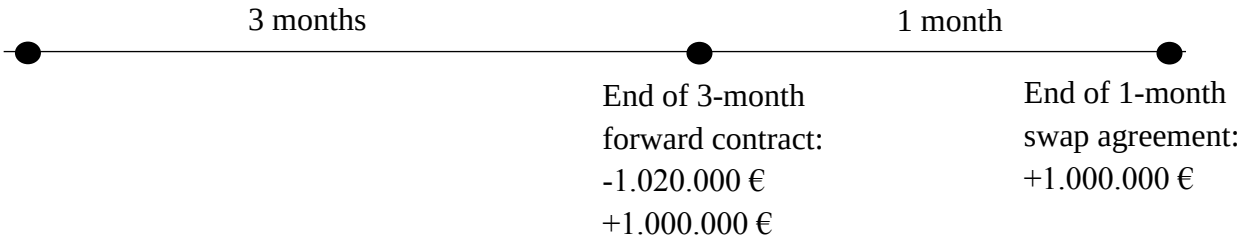
Foreign exchange swap is a combination of foreign exchange deal (normally for value spot) and a later dated outright forward deal in the opposite direction. Both deals are made with the same counterparty and one of the currency amounts in the deal in normally kept constant (Chrisholm, 2010). Swaps help firms match receipts and payments in a foreign currency, however, they also help companies to coordinate maturity of forward contracts with actual payments. It is not rare, or we can say it better, it is very often, that payments don't happen on the arranged day in project management business in which Company X operates.

One way that Company X could use swaps is to match receipts and payments in a foreign currency. For example, Company X would receive a FC 1 million today and it knows, that it has to make FC 1 million in 45 days – it could enter a swap arrangement, whereby it sells FC 1 million today (in exchange for euros on spot rate) and commits to purchase the same amount of FC in 45 day an exchange rate, that is predetermined. Entering into a swap allows the company to have access to euro for the next 45 days and eliminates foreign exchange exposure during this period (EDC, 2009). Swaps are simply a combination of a spot transaction (purchase or sale of foreign currency) and forward contract (EDC, 2009).

It can happen that most of the cash outflows of Company X are denominated in euros, as most of the suppliers come from the Eurozone. Company X could use swap instrument to match the inflow of FC with the payment to the bank.

Suppose Company X enters into a forward contract agreement with a bank, with an arrangement to buy € 1 million and sell FC 1 million, therefore at the rate of 1 EUR/FC. Let's say that the works on the project are late and therefore also the payment will happen 1 month later. Company X still has to supply FC 1 million on the arranged date. What will happen is, that Company X will supply/sell FC 1 million at the 3-months current spot rate (let's suppose the spot rate will be 1,02 EUR/FC) by exchanging € 1.020.000. In 1 month, we finally receive a payment of FC 1 million, which we exchange them into euros by arranged swap rate of 1 EUR/FC – on our account we get €1 million.

Figure 43. Swap timeline



The negative side of this combined instrument is that Company X has to bear the costs of change in exchange rate in the swap agreement period. In this example, Company X would lose €20.000, which is 2% of the whole deal.

4 RESEARCH

As already previously stated, Company X used no financial hedging in order to secure itself against currency risks. All invoices to foreign markets were issued in euro, because also all contracts were agreed in the Eurozone currency. As also shown in chapter 2.1, because of currency volatility, this often harmed sales potential in this specific foreign markets.

That said, a question raises. What if Company X became more flexible and started entering into contracts in a foreign currency? In today's world, where competition is stiff, companies are trying everything in order to please every customer's wish, and securing a contract in the currency of a customer may be such a demand. With this policy we enter into dangerous waters, since contracts projects often last many months and years and currency dynamics can often take a swift turn, up or down, and this may often harm the company's end result. That is why it is necessary to protect yourself with a certain hedge, which is most often a simple forward contract.

A perfect way to see, if a method would bring results is, if we make a historical analysis of past cash flows and future simulation. Of course, the best simulation is the one that takes into account all actual factors, which have a meaningful impact in real life. In our case, we want to test what it would be like, if we issued all our invoices in foreign currency, because of predetermined decision to come closer to our clients in the pursuit of increasing sales. We would like to test, what would be the result, if we issued all our invoices between 2013–2015 in a foreign currency and hedge them with a simple forward contract at the same time. On the other side, I will carry out a VAR5 simulation that would predict EBIT result for the future. Simulation should include all meaningful factors: the length of the order, the gradual issuing of invoices, corresponding and adequate forward contract and appropriate costs from issuing banks.

First part is, as already written, a historical analysis of past invoices. I have done a simulation of every Company X's invoice issued on the markets of Russia, United Kingdom, Sweden and Poland, if they were issued in the corresponding currency and hedged with adequate forward contract, for the years 2013, 2014 and 2015. The basis consists from 4799 invoices in the total sum of 60.438.048,21 €.

Second part is, as also already written, a VAR5 simulation of all examined markets, where I will try to prove that hedged cash flows result in better VAR5 and a more stable distribution of end results. Lastly, I will try to connect both first and second part in a meaningful conclusion.

In the next part I will first thoroughly describe a methodology, empirical development and final interpretation of results of the carried-out simulation.

4.1 1st Part: Historical analysis

4.1.1 Methodology

As written in the upper text, the purpose of this thesis is to:

1. choose the best model from financial derivatives in order to hedge the company in the best possible way

2. empirically define the results of the simulation.

Model choice

Even though there are more financial derivatives described in the thesis, that doesn't mean they are equally usable. The task of this thesis is to define the most applicable way, in order to hedge Company X from currency risk. That is why I had chosen that my model consists only of a simple forward hedge. Reasons for this choice are:

- forward contract simplicity,
- ability to plan stable cash flows,
- lower costs,
- easier operational use,
- bigger liquidity of forward contracts.

A question may arise why other instruments like options and swaps were not taken into account. The main reasons are:

- options are more complicated with more variables (besides the maturity also the choice of the strike price),
- lower liquidity for Polish, Russian and Swedish market and therefore higher costs,
- higher costs because of the option premium,
- inability to compose a so called "zero-cost collar" because of the premium discrepancy of put and call premiums.

4.1.2 Cost estimation

The mission of the thesis is to be as realistic as possible and that also means to include all possible costs in order to get empirically reliable and credible data. All the data of currency spot and forward rates are in form of the ASK prices – that means that bank margins are already included.

4.1.3 Empirical development

The main assumption of the simulation is that all our sales are now agreed in the foreign currency. With this assumption being made, we must now compare two scenarios:

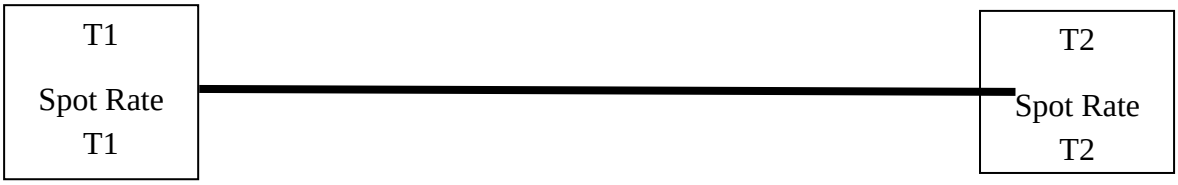
Scenario 1: we don’t hedge our receivables with forward contract.

Scenario 2: we do hedge our receivables with forward contract.

In both scenarios, the price is now fixed. That means that the customer now pays the same amount of FC as agreed at the order (before, the customer was the holder of the risk, now it’s Company X). The difference is the final outcome for Company X. In time T1, Company X gets the order. In scenario 1, by securing an order in T1, it would get paid in T2 with spot rate in T2. During the time T2-T1, the Company X is the bearer of currency risk. If we look at scenario 2, company would secure an order in T1. At the same time, it would also hedge itself with the appropriate forward contract with maturity of T2-T1.

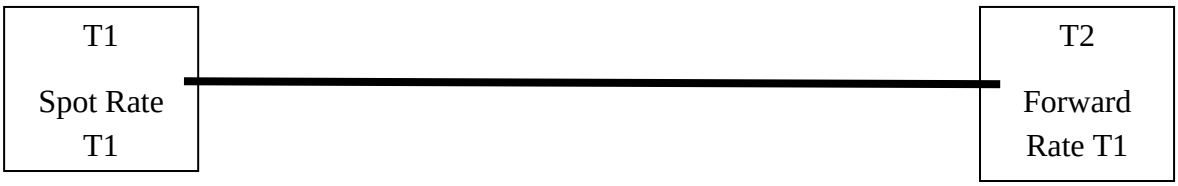
Scenario 1:

Figure 44. Scenario 1 timeline



Scenario 2:

Figure 45. Scenario 2 timeline



Final difference between outcomes in Scenario 1 and Scenario 2 is what will matter in the final analysis. Let’s also look at the practical example.

4.1.4 Example 1

Let us say Company X secures an order in the amount of 10.000 FC. Current spot rate (spot rate 1) is 5,0 FC/€. That means that currently our order is worth 2.000 €. Now we have two options, either to secure it with a forward contract or not. Time to payment from

order acquisition in this example is 2 months. That means we could hedge the receivable with 2 months' forward rate.

Let's assume, that spot rate in T2 is now 5,5 FC/€, FC has depreciated, while the rate of the 2-month forward contract we would secure in T1 is 5,1 FC/€, with all costs included. What does that mean?

In T2, when the payment comes, we ought to exchange FC into euros. In scenario 1, our final outcome is now 1.818 €, while in scenario 2 our final outcome is 1.960 €. That means we made a profit in the amount of 142€, which amounts to 7% of the original order.

Example 1 shows just one transaction. Our basis consists of 4799 transactions divided by 5 markets and the end aggregated result should give an applicable and reliable insight into currency hedging.

Final conclusion of this analysis is therefore a difference between Scenario 1 and Scenario 2, as shown in Example 1. For the comparability of the results between the markets, further derivative will be executed, named % difference, which is a simple share of the difference between Scenario 1 and Scenario 2 of the original order (by spot rate of the date of order).

$$\%\, Difference = \frac{Scenario\ 2 - Scenario\ 1}{Sum\ of\ original\ order} \tag{4}$$

4.1.5 Results

The results will be presented in two parts: the sheer presentation of the simulation results market by market and the latter analysis of the reasons – why are the results the way they are and what is the biggest factor influencing the % difference, which is our main result.

The first part of results presentation will therefore include:

1. Detailed tabular presentation of % difference, sorted by contract types
2. Figureical presentation of % difference in a timeline mode, with a) spot rate dynamics and b) effective forward points dynamic
3. Presentation of correlation coefficients of % difference with spot rate and effective forwards points rate

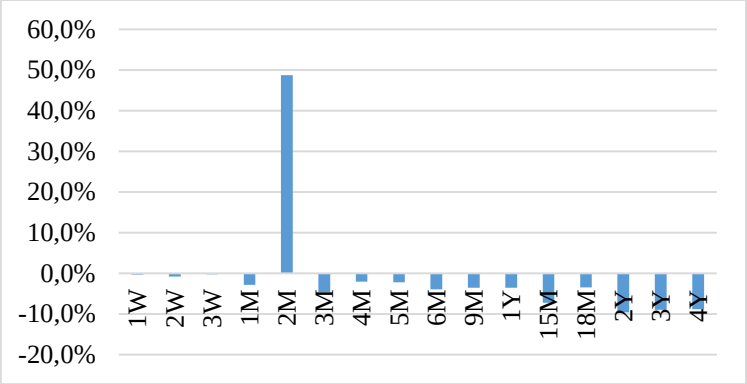
At this point a question arises, what does the term *effective forward point* mean? **Effective forward rates are a calculated rate of n-forward contract rates, which were executed on a given day**. For example, if on day 1, we get a FC10.000 order, which on day T is worth €15.000 from executed forward contracts (forward contract 1, forward contract 2,… are secure on day 1), that means that the effective forward rate for this day is 1,5 €/FC.

4.1.5.1 United Kingdom

Table 11. End analysis for UK Market: Performance of Forward contracts in the span of 2013–2015

Forward contract	Average span [in days]	Invoice sum [by spot rate of order, in €]	# of invoices	Scenario 1 [spot rate of date of payment, in €]	Scenario 2 [forward rate of date of order, in €]	Difference [Scenario 2-Scenario 1, in €]	Standard Deviation of the difference (in %)	% Difference of Invoice by spot rate of order (in %)
1W	5	-11.756,76	1	-11.716,23	-11.755,75	-39,51	0,0	-0,3
2W	13,7	-17.214,76	6	-17.074,53	-17.213,20	-138,68	1,2	-0,8
3W	20,7	42.982,90	3	43.047,92	42.968,85	-79,08	2,6	-0,2
1M	32,4	-6.355,93	5	-6.175,82	-6.354,80	-178,98	1,9	-2,8
2M	71,3	-66.950,53	46	-99.513,26	-66.919,43	32.593,83	3,9	48,7
3M	92,3	5.057.912,11	181	5.284.453,61	5.051.533,04	-232.920,56	3,0	-4,6
4M	121,5	1.809.374,09	165	1.842.926,11	1.806.251,95	-36.674,17	3,4	-2,0
5M	153,6	2.440.420,00	177	2.490.097,78	2.435.940,10	-54.157,69	3,8	-2,2
6M	194,9	5.113.046,44	340	5.301.349,68	5.100.837,39	-200.512,29	4,2	-3,9
9M	265,5	4.103.034,01	299	4.233.099,19	4.089.183,11	-143.916,08	5,6	-3,5
1Y	370,4	3.098.406,34	279	3.192.840,96	3.083.163,14	-109.677,81	7,0	-3,5
15M	447,1	3.195.260,31	172	3.406.569,63	3.176.774,68	-229.794,95	6,7	-7,2
18M	554,9	1.318.830,73	130	1.355.972,72	1.310.042,42	-45.930,30	5,7	-3,5
2Y	756,8	1.780.516,82	159	1.933.633,35	1.763.465,59	-170.167,76	6,8	-9,6
3Y	1073,8	106.291,07	44	114.518,82	105.035,11	-9.483,71	6,8	-8,9
4Y	1417,9	4.627,56	10	4.983,45	4.576,72	-406,73	6,5	-8,8
TOTAL		**27.968.424,40**	**2017**	**29.069.013,39**	**27.867.528,91**	**-1.201.484,48**	**5,8**	**-4,3**

Figure 46. Forward contract performance by type in UK Market



British Pound sterling all the time slowly but steadily appreciated compared to euro in the 2013–2015 period, that is why (as it was already expected in Data Descriptives chapter) it was expected, that no hedging scenario would benefit Company X strongly, as the company would profit from pound depreciation. The analysis confirms that hypothesis. If Company X didn't hedge, it would get €29,1 million on its account, and if it did hedge, it would get €28,9 million, which is a negative difference of €1,2 million. At the end, those €1,2 million means a negative difference in share of -4,3%. All the forward contracts are performing negatively, except 2M contract, as we can see in Figure 46. Why is 2M contract performing exceptionally well? The difference is made by two invoices issued in a fairly large sum (over €180.000 each), which also captured a fairly good forward rate. If we eliminate those two invoices, results would be similar.

Figure 47. Performance of hedged invoices with spot rate dynamics

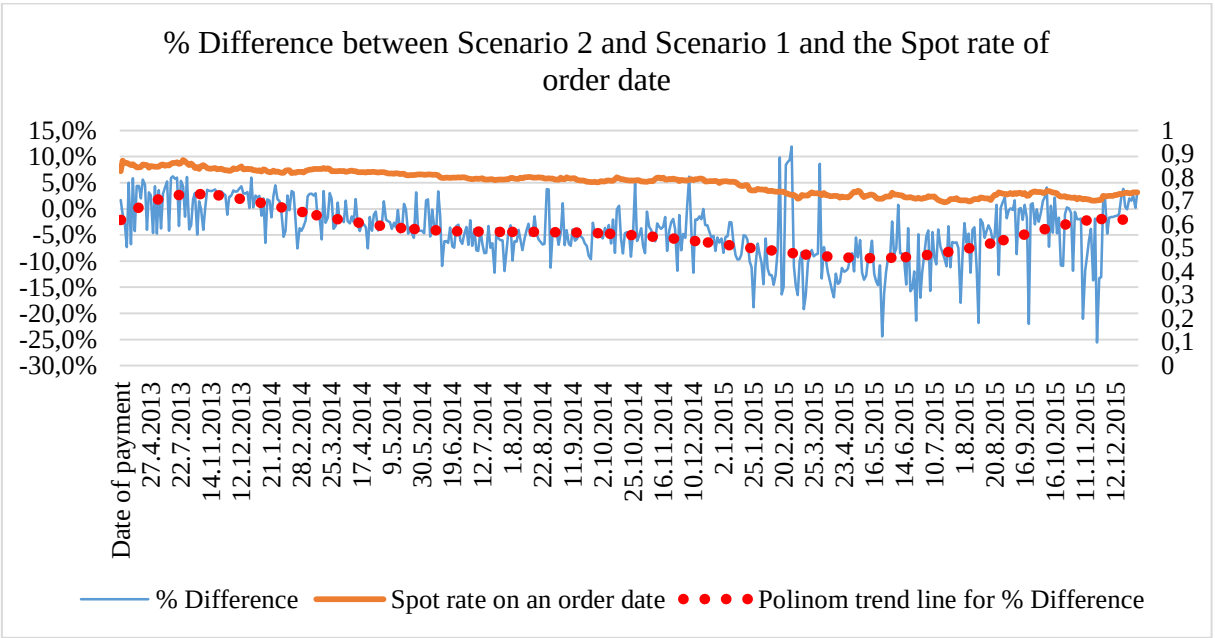
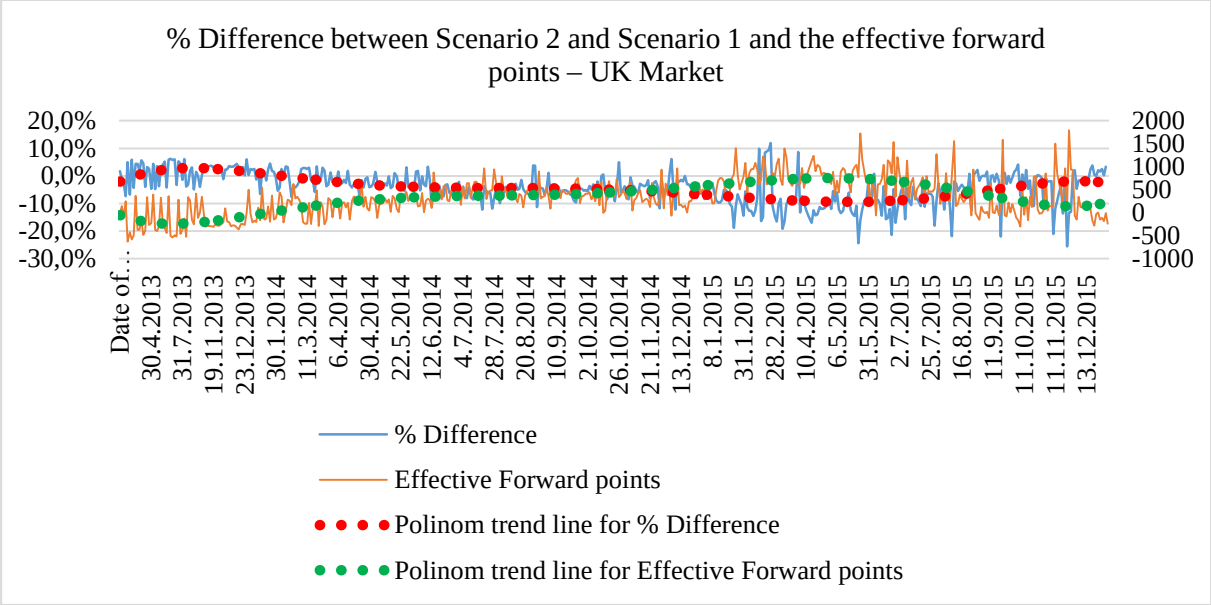


Figure 48. % Difference and the effective forward points – UK Market



The polynomial trend line of % Difference (blue line and red trend line of Polinom of order 6) in Figures 47 and 48 shows that result is mostly negative (below 0%), except in the start of 2013. Also, we can observe a high correlation of the % Difference with spot rate and effective forward points rate. The Pearson Coefficients of correlation are as follows:

Table 12. Correlation coefficients: British market

	% Difference and Spot Rate	% Difference and effective forward point rate
Pearson Coefficient of Correlation (in%)	0,51	-0,88
P-Value	0,00	0,00

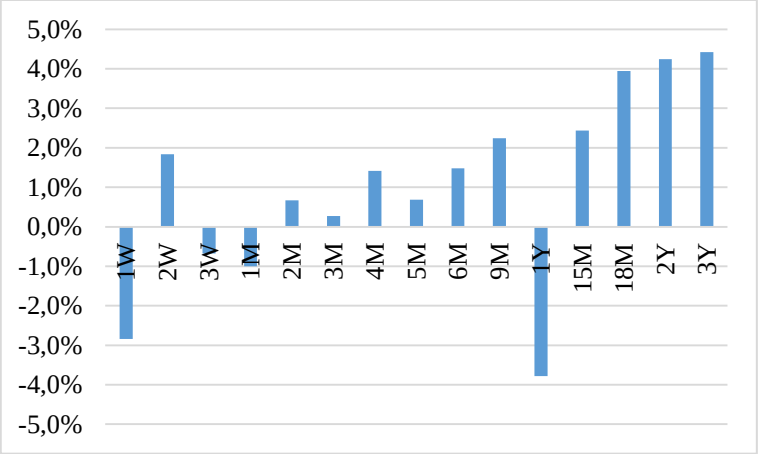
The Figures, as well as correlation coefficients show a medium positive correlation with spot rate and strong negative correlation with effective forward point rate, both at the P-Value of 0,00. As Euro goes down and the foreign currency appreciates (pound sterling in our case), also the % Difference goes down. Why? In Scenario 2, we are hedged and therefore don't profit from the natural movement of the currency. As euro constantly depreciated, it got more sources from pound appreciation, therefore we can observe a medium positive correlation between spot rate dynamics and % Difference.

Between the % Difference and effective forward point rate, we can observe a strong negative correlation. As already explained in Section 5.1.4, effective forward rate is an average rate of all contracts for all hedged orders in a given day. That means that if effective forward rate is for 100 points higher than the spot rate, that means an effective appreciation of euro, which in turn means a negative result for use as we get less sources. The same applies for the negative effective forward rate – that means the effective depreciation of euro, which means more sources for Company X.

Table 13. End analysis for Swedish Market: Performance of Forward contracts in the span of 2013–2015

Forward contract	Average span [in days]	Invoice sum [by spot rate of order, in €]	# of invoices	Scenario 1 [spot rate of date of payment, in €]	Scenario 2 [forward rate of date of order, in €]	Difference [Scenario 2- Scenario 1, in €]	Standard Deviation of the difference (in %)	% Difference of Invoice by spot rate of order (in %)
1W	7,7	-15.233,82	3	-14.801,57	-15.234,07	-432,50 €	0,8	-2,8
2W	16	545,35	2	535,16	545,18	10,02 €	1,5	1,8
3W	21	-157.500,00	2	-156.434,09	-157.495,14	-1.061,05 €	-	-0,7
1M	40,8	339.227,70	54	342.565,33	339.175,47	-3.389,86 €	1,8	-1,0
2M	60,6	1.229.316,78	90	1.220.775,86	1.228.971,53	8.195,67	1,6	0,7
3M	92,9	469.959,43	63	467.473,83	468.742,57	1.268,75	1,5	0,3
4M	121	1.268.147,07	55	1.249.129,76	1.267.080,02	17.950,26	2,2	1,4
5M	151,6	552.130,32	34	546.709,69	550.510,28	3.800,59	1,9	0,7
6M	203	1.718.062,82	61	1.689.774,33	1.715.189,74	25.415,41	2,0	1,5
9M	245,4	383.093,75	51	373.362,21	381.935,02	8.572,81	1,9	2,2
1Y	342	-9.852,72	3	-9.390,88	-9.763,44	-372,56	3,4	-3,8
15M	465	55.791,60	4	53.633,31	54.993,84	1.360,53	4,7	2,4
18M	543,5	91.221,86	4	86.089,93	89.685,51	3.595,58	0,6	3,9
2Y	807,2	464.447,43	16	434.149,51	453.875,44	19.725,93	5,1	4,2
3Y	967,7	213.269,70	14	196.645,37	206.073,32	9.427,96	2,7	4,4
TOTAL		**6.602.627,27**	**456**	**6.480.217,76**	**6.574.285,27**	**94.067,51 €**	**2,2**	**1,4**

Figure 49. Forward contract performance by type in Swedish Market



Sweden represents a success and a positive side of this simulation. As already expected and written in the Sweden part of exposure part in Chapter 2.3.2, we can observe a slow but steady rise of euro compared to krona, so in this example it would be wise to hedge. Analysis has proven us right, as the simulation achieved overall 1,4% difference between Scenario 1 and Scenario 2, with all contract types performing positively except 1W and 1Y – the reason is in small number of corresponding maturity invoices.

We can observe a positive result of €94.000 in the span of 3 years. Looking also at the timeline of Swedish market, we can see that the result was most of the time positive, correlated also with the euro slow and steady rise. As the dynamics somehow stabilized at the end of 2015, result was still positive.

Figure 50. Performance of hedged invoices with spot rate dynamics

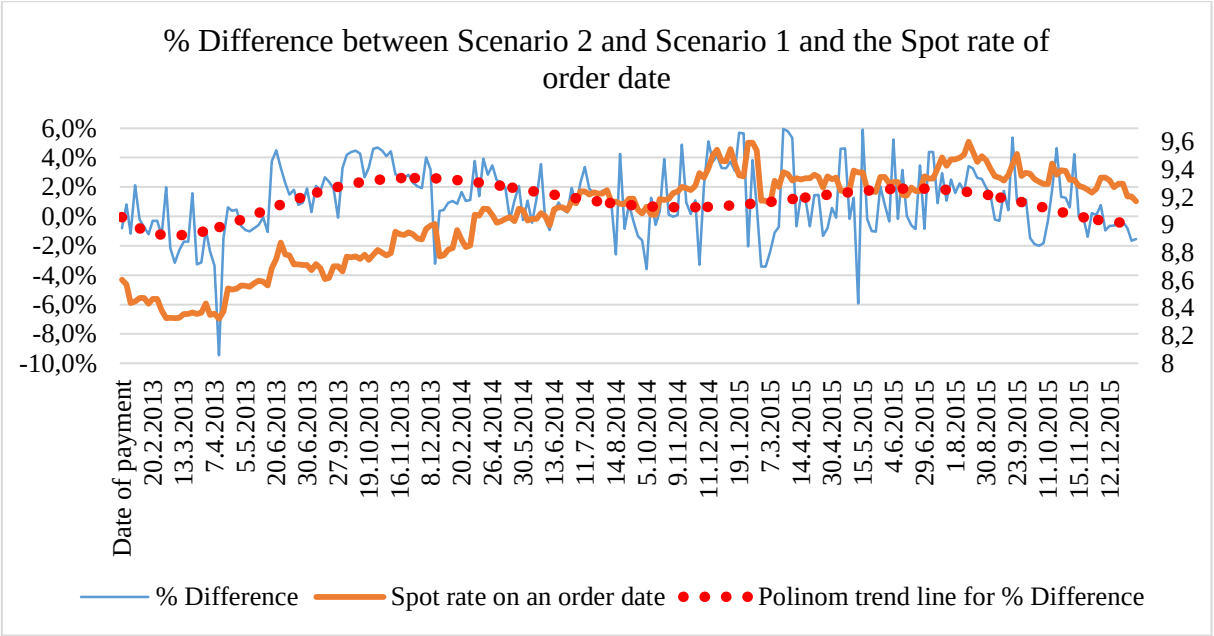
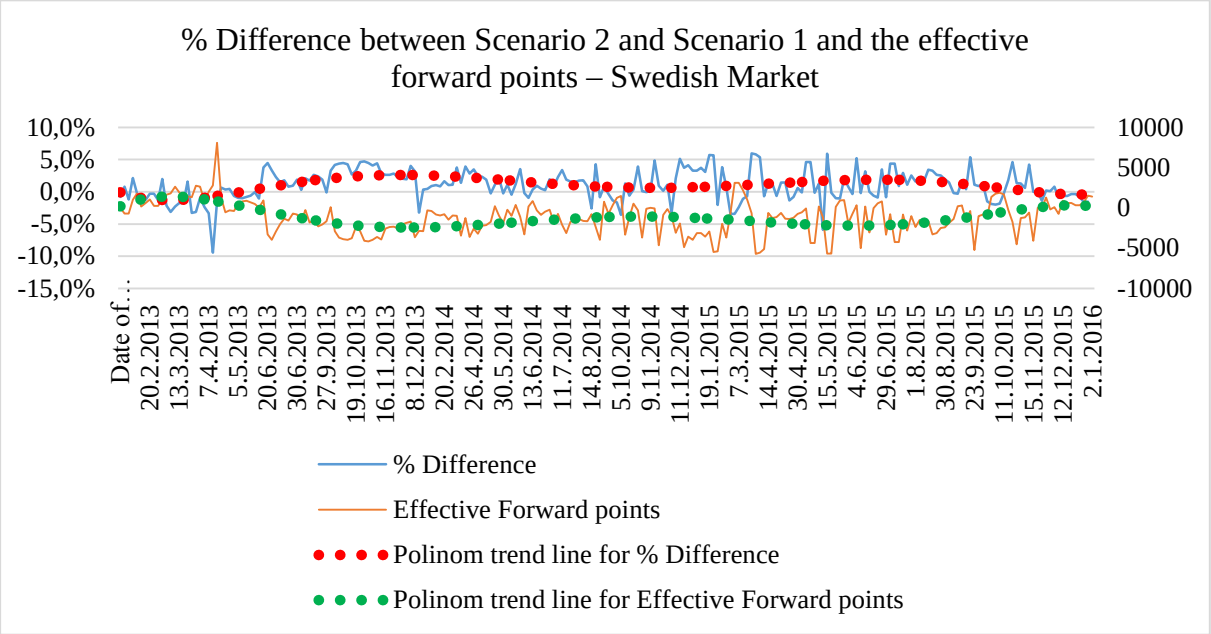


Figure 51. % Difference and the effective forward points – Swedish Market



The correlation between spot rate and the % Difference is weak but positive with P-Value of 0,00, however, similar as in the UK market, the correlation between % Difference and effective forward point rate is negative but strong.

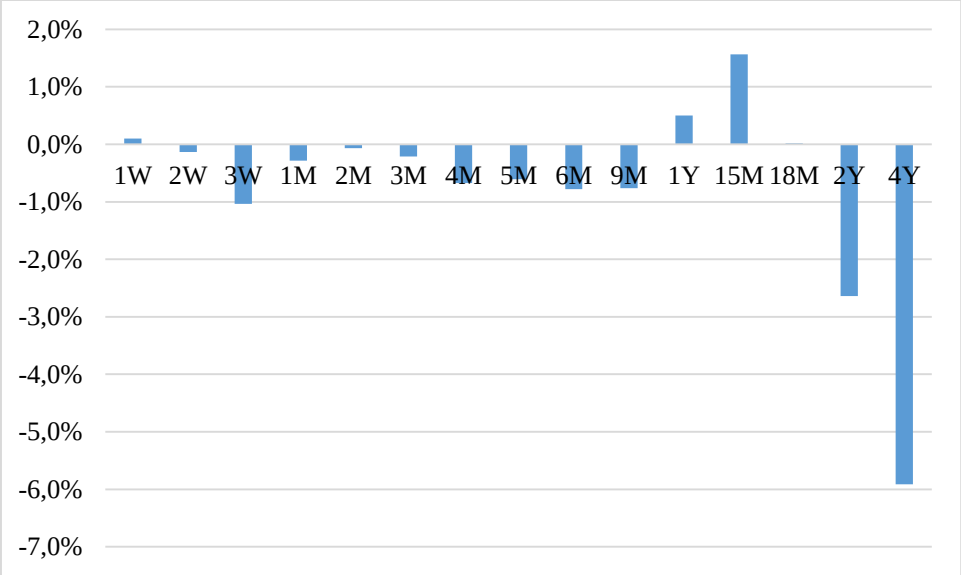
Table 14. Correlation coefficients: Swedish market

	% Difference and Spot Rate	% Difference and effective forward point rate
Pearson Coefficient of Correlation (in%)	0,25	-0,84
P-Value	0,00	0,00

Table 15. End analysis for Swiss Market: Performance of Forward contracts in the span of 2013–2015

Forward contract	Average span [in days]	Invoice sum [by spot rate of order, in €]	# of invoices	Scenario 1 [spot rate of date of payment, in €]	Scenario 2 [forward rate of date of order, in €]	Difference [Scenario 2- Scenario 1, in €]	Standard Deviation of the difference (in %)	% Difference of Invoice by spot rate of order (in %)
1W	6,3	189.119,03	18	188.941,39	189.125,25	183,86	0,4	0,1
2W	13	54.477,47	6	54.554,12	54.479,88	-74,24	0,8	-0,1
3W	23	87.895,29	18	88.820,68	87.909,04	-911,63	1,3	-1,0
1M	37,6	1.153.074,02	140	1.156.732,23	1.153.432,66	-3.299,57	2,3	-0,3
2M	59,4	858.053,70	117	859.265,42	858.697,76	-567,66	1,3	-0,1
3M	89,2	901.501,50	127	904.240,80	902.315,45	-1.925,35	2,9	-0,2
4M	121,3	1.326.200,07	119	1.337.191,97	1.328.266,37	-8.925,60	3,8	-0,7
5M	152,7	830.531,13	64	837.362,62	832.310,31	-5.052,31	1,8	-0,6
6M	187,6	1.243.998,16	107	1.255.872,36	1.246.191,26	-9.681,10	5,5	-0,8
9M	269,9	607.501,22	59	613.568,40	608.923,79	-4.644,61	6,7	-0,8
1Y	355,2	516.434,83	58	516.050,46	518.627,36	2.576,89	5,3	0,5
15M	446,5	54.736,69	12	54.156,19	55.012,36	856,16	1,8	1,6
18M	569,8	131.863,20	16	132.448,27	132.467,95	19,68	2,1	0,0
2Y	733,7	120.014,53	21	123.712,13	120.546,74	-3.165,39	9,9	-2,6
4Y	1377	1.117,70	1	1.242,89	1.176,83	-66,06	-	-5,9
TOTAL		**8.076.518,54**	**883**	**8.124.159,93**	**8.089.482,99**	**-34.676,94**	**5,7**	**-0,4**

Figure 52. Forward contract performance by type in Swiss Market



Situation is very interesting is the Swiss market. Situation on the spot market was stable until the start of 2015 with the sudden rise of franc. In the period of 2013–2015, the simulation has achieved a negative result of -0,4% or 34.676 €. In this period, 883 invoices would be hedged. All the contract types would perform somehow similar, with only 1Y and 15M exceeding the positive side.

Also, the timeline is very illustrating. Before January 2015, when spot rate was stable, also the result would be stable and around zero. However, with the January 2015 upset, we can observe a larger variance in the result and a strong positive curve of the polynomial trend line (order 6 of the result).

Figure 53. Performance of hedged invoices with spot rate dynamics

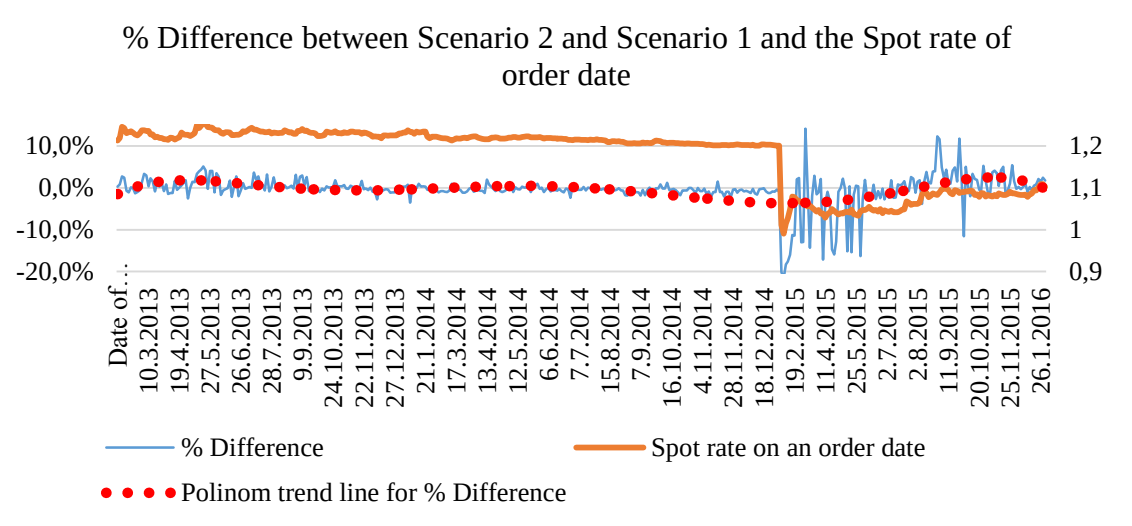
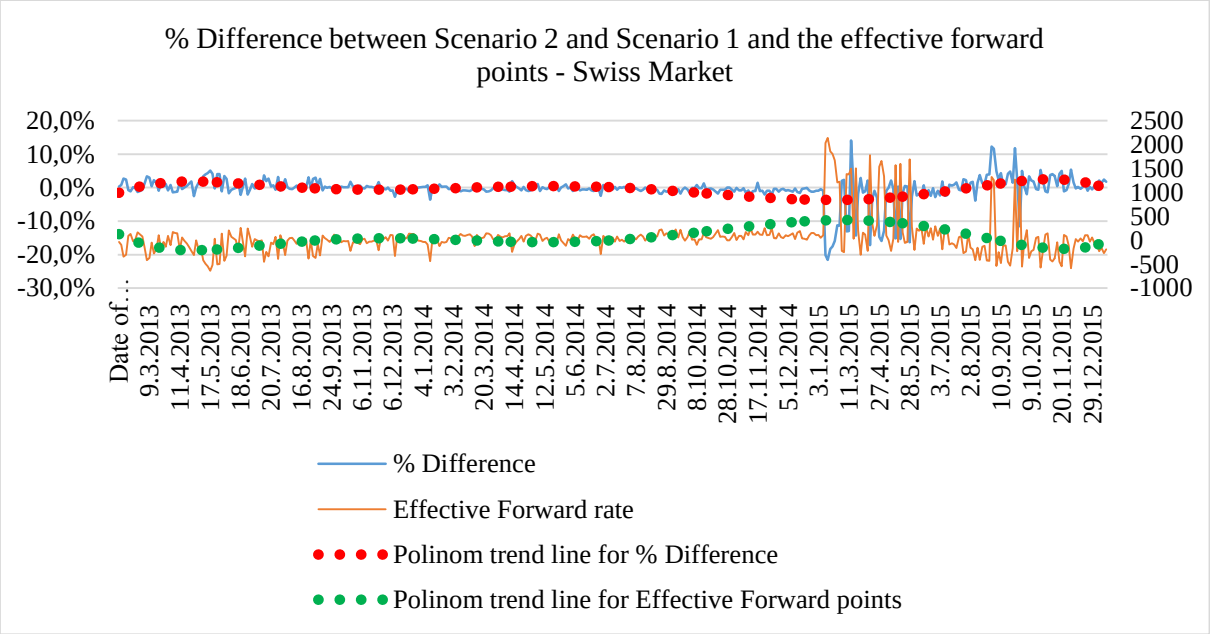


Figure 54. % Difference and the effective forward points – Swiss Market



The correlation between Spot rate and % Difference between Scenario 1 and Scenario 2 is positive but weak, with a correlation coefficient of 0,25 and P-value 0,00 and the correlation between effective forward rate and % difference is again negative and strong.

Table 16. Correlation coefficients: Swiss market

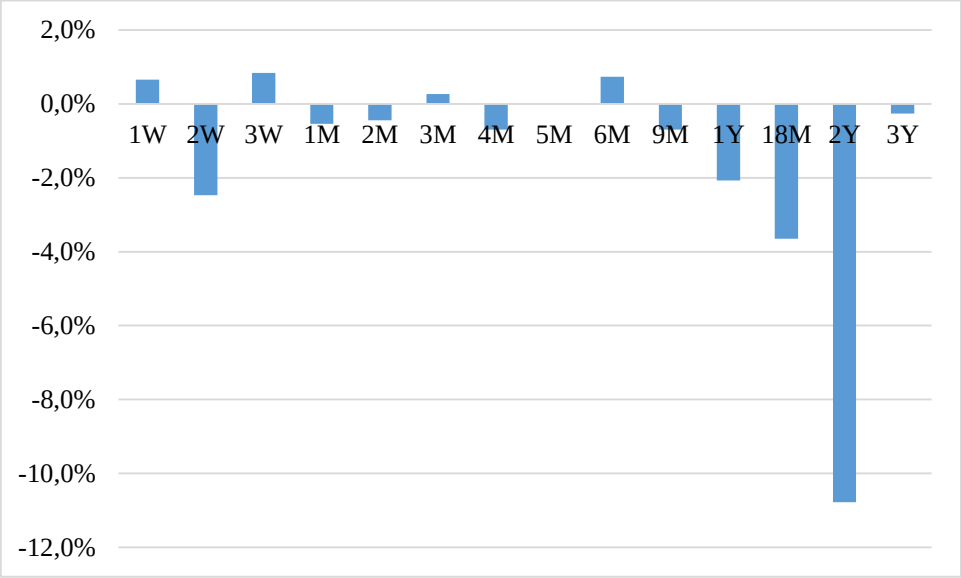
	% Difference and Spot Rate	% Difference and effective forward point rate
Pearson Coefficient of Correlation (in%)	0,25	-0,76
P-Value	0,00	0,00

4.1.5.4 Poland

Table 17. End analysis for Polish Market: Performance of Forward contracts in the span of 2013–2015

Forward contract	Average span [in days]	Invoice sum [by spot rate of order, in €]	# of invoices	Scenario 1 [spot rate of date of payment, in €]	Scenario 2 [forward rate of date of order, in €]	Difference [Scenario 2- Scenario 1, in €]	Standard Deviation of the difference (in %)	% Difference of Invoice by spot rate of order (in %)
1W	7	5.127,12	2	5.091,04	5.124,80	33,76	1,9	0,7
2W	13	3.484,73	1	3.568,86	3.482,72	-86,15	1,9	-2,5
3W	22	48.451,16	6	47.990,04	48.396,20	406,15	1,2	0,8
1M	36	70.227,71	13	70.492,81	70.111,16	-381,65	1,5	-0,5
2M	61,7	473.299,44	51	473.623,12	471.537,08	-2.086,03	1,9	-0,4
3M	91	1.232.837,54	115	1.222.997,17	1.226.304,59	3.307,42	1,5	0,3
4M	122,1	1.382.988,36	151	1.382.922,73	1.373.353,74	-9.568,99	2,4	-0,7
5M	150,8	1.116.541,74	105	1.105.952,81	1.106.060,62	107,81	2,7	-
6M	197,8	1.405.056,04	157	1.379.802,92	1.390.107,53	10.304,62	3,3	0,7
9M	270,5	821.002,18	105	812.295,89	806.567,43	-5.728,46	3,2	-0,7
1Y	378	542.747,10	70	537.176,70	525.940,75	-11.235,95	3,2	-2,1
18M	528,9	276.019,11	37	274.225,29	264.157,62	-10.067,67	2,6	-3,6
2Y	716,8	86.956,63	9	91.671,80	82.297,94	-9.373,86	3,0	-10,8

Figure 55. Forward contract performance by type in Polish Market



Situation from the aspect of results is similar to the Swiss market, we can record a minimal loss of 0,5% of % difference between Scenario 1 and Scenario 2, as in the span of 3 years a loss of €34.374 would be made. All the contract types perform in the span of +0,8% (-2,5%), except the 18M and 2Y contract. As the standard deviation of those contracts is also in a normal frame, we can conclude that the result of those contracts was simply bad, as we can start finding the reason in the pricing of those exact forward rates.

Figure 56. Performance of hedged invoices with spot rate dynamics – Polish market

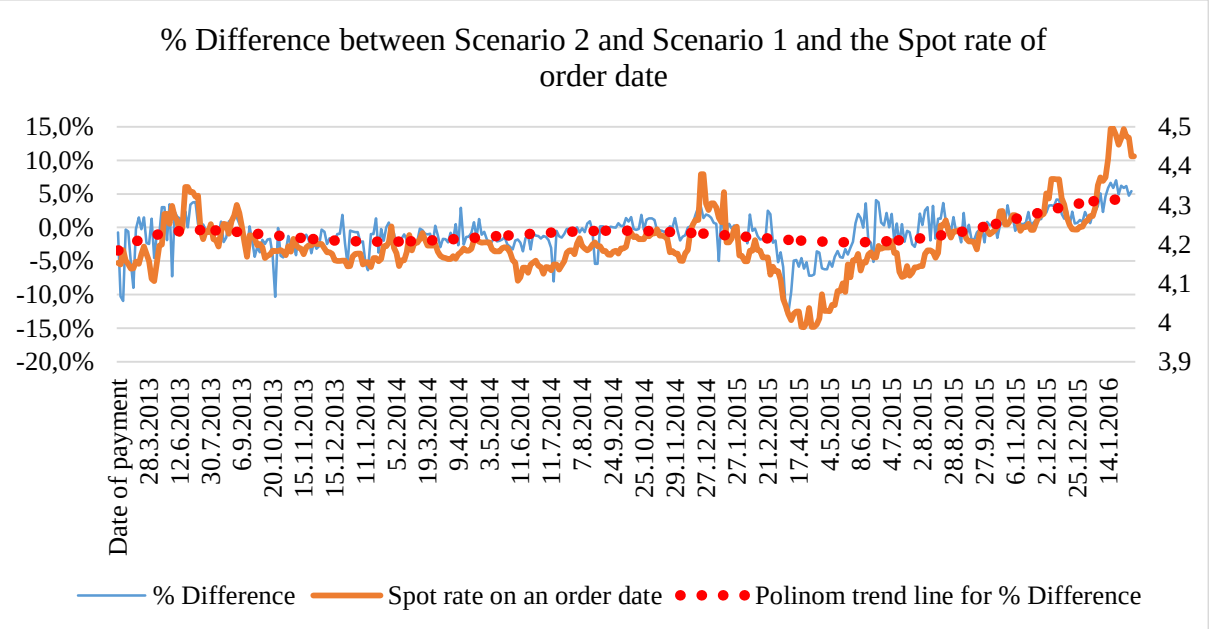
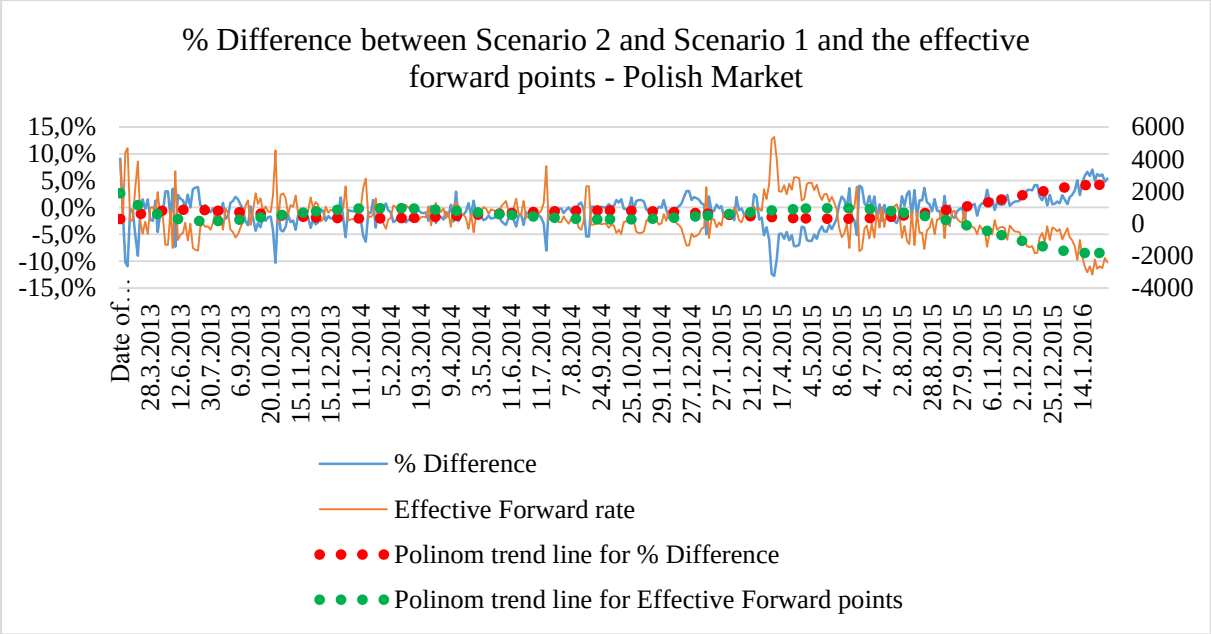


Figure 57. % Difference and the effective forward points – Polish Market



Looking at the timeline, we can observe a slight correlation between the spot price and % difference, and that proves also the Pearson correlation coefficient in the amount of 0,71 with P-value of 0,00. The correlation of % Difference and the effective forward point rate again amounts to negative and strong amount of -0,92.

Table 18: Correlation coefficients: Swiss market

	% Difference and Spot Rate	% Difference and effective forward point rate
Pearson Coefficient of Correlation (in%)	0,71	-0,92
P-Value	0,00	0,00

58.

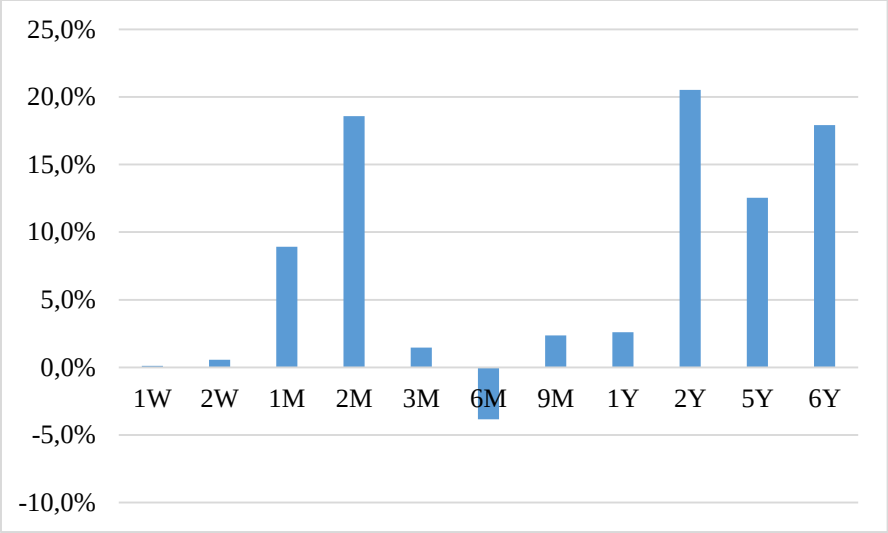
4.1.5.5 Russia

Table 19. End analysis for Russian Market: Performance of Forward contracts in the span of 2013–2015

Forward contract	Average span [in days]	Invoice sum [by spot rate of order, in €]	# of invoices	Scenario 1 [spot rate of date of payment, in €]	Scenario 2 [forward rate of date of order, in €]	Difference [Scenario 2- Scenario 1, in €]	Standard Deviation of the difference (in %)	% Difference of Invoice by spot rate of order (in %)
1W	0	-615,98	1	-615,98	-615,25	0,73 €	-	0,1
2W	15,2	24.353,50	9	24.123,99	24.260,22	136,23 €	2,2	0,6
1M	37,4	766.885,93	37	692.449,92	760.854,13	68.404,20 €	5,6	8,9
2M	58,9	1.301.098,48	43	1.040.381,98	1.282.058,08	241.676,10 €	9,8	18,6
3M	107,4	1.518.889,16	81	1.459.227,77	1.481.502,63	22.274,86	15,5	1,5
6M	186,6	2.231.255,27	127	2.209.405,87	2.123.867,08	-85.538,79	15,4	-3,8
9M	268,8	2.502.670,60	117	2.310.303,73	2.369.488,62	59.184,89	10,2	2,4
1Y	405,9	664.956,72	65	607.913,01	625.265,40	17.352,39	8,8	2,6
2Y	661	368.712,21	51	243.987,66	319.645,69	75.658,03	17,5	20,5
5Y	1906,8	85.285,81	4	74.590,83	85.285,81	10.694,98	1,3	12,5
6Y	2069,9	118.288,22	7	97.082,91	118.288,22	21.205,31	0,2	17,9
Total		**9.581.779,93**	**542**	**8.758.851,70**	**9.189.900,63**	**431.048,92**	**5,7**	**4,5**

Figure
Forward
contract

performance by type in Russian Market



Russia is a pure example of how unpredictable and volatile an exchange rate can be and a good indicator that none of the forecasting models can predict such dynamics, as there are a lot of non-empirical factors included, such as politics, wars, trade bans… From a managerial point of view, Russia is the best market, where serious consideration for currency hedging would be needed. Also, the results of the simulation show the best positive impact among the analysed markets positive impact, as the difference between Scenario 2 and Scenario 1 would amount to 4,5% or 94.067,51 €. The best performing contracts were the long-term ones, 2Y, 5Y and 6Y, as they were fixed before the rouble fall. This is the best indicator of this research – it shows, what a successful forward contract can be in case of so unpredictable events, like in Russia.

Figure 59. Performance of hedged invoices with spot rate dynamics – Russian market

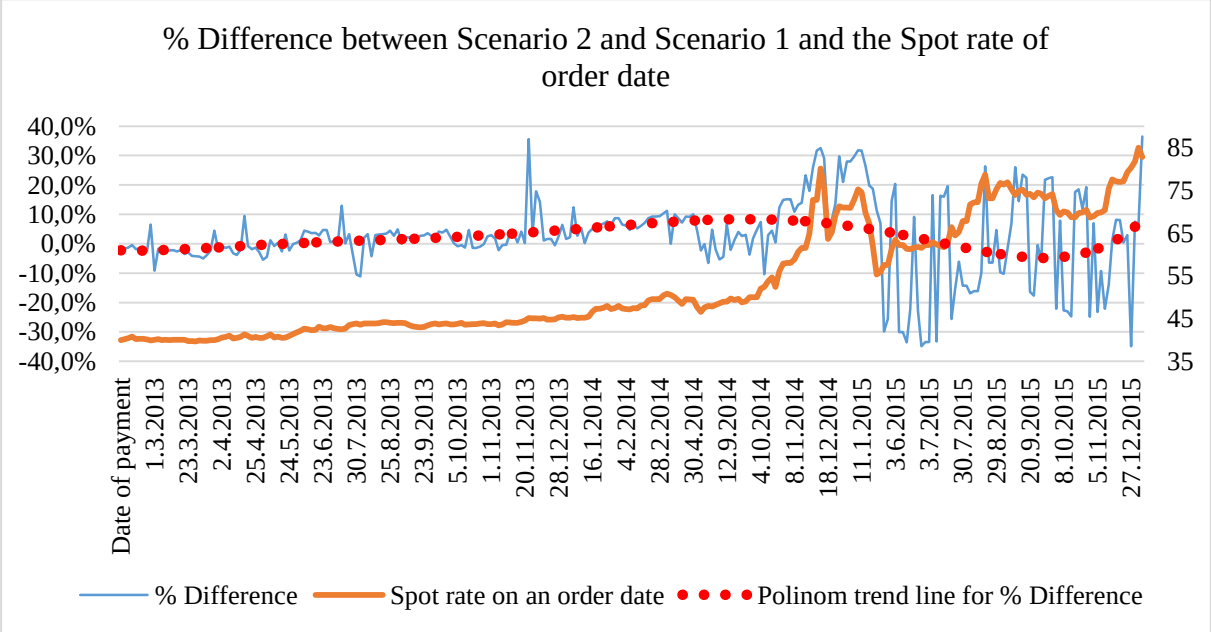
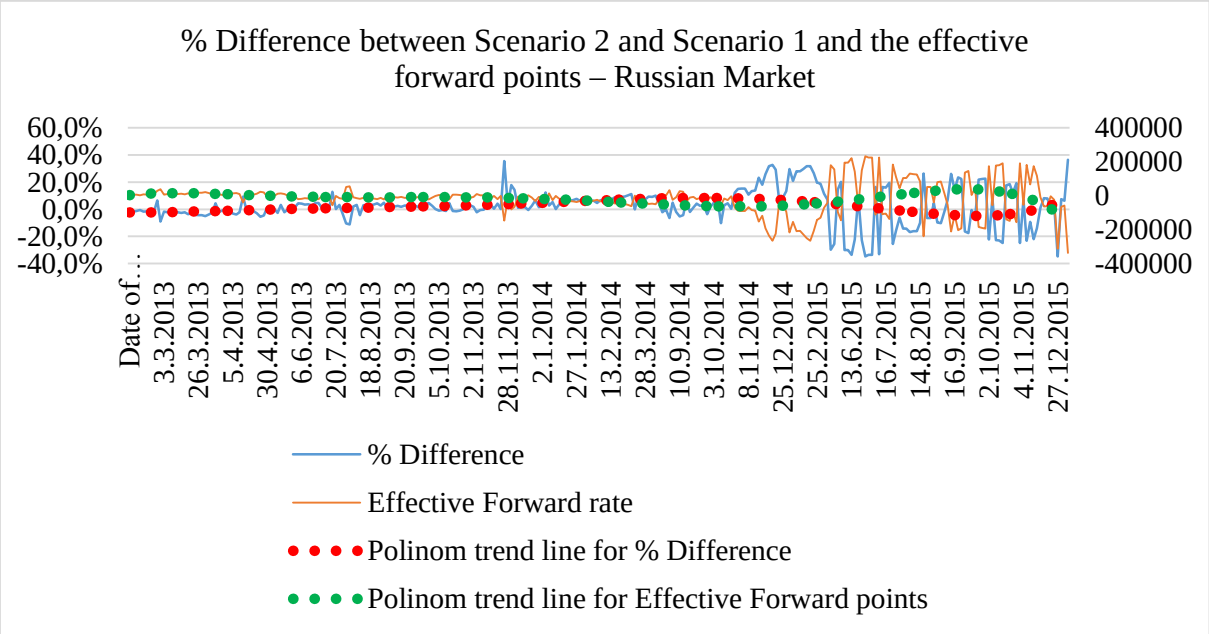


Figure 60. % Difference and the effective forward points – Russian Market



As we observe the timeline with polynomial trend line of order 6, we can observe that the biggest profit was made at the start of the rouble crisis in October 2014. There, rouble was starting to fall, however in simulation, rates were fixed and there comes the big difference.

What is interesting here is, that we cannot confirm a correlation of the % difference with the spot rate dynamics, as the correlation is still weak and positive, with P-Value of 0,07.

Table 20. Correlation coefficients: Russian market

	% Difference and Spot Rate	% Difference and effective forward point rate
Pearson Coefficient of Correlation (in%)	0,11	-0,91
P-Value	0,07	0,00

4.1.6 Summary

Table 21.Summary of end results of historical analysis

	Invoice sum [by spot rate of order, in €]	Scenario 1 [spot rate of date of payment, in €]	Scenario 2 [forward rate of date of order, in €]	Difference [Scenario 2-Scenario, in €]	% Difference of Invoice by spot rate of order (in %)
Great Britain	27.968.424,40 €	29.069.013,39	27.867.528,91	-1.201.484,48	-4,30
Sweden	6.602.627,27 €	6.480.217,76	6.574.285,27	94.067,51	1,40
Switzerland	8.076.518,54 €	8.124.159,93	8.089.482,99	-34.676,94	-0,40
Poland	7.466.899,29 €	7.409.782,57	7.375.407,90	-34.374,67	-0,50
Russia	9.581.779,93 €	8.758.851,70	9.189.900,63	431.048,92	4,50
Total	**59.696.249,43 €**	**59.842.025,34**	**59.096.605,69**	**-745.419,66**	**-1,25**

Table 21 shows the end results. The end result is negative, in the amount of €745.419,66 €, mostly because of a negative impact of Great Britain. So, if we exempt Great Britain, the end result would be positive. Pound sterling enjoyed a steady appreciation, so hedging in this case would mostly hurt Company X as it would endure high opportunity costs in the amount of €1,2 million. However, if we look at the other markets, Sweden, Switzerland, Poland and Russia, results are very optimistic. On markets of Switzerland and Poland we endure a minimal loss in the amount of -0,4 and -0,5%, while on Sweden simulation has achieved 1,4% of positive impact. The story of success goes to Russia, as Russian rouble was also the reason behind this thesis because of its volatility. On Russian market, simulation would achieve 4,5% success and this is the story to build on.

4.2 2nd Part: VAR5 Simulation

4.2.1 Methodology

The main goal of VAR5 simulation was to introduce and prove a distribution of results without hedging and distribution of results with hedging, as VAR5 simulation provides accurate forecasts, that .are vital to many financial intermediaries (Batten, Kinateder, & Wagner, 2013). Also, VaR has become an integral part of risk management operations for financial regulations and institutions since being mandated by the Basel Committee (Aloui & Rania, 2015). The methodology of calculation was as follows:

1. Calculating growth rates: weekly growth rates of spot and future prices were calculated. Corresponding future instruments were chosen based on average time of payment at each examined market, as already described in chapter 2.3. Correspondingly also standard deviation of both growth rates was calculated – standard deviation of weekly growth rates was then chosen as the holder for the randomly generated and normally distributed weekly growth rates.

2. Calculating VAR5 with no hedged cash flows: VAR5 calculation with no hedged cash flows assumes, that we issue invoices in foreign currency and don't hedge them. That means, that spot rate is our only indicator of currency dynamics; if foreign currency appreciates, we profit, if foreign currency depreciates, we lose money. That is why distribution should be a lot more scattered and dispersed.

First, the randomly generated growth rate on the basis of individual foreign currency's standard deviation was created. Then for each week, accumulated growth rates were calculated – that means, growth rate in week X showed change with respect to the first week. Those rates are then multiplied with average weekly amount of sales, decreased by a variable cost (assumed at 50% of sales, which is Company X's average) and fixed costs (different for every market), so that weekly EBIT was formed. Weekly EBITs were then summed into a yearly EBIT. This process was repeated 10.000 times, generating a good sample for a distribution review. From this 10.000 samples, standard deviation, VAR5 and histogram are then calculated using a standard procedure.

3. Calculating VAR5 with hedged cash flows: the procedure is the same as in step 2, but with a difference that the process goes separate way by calculating EBIT. Correlated with randomly generated spot rates, future rates are calculated based on the Generating Correlated Time Series procedure. As future spot rates are calculated in correlation with randomly generated spot rates, we can calculate a **financial result**, which consist of multiplying a randomly generated weekly EBIT with future growth rate and optimal hedge ratio (described in Chapter 4.1.2). Next, financial result is deducted from EBIT result as already derived in step 2. We then get a weekly EBIT influenced also by a hedged **financial result**, and then yearly EBIT by summing all weekly EBITs. Process is repeated 10.000 times and same as in step 2. Again, VAR5, histogram and standard deviation are calculated using a standard procedure.

4.2.2 Results

4.2.2.1 United Kingdom

Table 22.: VAR5 Comparison between hedged and non-hedged simulation. Market: United Kingdom

Simulation of non-hedged cash flows		**Simulation of hedged cash flows**	
Mean Year (in €)	3.194.676,71	Mean Year (in €)	3.191.484,58
Median Year (in €)	3.179.821,44	Median Year (in €)	3.200.568,09
St Dev Year (in €)	335.207,72	St Dev Year (in €)	210.767,63
5% Percentile Year (in €)	2.660.160,30	5% Percentile Year (in €)	2.842.203,39
25% Percentile Year (in €)	2.964.573,03	25% Percentile Year (in €)	3.049.704,54
Standard deviation of spot rate (in %)		0,77	
Standard deviation of future rate (in %)		0,76	
Average weekly order sum (in €)		186.456,16	
Weekly fixed costs (in €)		31.697,55	
VC factor (in %)		50,0	
Contract chosen		2M	

Figure 61. Histogram of EURGBP Simulation – non-hedged performance

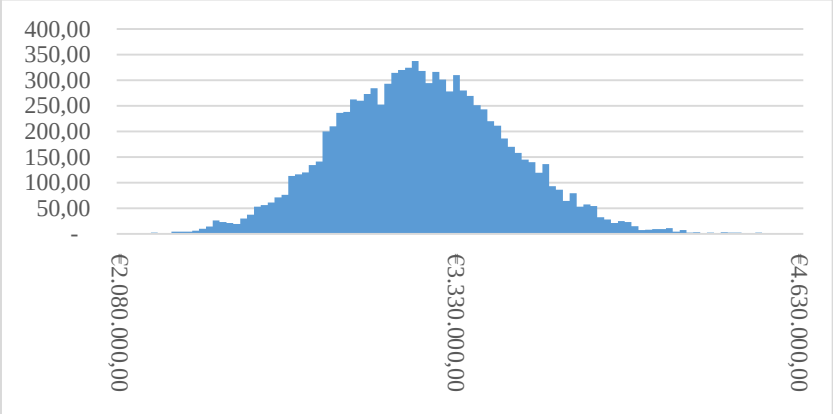


Figure 62. Histogram of EURGBP Simulation – hedged performance

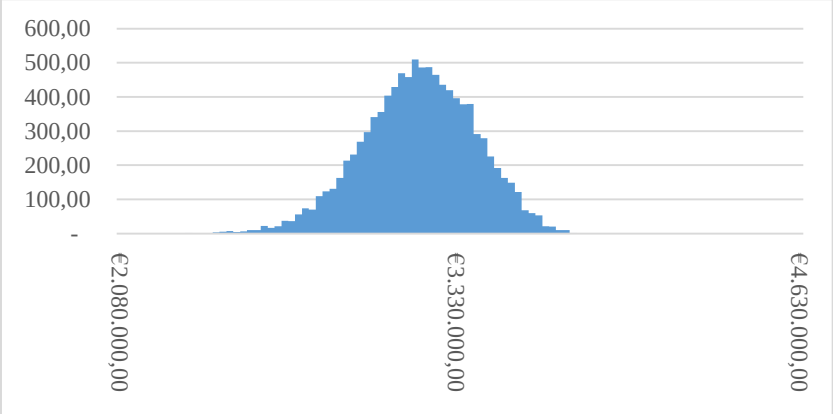


Table 22 and Figures 61 and 62 show the first results of the simulation. With weekly average order sum of 186.456,16 € and fixed costs of 31.697,55 € and variable factor of 0,5 – the non-hedged distribution is more dispersed than the hedged distribution. Also, the 5th (VAR5) and 25th Percentiles are higher. For information, VAR5 is 6,84% higher than in non-hedged simulation. What is important is the standard deviation – standard deviation in the hedged simulation is 37,1% lower, which indicates a more stable prediction of the outcome. As the average time to payment was 65 days, 2M forward contract was chosen. The standard deviation of the spot rate and 2M forward rate amounted to 0,77% and 0,76% on a weekly basis respectively.

4.2.2.2 Sweden

Table 23. VAR5 Comparison between hedged and non-hedged simulation. Market: Sweden

Simulation of non-hedged cash flows		**Simulation of hedged cash flows**	
Mean Year (in €)	755.036,95	Mean Year (in €)	751.754,78
Median Year (in €)	756.229,15	Median Year (in €)	752.135,13
St Dev Year (in €)	57.287,54	St Dev Year (in €)	40.193,86
5% Percentile Year (in €)	658.038,98	5% Percentile Year (in €)	685.929,65
25% Percentile Year (in €)	716.342,74	25% Percentile Year (in €)	724.190,94
Standard deviation of spot rate (in %)		0,62	
Standard deviation of future rate (in %)		0,62	
Average weekly order sum (in €)		44.017,52	
Weekly fixed costs (in €)		7.482,98	
VC factor (in %)		50,0	
Contract chosen		1M	

We can observe a similar story in Swedish market – Table 23 and Figures 63 and 64 again show that the simulation with hedged cash flows gives a more stable and narrower distribution as with the non-hedged cash flows. With average weekly order sum of 44.017,52€ and fixed costs of 7.482,98 € here again the 5th and 25th Percentile are higher, with VAR5 higher for 4,24%, with mean and median on approximately the same level. Standard deviation, which shows the dispersion of the distribution is lower for 29,8% by the hedged simulated distribution. Average time to payment was 26 days, so 1M Forward contract was chosen as representative rate. Standard deviation of both spot rate and 1M forward rate amounted to 0,62%.

Figure 63. Histogram of EURSEK Simulation – non-hedged performance

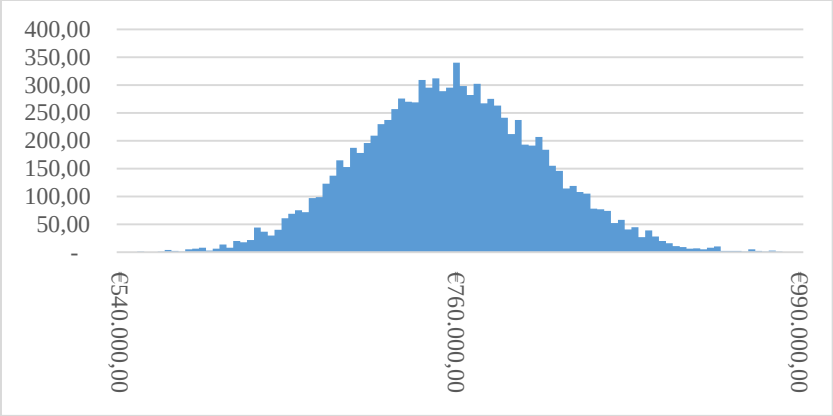
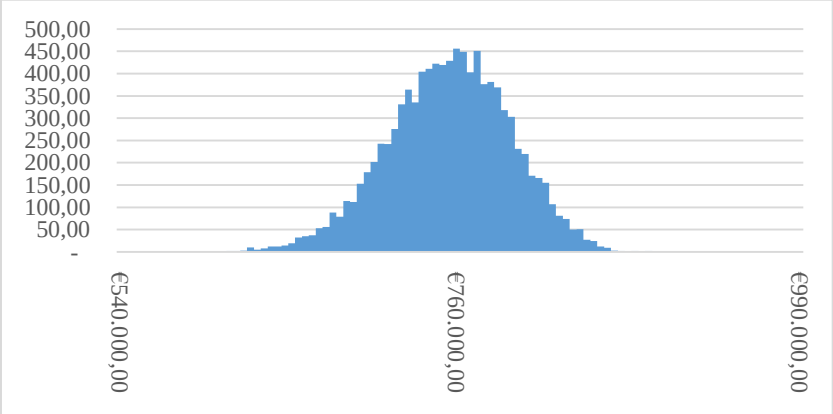


Figure 64. Histogram of EURSEK Simulation – hedged performance.



4.2.2.3 Switzerland

Table 24. VAR5 Comparison between hedged and non-hedged simulation. Market: Switzerland

Simulation of non-hedged cash flows		**Simulation of hedged cash flows**	
Mean Year (in €)	924.452,48	Mean Year (in €)	914.122,03
Median Year (in €)	919.560,47	Median Year (in €)	917.898,56
St Dev Year (in €)	114.806,10	St Dev Year (in €)	80.395,85
5% Percentile Year (in €)	750.958,99	5% Percentile Year (in €)	774.134,09
25% Percentile Year (in €)	843.935,73	25% Percentile Year (in €)	865.025,63
Standard deviation of spot rate (in %)		0,98	
Standard deviation of future rate (in %)		0,99	
Average weekly order sum (in €)		53.843,46	
Weekly fixed costs (in €)		9.153,39	
VC factor (in %)		50,0	
Contract chosen		1M	

Average weekly order amounted to 53.843,46€ with weekly fixed costs of 9.153,39 € and variable cost factor of 0,5. As VAR5 goes, Switzerland achieves a solid result, with VAR5 higher for 3,09% in hedged simulation in comparison to non-hedged simulation, with also 25th Percentile achieving better result. Also, here the distribution is more dispersed in non-hedged simulation, with standard deviation higher for 29,9%. Mean and median values stay on approximately the same level. Average time to payment in Switzerland amounted to 31 days, therefore 1M Forward contract was chosen. Standard deviation of spot rate amounted to 0,99% and 0,98% for the 1M Forward rate.

Figure 65. Histogram of EURCHF Simulation – non-hedged performance

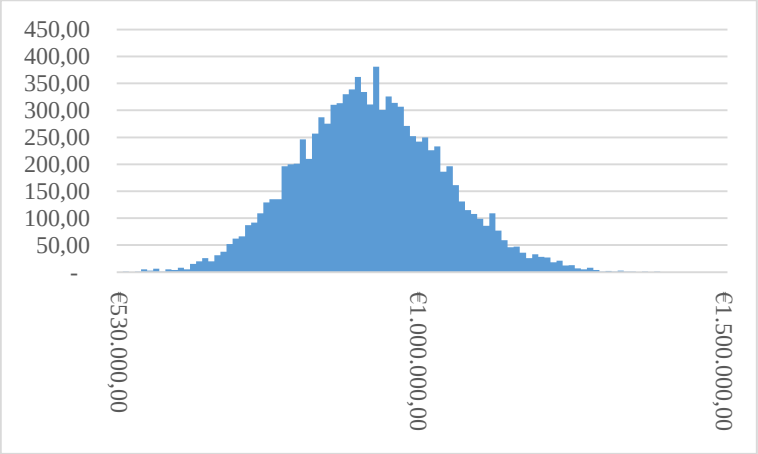
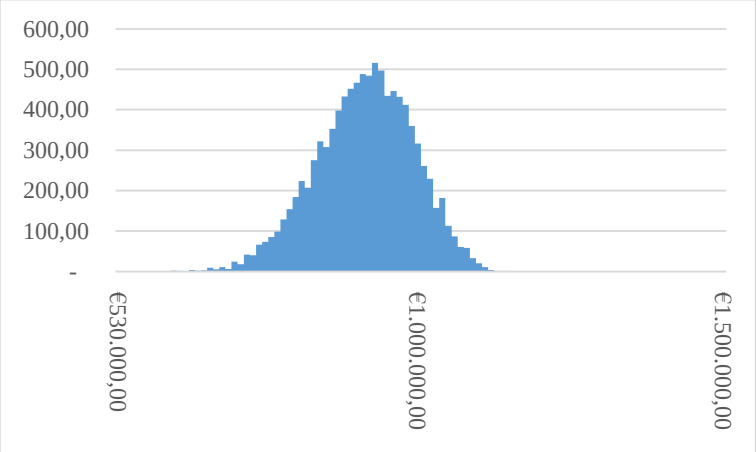


Figure 66. Histogram of EURCHF Simulation – hedged performance



4.2.2.4 Poland

Table 25. VAR5 Comparison between hedged and non-hedged simulation. Market: Poland

Simulation of non-hedged cash flows		**Simulation of hedged cash flows**	
Mean Year (in €)	855.903,72	Mean Year (in €)	851.249,91
Median Year (in €)	854.740,76	Median Year (in €)	851.595,34
St Dev Year (in €)	64.073,34	St Dev Year (in €)	42.909,72
5% Percentile Year (in €)	754.677,55	5% Percentile Year (in €)	781.580,60
25% Percentile Year (in €)	812.675,08	25% Percentile Year (in €)	822.675,91
Standard deviation of spot rate (in %)		0,59	
Standard deviation of future rate (in %)		0,59	
Average weekly order sum (in €)		49.779,33	
Weekly fixed costs (in €)		8.462,49	
VC factor (in %)		50,0	
Contract chosen		2M	

In Poland, average weekly order sum amounted to 49.779,33 € with fixed costs 8.462,49 € and VC factor of 50%. Standard deviation was 33,0% higher in non-hedged distribution, and VAR5 of 3,56% higher. 25th Percentile is also higher, while again the mean and median values stay on approximately the same level. Average time to payment in Poland amounted to 31 days, therefore 1M Forward contract was chosen. Standard deviations of both 1M forward and spot rate amounted to 0,59%.

Figure 67. Histogram of EURPLN Simulation – non-hedged performance

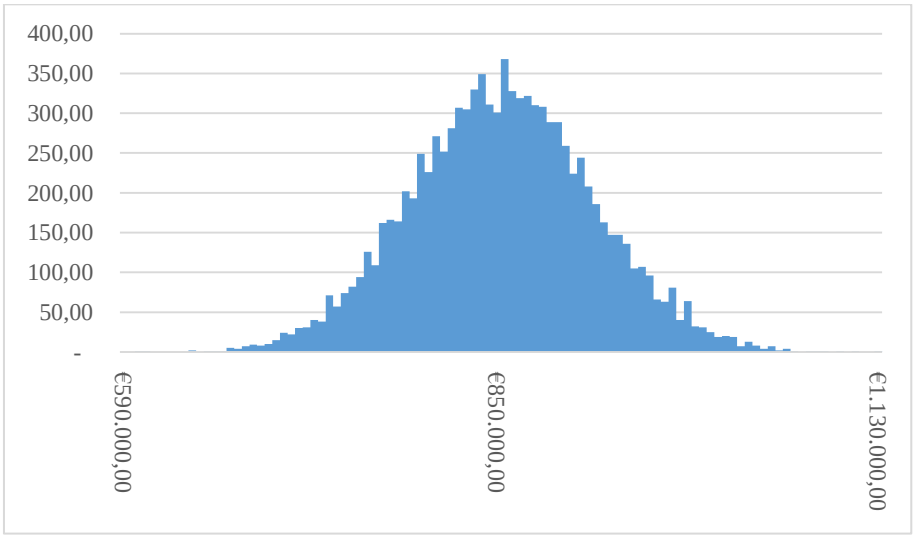
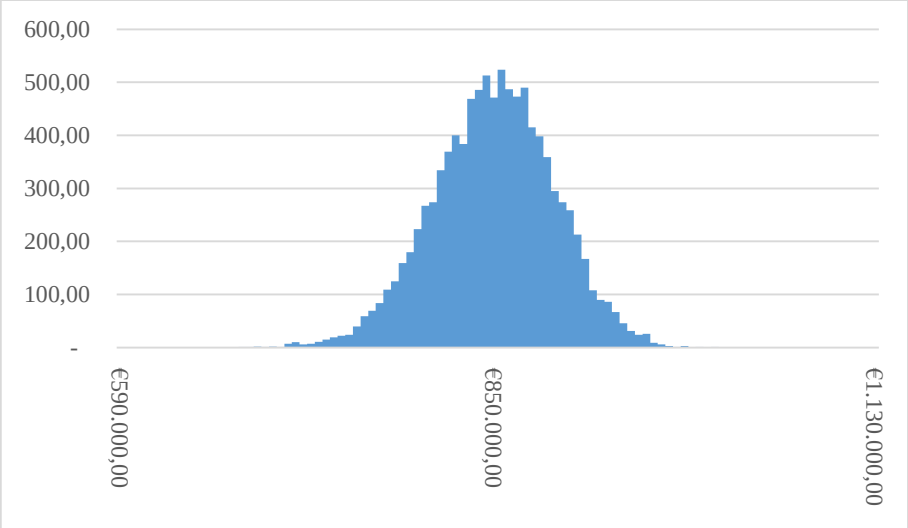


Figure 68. Histogram of EURPLN Simulation – hedged performance



4.2.2.5 Russia

Table 26. VAR5 Comparison between hedged and non-hedged simulation. Market: Russia

Simulation of non-hedged cash flows		**Simulation of hedged cash flows**	
Mean Year (in €)	1.092.644,03	Mean Year (in €)	1.039.270,50
Median Year (in €)	1.055.233,45	Median Year (in €)	1.063.036,82
St Dev Year (in €)	411.020,75	St Dev Year (in €)	271.656,97
5% Percentile Year (in €)	455.746,25	5% Percentile Year (in €)	533.922,56
25% Percentile Year (in €)	821.705,56	25% Percentile Year (in €)	877.040,96
Standard deviation of spot rate (in %)		2,85	
Standard deviation of future rate (in %)		2,91	
Average weekly order sum (in €)		63.878,53	
Weekly fixed costs (in €)		10.859,35	
VC factor (in %)		50,0	
Contract chosen		2W	

Figure 69. Histogram of EURRUB Simulation – non-hedged performance

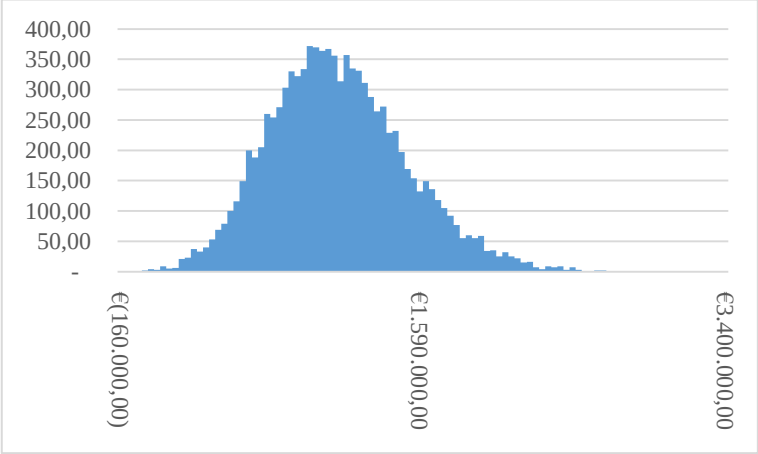
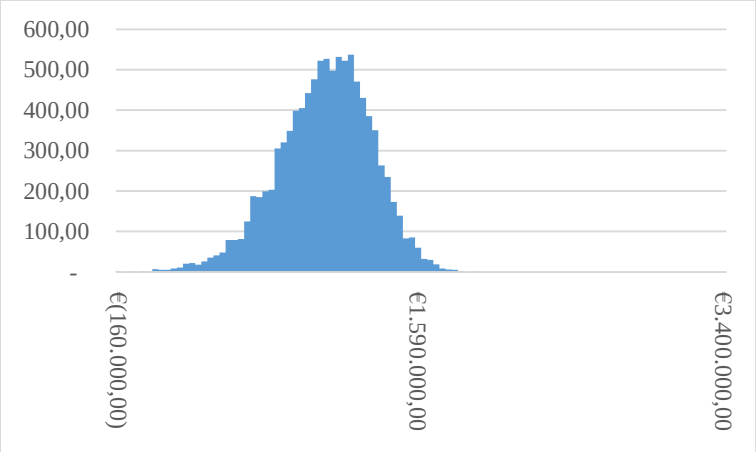


Figure 70. Histogram of EURRUB Simulation – hedged performance



Average weekly order sum was 63.878,53 €, with weekly fixed costs of 10.859,35 €. Both mean and median stay again on approximately the same level, while 25th and 5th Percentile are higher in non-hedged simulation. VAR5 is therefore 17,15% higher, which is the most of all the markets, with standard deviation lower for 33,9%. Here also the standard deviation of the spot rate is 2,85% and 2,91% for the 2W forward rate as the average time to payment was 16 days in Russia.

4.2.3 Analysis

As we can observe from results in 5.2.2, we can draw the following phenomena that can be observed on all the markets:

1. 5th and 25th percentiles are higher in hedged simulations
2. standard deviation is lower in hedged simulations, on average for 32%
3. VAR5 is on average higher for 6,97% in non-hedged simulation
4. As we observe the markets, VAR5 is higher in markets with bigger volatility of spot and forward rates, represented by standard deviation of the currency growth rates

Points 1–3 are the result of logical conclusion. Since the distribution of hedged simulation is more narrow, the VAR5 is always higher and standard deviation is smaller – that result gives us an indication, that hedged cash flows give us more stable and more predictable distribution of possible outcomes.

What is interesting is point 4. Let's look at the simple table of comparison of VAR5 results between the simulations and the standard deviations of spot rate.

Table 27. Comparison of VAR5 result and volatility of spot rate

	VAR5 of hedged simulation / VAR5 of non-hedged simulation (in %)	Standard deviation of spot rate (in %)
United Kingdom	6,84	0,77
Sweden	4,24	0,62
Switzerland	3,09	0,98
Poland	3,56	0,59
Russia	17,15	2,85

Looking at Table 27, we can draw an easy conclusion – we can see that VAR5 result is better (that means that the difference was bigger in hedged simulation in comparison to non-hedged simulation) on the markets, where there is a bigger volatility of the currency. For example, Russia achieves the best result because of the biggest volatility of currency, while Poland performs the worst, while also the volatility of zlot is the smallest. This correlation is also confirmed with Pearson coefficient of correlation in the value of 0,95, with P-Value 0,00.

CONCLUSION

Company X is an international company with a base in Slovenia. Faced with an industry segment with low differentiation of products, measures out of the box are needed to increase sales. Company X still issues all of the contracts and orders in euro, however, there are important markets also out of the Eurozone, which hold an important sales share in company's structure. However, looking at the sales and spot rate dynamics in the most important markets outside of the euro zone (Sweden, Russia, Poland, UK, Switzerland), we can see a high correlation of the spot rate dynamics with won orders – as the euro appreciates, we can observe a fall in sales and vice versa.

Company X already has a plan of sales on markets with foreign currency with an annual growth of 12%, which is not so easy to achieve on already saturated market. Therefore, some other strategies must be taken into account and one of them is to issue orders and contract in a foreign currency in order to get closer to the customer and to take exchange rate risk into own shoulders.

Exchange rate risk is therefore divided into three branches: transaction, translation and economic risk. Transaction risk, which is basically cash flow risk, deals with the effect of exchange rate moves on transactional account exposure related to receivables (export contracts), payables (import contracts) or repatriation of dividends. Translation risk refers to the impact of exchange rate changes on the valuation of foreign assets (mainly foreign subsidiaries) and liabilities on a multinational company's consolidated balance sheet, while economic risk reflects basically the risk to the firm's present value of future operating cash flows from exchange rate movements. This thesis deals with the transaction risk, as it analyses the changes of the cash flows regarding the use of different scenarios.

Foreign currencies can be hedged with different instruments: forwards, options and swaps. Forward contracts are simple agreements between two parties where the exchange rate is fixed for a specific time in the future. With options, unlike by forward contracts, we have an option to exercise the agreement. Swaps on the other hand serve as a good tool to overcome maturities of both forward contracts and invoice maturities. For the purpose of this thesis, only futures and forwards are examined in the theoretical part.

Research and empirical part was divided into two parts: historical analysis of real-time cash flows and simulation of assumed future cash flows using the VAR5 method.

For both methods, only forward contract method was used. Reasons for forward contract use were simplicity, ability to plan stable cash flows, lower costs, greater liquidity and easier operational use. In the historical analysis, the main result of the simulation was a difference between two scenarios: Scenario 2 (where we hedge our invoices) and Scenario 1 (where we don't hedge our invoices). A total of 4799 invoices were analysed and each of them was linked to the adequate forward contract on which the appropriate result was calculated.

Results were very dependent on the market and corresponding exchange rate. Great Britain did the worst, as was also expected, because of steady appreciation of the pound sterling, Poland and Switzerland marked a minimal loss, Sweden did a good positive result, while Russia, as also a benchmark of why should we hedge our transactions, did the best.

Further analysis was made, about what influences the result on a given market. A strong correlation was proved, that effective forward rate best influences the market's result. Effective forward rates are a calculated rate of n-forward contract rates, which were executed on a given day.

In the second part of empirical part, the VAR5 simulation was exercised on all of the five examined markets. The purpose of the simulation was to examine the difference, if we hedge the cash flows or if we don't hedge them. Process was repeated 10000 times in order to get a relevant distribution basis. Results showed that 5^{th} and 25^{th} percentiles are higher in hedged scenario, while mean and median stay on approximately the same level. However, VAR5 difference between the simulations is strongly correlated with the volatility of the foreign currency spot rate. Pearson coefficient of correlation of 0,95 shows that as the currency is more volatile, hedged simulation will have a better VAR5 result.

Thesis therefore unites two different methods in order to evaluate currency hedging: a historical analysis of concrete information in a sort of what-if analysis and a methodical big-scale simulation. Historical analysis gives us a good information of what would happen in the future on the one side, as simulation of hedged and non-hedged cash flows gives us a strong indication, that our forecasted cash flows would be more stable and predictable in case of hedging.

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