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CURRENT TRENDS IN CURRENCY RISK MANAGEMENT BY POLISH SHIPBUILDING ENTERPRISES

AKTUALNE TRENDY W ZARZĄDZANIU RYZYKIEM WALUTOWYM PRZEZ POLSKIE PRZEDSIĘBIORSTWA STOCZNIOWE

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Summary: The article presents modern trends related to the development of currency risk management methods and the opportunities and benefits associated with their implementation. Risk is a factor that should be considered when conducting business. Because economic decisions should be made in accordance with the economic calculation taking into account the opportunity costs and the effects of internal and external factors. To emphasize the importance of this issue, it is worth noting that currency risk can be the cause of both significant losses and large profits, as evidenced by numerous cases in real economic practice. Actions taken to manage currency risk increase the company's financial security. The article presents the currency risk control system on the example of Polish shipbuilding companies. At the same time, contemporary solutions used in shipbuilding enterprises in Poland were assessed together with an assessment of their effectiveness.

Keywords: currency risk, current trends in management, shipbuilding enterprises, financial risk, shift of economic circumstances, risk management.

Streszczenie: Artykuł przedstawia nowoczesne trendy związane z rozwojem metod zarządzania ryzykiem walutowym oraz możliwościami i korzyściami związanymi z ich realizacją. Ryzyko jest czynnikiem, który należy wziąć pod uwagę podczas prowadzenia działalności gospodarczej. Decyzje gospodarcze powinny być bowiem podejmowane zgodnie z kalkulacją ekonomiczną uwzględniającą koszty alternatywne oraz skutki czynników wewnętrznych i zewnętrznych. Aby podkreślić wagę tej problematyki, warto

zauważyć, że ryzyko walutowe może być przyczyną zarówno znacznych strat, jak i wielkich zysków, o czym świadczą liczne przypadki w rzeczywistej praktyce gospodarczej. Działania podejmowane w celu zarządzania ryzykiem walutowym pozwalają na zwiększenie bezpieczeństwa finansowego spółki. W artykule przedstawiono system kontroli ryzyka walutowego na przykładzie polskich firm stoczniowych. Jednocześnie dokonano oceny współczesnych rozwiązań stosowanych w przedsiębiorstwach stoczniowych w Polsce wraz z oceną ich efektywności.

Słowa kluczowe: ryzyko walutowe, aktualne trendy w zarządzaniu, przedsiębiorstwa stoczniowe, ryzyko finansowe, zmiana warunków ekonomicznych, zarządzanie ryzykiem.

1. Introduction

Currency risk is considered one of the greatest challenges in financial theory and practice in the 21st century [Bennett 2000]. It is not only a global problem but also an important consideration in the Polish economy which is undergoing intense structural changes. Risk is present in all human endeavours. It is particularly noticeable in business activity. The terms "risk" and "uncertainty" are often considered to have the same meaning, but in fact these are two different notions. Contrary to "risk", "uncertainty" applies to changes or events which due to the limited availability of data may not be evaluated. Still, in specialist financial literature the two terms are often used interchangeably. It is worth noting that, considering its financial aspect, uncertainty of results does not have to be negative. In business activity, the chance for achieving results that are better than expected may be equal to the chance of achieving results that are worse than expected. In dictionaries, the term "risk" is described as: "potential for loss or gain accompanying an activity; a dangerous attempt; daring to take a dangerous step; a dangerous endeavour". The word "risk" comes from the Old Italian word "risicare", meaning "to dare". Thus, the semantics of this word indicate that taking a risk is a choice, not an inevitable destiny. Risk does not necessarily have to refer to something negative e.g. failure to achieve the set goals, results, deviation from expectations or incurring losses [Best 2004]. There are also positive aspects to risk.

Risk is a factor which must be taken into account when conducting any business activity. Any economic decisions should be made in accordance with an economic calculation which should take into consideration opportunity costs and account for the effects of internal and external factors [Miciuła 2015]. Yet despite our best efforts, we are not capable of controlling or exactly predicting the future. Neither economic practitioners nor theorists have the required economic knowledge to do this and they are fully aware of that. Therefore it is essential to know the methods of effective currency risk reduction and develop them continuously. Limitations in understanding and application of even the simplest methods and in the interpretation of study results often prevent the effective management of currency risk. For this reason it is necessary to popularise the various methods of limiting this risk. Improving this knowledge will impact on decision-making as it will allow

for using different methods for predicting economic and financial circumstances and evaluating them correctly. It is also important to constantly develop new instruments and adapt the existing ones to the ever-changing conditions. As a result there exists a drive to develop a universal and effective currency risk management method. Current methods used for mitigating currency risk are based on more or less subjective assumptions. Knowledge, intuition and the experience of an analyst have a major impact on final decisions [Berenstein 1997]. At the same time the success of the entire economic entity depends on selecting the correct currency risk mitigation method. The importance of this issue has been noted by practitioners and as a result companies now create separate departments responsible for controlling all types of financial risk, especially currency risk [Adamska 2004]. Companies also take action to create their own more effective methods to protect themselves against currency risk. The paper presents this process applied in Polish shipbuilding companies.

2. Sources of currency risk in Polish shipbuilding companies

Currency risk is derived from the expected financial flow, which in the case of Polish shipyards involves mostly payments from shipowners (USD, EUR) and expenditure (mostly PLN, USD, EUR).

The main sources of financial flow in shipyards are [Krakowiak et al. 2011]:

1. **Advanced payments from shipowners** (flow time and value depend on concluded contracts). Advanced payments from shipowners (received mostly in USD and EUR) are used to finance the construction of ships or material expenditure. In the former case the USD/PLN exchange rate shall be subject to protection while in the latter case protection shall apply to the EUR/USD and USD/PLN currency rates.

2. **Line of credit expenses** (dates and value of individual tranches in accordance with concluded credit agreements). The Stocznia Szczecińska "Nowa" shipyard uses credit lines in the main contract currency which provides natural protection against currency risk at the time of loan repayment. However, expenditures from the credit line in USD or EUR are made to cover payments in PLN, USD and EUR, so the exchange rates which need protection are USD/PLN and EUR/USD. Every renewal of a credit line (after commissioning a ship and the partial repayment of the loan) is a cause of currency risk and protection against it is required.

3. **Payments of shipowner after ship delivery, following loan repayment** (flow time and value depending on concluded contracts). This value is the difference between the final payment upon ship delivery and the loan repayment amount. The means are usually used to cover current expenditures, therefore it is hard to predict to which currency they will apply. In light of the above and also

due to their rather insignificant values when compared to global financial flow, they are not taken into consideration for the purpose of long-term currency risk protection.

4. **Additional advanced payments of shipowners** (date and value of flow depending on concluded annexes to contracts). Similarly to the final income after the payback of loan, the advanced payments do not have an intended use (type of currency). They also appear irregularly so they are not taken into consideration for the purpose of long term currency risk protection.

Financial flow categories 3 and 4 may be immediately used as supplementary source for settlements of protected transactions for which the settlement date does not coincide with the date of payment from other sources.

"Netting" of currency flows is increasingly popular among Polish shipbuilding companies as a natural form of protection against currency risk. The process works in the following way: payments from contracts in EUR are used to finance EUR expenditures incurred in relation to works on other ships, and the settlements between ships are done in USD and PLN depending on their needs. In this way the EUR/USD currency risk is limited in a natural way.

3. Currency risk mitigation methods used in Polish shipbuilding companies

The simplest and least expensive instruments used in the shipbuilding industry, where contracts have a validity period of several years, are indexation clauses or concluding contracts with foreign partners in the local currency. The use of these methods transfers the risk to the other party. However, the ability to employ such instruments depends on the negotiating position of each of the parties. Polish companies are usually the weaker party, which does not allow them to use the above methods. Additionally, due to strong competition in this market and the development of more advanced financial instruments, these methods are no longer frequently used. Currently, the instruments most commonly used for the mitigation of currency risk by Polish shipbuilding companies are divided into three groups [Krakowiak et al. 2011]:

- forward transactions,
- foreign exchange options,
- option structures.

Forward transactions

This group includes the simplest instruments, i.e. forward transactions. These are contracts regulating the exchange of a specific amount in one currency for a specific amount in another currency at a specified date and time between two parties [Hońdo 2007]. In the case of each contract, the amount of currency to be sold or bought is known before the transaction is concluded.

Foreign exchange options

An option is the right to purchase or sell a specific amount of currency at a specified time and exchange rate. Depending on exercise dates, options are classified as European which are exercised on their maturity date, and American options which may be exercised at any time between their conclusion and the maturity date [Mielus 2002]. In the case of Asian options, the ability to exercise them depends on the average exchange rate in a given period. Options are a form of asymmetrical liability as the buyer may but does not have to exercise their rights. At the same time the buyer is obliged to pay a premium, which reduces the effective exchange rate of this protection method. The premium amount depends on the option parameters but in principle the greater the rights derived from the option, the more expensive it is. If we would like to purchase USD put options with an exchange rate of PLN 4.00 and a maturity period of one week while the present USD/PLN exchange rate is PLN 3.00, such options will be very expensive. However, if we set the options exchange rate at PLN 3.10 the cost will be considerably lower. There are numerous types of foreign exchange options but in recent years, Polish shipbuilding companies have focused mostly on vanilla, barrier and Asian options. Barrier options can be further divided into two types:

- knock-in,
- knock-out.

A knock-in option is activated only when the price of the underlying instrument, i.e. the exchange rate, reaches a barrier value. Options of this type cost less than standard options and at the same time allow for taking a similar position. The profile of knock-out options depends on whether the price of the underlying instrument reaches a specified barrier level. The knock-out option profile is similar to standard options, the only difference being that the holder loses their rights if the price of the underlying instrument reaches a predetermined level. The price of knock-out options is lower than that of standard options as the buyer is at risk of losing their rights.

In the case of Asian options, the payoff depends on the average reference exchange rate for a specified time period. Asian options are used mostly when the market variability is low. Options of this type are used when currency flows occur periodically and their volumes are similar to each other. Asian options are cheaper than standard options due to the reduced variability of the underlying instrument price.

Option structures

The final group consists in option strategies which combine several different options so that a zero-cost product is obtained. Option strategies may include standard and barrier options. Such structures were used for example in the Stocznia Szczecińska "Nowa" S.A. and Grupa Stocznia Gdynia S.A. shipyards:

1. The former uses a combination of standard options creating a collar (risk reversal) which includes put and call options. In this case the put option exercise rate is lower than the call option exchange rate. Depending on risk exposure, one of the options is purchased, while the other is sold. For example, an exporter who wishes to secure themselves against a decreasing exchange rate will purchase put options and sell call options. In this way they know that they will not sell currency at an exchange rate lower than that specified in the put option, i.e. at the lower limit of the collar. If at the maturity date the reference exchange rate is higher than the lower collar limit but not higher than its upper limit, the company will be able to sell currency at the market exchange rate. If the reference exchange rate is higher than the upper limit, i.e. above the exercise rate set for the call option, the company will be obliged to sell currency at this exchange rate. The collar strategy is used in a situation when a company wants to be fully protected and at the same time is expecting a positive change of exchange rate and wants to benefit from it. Unfortunately, in the case of a very large positive change of exchange rate, the company only participates in it partially. Despite this limitation, such a form of risk mitigation is much more flexible than a forward contract.

2. A solution characterised by even greater flexibility, which at the same time provides full protection, is a flexible forward (knock-in forward) comprising a single standard option and one barrier option. If the company is an exporter, it purchases a standard put option with a specified exercise rate, and sells a barrier call option whose exercise rate is identical to the put option exchange rate, with the barrier set considerably higher than this rate. This barrier belongs to the up-and-in type, i.e. the call option is activated when the market exchange rate reaches the barrier exchange rate at least once. In such case, regardless of the reference exchange rate on the exercise date, the company is obliged to sell the currency at the exchange rate of the protecting instrument. If the barrier exchange rate has not been reached, the reference exchange rate on the exercise date is considered the market exchange rate. However, if the reference exchange rate is below the instrument's exchange rate, the company will sell its currency at this exchange rate. This shows that the company is always protected against a decreasing exchange rate, while at the same time it is able to participate in exchange rate increases up to the barrier level. Unfortunately the activation of a barrier obliges the company to sell the currency at the instrument's exchange rate, even if the market exchange rate is much higher. Such strategies are used when a company wants to protect itself against negative changes in exchange rates and at the same time benefit from positive changes. When setting the protection and barrier levels it is important to consider the support and resistance levels for each exchange rate.

Other structures used in the past by the Stocznia Szczecińska "Nowa" and Grupa Stoczni Gdynia S.A. shipyards were the "flexible collar", "FX accumulator" and "fan" (their names vary in different banks). Stocznia Szczecińska uses only zero-cost option structures [Krakowiak et al. 2011]. These structures use identical

put and call option prices, which is possible if different face values, different exercise exchange rates or different maturity dates are used. Stocznia Szczecińska "Nowa" S.A. uses combinations of options with different strike values and face values. The company uses credit lines for derivative transactions, whose time span partially or fully coincides with the period in which the risk is present. The amounts of these credit lines depend on the value of the project that needs financing.

4. Example application of option strategies in managing currency risk

Companies exporting goods or service are in the so-called long currency position, which means their receivables in foreign currencies are higher than their liabilities. In this situation there is a risk that the exchange rate will strengthen (appreciation) and as a result the company will incur a loss because of those changes. As a protection against this it is possible to use currency options. The development of such instruments resulted in the creation of numerous solutions based on their combinations and adaptations. Currency options are used to reduce exposure to risk of losses and at the same time possibly provide additional income if exchange rates shift favourably. Currently the largest portfolios of currency options are available in the following Polish banks:

- BRE Bank,
- Citibank Handlowy,
- Societe Generale,
- Bank BPH – however this bank does not have exotic options in its portfolio.

These banks also provide various option strategies. In other banks which are not listed above it is only possible to take a long position or there are no services related to options. As stated earlier, in order to create advanced strategies limiting premiums or reducing them completely, it is required to hold a short and long position at the same time. Although hedging with options is not 100% secure, it is more effective than using other methods [Gryglik 2001]. It is possible to construct various strategies or select parameters so that protection does not cost anything or its cost is limited. It is possible to use activation and extinguishing barriers in instruments, which then become known as exotic instruments.

In general, all strategies are divided into two types:

- 1) speculation on or protection against a specific change of the exchange rate (increase or decrease) in the future – exchange rate is therefore the subject of trade,
- 2) speculation on or protection against a specified scope of exchange rate changes – volatility is the subject of trade.

Standard currency options form the basis for various combinations which may be used to limit the exporters' risk (the risk of an increasing exchange rate). They are as follows:

- taking a long position in a classic put option,
- taking a short position in a standard call option,
- taking a short position in a call option and introducing an upper activation barrier,
- taking a long position in a put option and introducing an upper or lower extinguishing barrier,
- classic zero-cost collar involving selling call options and buying put options simultaneously,
- asymmetric zero-cost collar involving selling call options and buying put options with different face values simultaneously,
- barrier zero-cost collar involving selling call options and buying put option with an extinguishing barrier,
- asymmetrical barrier zero-cost collar involving selling call options and buying put options with an extinguishing barrier at various face values.

4.1. Taking a long position in a put option

The difference between selling currency at a specific forward exchange rate and an option is that an option grants the right to exercise it but does not result in such an obligation. Therefore, if the market situation requires refraining from exercising an option, the buyer only loses the premium amount. On the maturity date the following scenarios are available:

- the market exchange rate is higher or equal to the exercise price – the buyer does not exercise their rights, because they are able to sell their currency at an identical or better exchange rate;
- the market exchange rate is lower or equal to the exercise price – the holder exercises their rights and is able to sell currency at an exchange rate that is more favourable than the current market exchange rate.

In exchange for their right to exercise the option at a given time, the buyer pays a premium. The value of the premium depends on:

- amount of underlying instrument for which the contract is concluded (directly proportional),
- option exercise price for put option – the greater the price, the more expensive the option and in the case of the call option, the greater the price, the lower the premium,
- expected change in the exchange rate of currency to which the contract applies – the greater the change, the greater the premium,
- current exchange rate – the greater the difference between the current exchange rate and the exercise price, the lower the premium,
- period for which the contract is concluded – the longer the period (greater time span), the higher the premium,

- base currency interest rate – inversely proportional relation,
- counter currency interest rate – directly proportional relation,
- difference between interest rates of the two currencies – swap points are either added to or subtracted from the spot rate,
- interest rates which affect the option price through current values calculated using the current pricing model, thus affecting the present premium value.

Table 1. Premiums when purchasing a classic put option for the EUR/PLN exchange rate at transaction value of EUR 100,000

| Month | Exercise price | Premium (points) | Premium (PLN) |
|----------------|----------------|------------------|---------------|
| June 2018 | 4.35 | 840 | 8400 |
| June 2018 | 4.30 | 610 | 6100 |
| September 2018 | 4.38 | 1200 | 12000 |
| September 2018 | 4.34 | 1045 | 10450 |

Source: own elaboration.

When buying an option with a maturity date of 30 June and an exercise exchange rate of 4.30, the company will pay a premium of 610 points, which equals PLN 6100 at the transaction value of EUR 100,000. In the case of an identical option with the same maturity date but with the exercise price of 4.35, the company will pay a premium of 840 points, amounting to PLN 8400. This demonstrates how the exercise price affects the premium paid for purchasing options. The greater the exercise price, the higher the premium that must be paid.

4.2. Taking a short position in a standard call option

A call option gives its holder the right to purchase an underlying instrument at a specified price and a specified time. Therefore, by taking a short position, the company has an obligation to sell its currency at a specified time at the exercise price. This means the bank has the right to buy the currency. On the maturity date, the following scenarios are available:

- the market exchange rate is higher than the exercise price – the company is obliged to sell its currency at the exercise price,
- the market exchange rate is lower or equal to the exercise price – the option is not exercised because the bank can buy currency at the market exchange rate.

In this case, in exchange for taking the risk that the market exchange rate will exceed the exercise price, the company receives a premium.

In exchange for an obligation to sell currency at the end of June, at an exchange rate of 4.35, the company will receive a premium of 730 points, which equals PLN 7300 in the case of a transaction amounting to EUR 100,000. Taking a short position in a call option does not protect against PLN appreciation but allows for

Table 2. Premium on selling EUR/PLN call options at transaction value of EUR 100,000

| Month | Exercise price | Premium (points) | Premium (PLN) |
|----------------|----------------|------------------|---------------|
| June 2018 | 4.40 | 515 | 5150 |
| June 2018 | 4.35 | 730 | 7300 |
| September 2018 | 4.47 | 745 | 7450 |
| September 2018 | 4.50 | 645 | 6450 |

Source: own elaboration.

selling currency at a better exchange rate owing to the premium received from the bank for selling the options. As demonstrated by the examples above, buying standard options can be costly. Thus, if an exporter expects that the PLN exchange rate will improve, a forward transaction is a better solution as it does not generate any additional costs. If on the other hand, it is difficult to foresee the future PLN exchange rate, it is possible to use the put option with an additional barrier. This allows for reducing the premium by a set amount, depending on the established barrier.

4.3. Barrier options

Barrier options can be divided into [Hamrol, Ślęzak 2004]:

- barrier "out" options – extinguished when the price of an underlying instrument reaches a set barrier level,
- barrier "in" options – activated when the price of an underlying instrument reaches a set barrier level.

"In" options are also known as instruments with an activation barrier, while "out" options are known as instruments with an extinguishing barrier. Setting an upper activation limit means that reaching a set exchange rate is required in order for the option to be exercised. Using this strategy, an exporter is exposed to lower risk than in the case of using standard call options.

An option with an extinguishing barrier requires setting a certain exchange rate, at which the option ceases to exist. This exchange rate may be lower or higher than the option's exercise price. From an exporter's point of view it would be preferable to create an upper extinguishing barrier, i.e. one above the exercise exchange rate. This stems from the fact that if PLN depreciates, it does not make sense to use a put option as protection, because at higher EUR/PLN exchange rates the company will be able to conclude a more favourable transaction. In such case the loss of protection provided by a put option will not be an issue. In this situation it will not be beneficial to set the extinguishing barrier below the exercise price of the option contract, because if the spot EUR/PLN exchange rate increases, the deactivation barrier may be reached and the option will cease to exist. As a result the exporter loses protection.

Table 3. Premiums when purchasing a put option with an upper extinguishing barrier for the EUR/PLN exchange rate at transaction value of EUR 100,000

| Month | Exercise price | Extinguishing barrier | Premium (points) | Premium (PLN) |
|----------------|----------------|-----------------------|------------------|---------------|
| June 2018 | 4.35 | 4.47 | 750 | 7500 |
| June 2018 | 4.30 | 4.42 | 470 | 4700 |
| September 2018 | 4.38 | 4.50 | 985 | 9850 |
| September 2018 | 4.34 | 4.47 | 775 | 7750 |

Source: own elaboration.

Analysis of the above data shows that premiums for barrier options are always lower than in the case of standard instruments, which allows for reducing protection costs. For example, when comparing a put option with an exercise price of 4.38 with an option with a barrier at 4.50, the premium decreased from 1200 to 985 points (by 215 points), which at the transaction value provided in the example amounts to a difference of PLN 2150. However, it must be noted that if the spot exchange rate reaches the barrier level, the company will no longer be protected and must create a new strategy or incur a loss. It is also possible to create an upper and lower extinguishing barrier simultaneously, which will further reduce the cost of using options as protection. This strategy is only viable for a horizontal trend in the currency market during the option's life span.

4.4. Zero-cost collar

A zero-cost collar comprises a long position in a put option with a low exercise price and a short position in a call option with a high exercise price. This instrument, also known as short-range forward, guarantees that at the maturity date of both options the underlying asset may be sold at a price between the lower and higher exercise price, specified when buying and selling the options respectively. The idea behind this strategy is that the premium received by the company for selling the call option is equal to the premium paid for the put option.

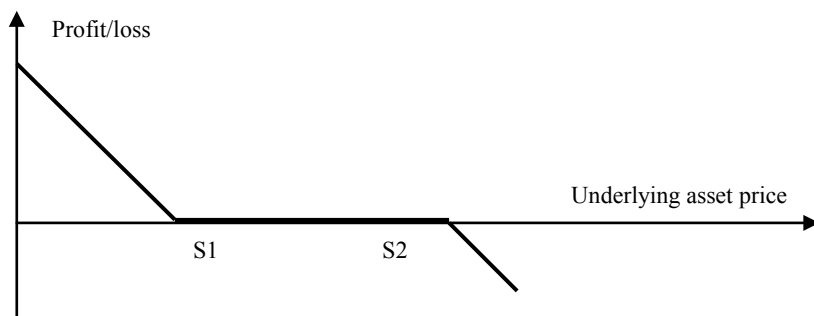


Fig. 1. Payoff in zero-cost collar

Source: [Chrzan 2007].

where: S1 – put option exercise price, S2 – call option exercise price.

Apart from a classic zero-cost collar, there are other, modified versions of this strategy:

- asymmetric zero-cost collar – in this case the values of both options are different. This allows for increasing the amount sold of the call option in relation to the put instrument, which better protects the sale of foreign currency by the company. In practice, most often a collar with a ratio of 1–1.5 between the sold and bought options is used;
- barrier zero-cost collar – involving selling call options and buying put option with an upper extinguishing barrier. Similarly to an asymmetrical zero-cost collar, the exercise prices of both options should be selected so that the total cost of the strategy is zero;
- asymmetrical barrier collar – involving selling call options and buying put options with an extinguishing barrier. Options used in this strategy have different values.

Using the three basic derivatives: forward contracts, put options and call options, it is possible to build option strategies with the required risk profile. The presented linear programming model aids in deciding which option strategy to use when protecting a given exchange rate.

The model uses four option strategies:

- long call – long position in call options,
- long put – long position in put options,
- short call – short position in call options,
- short put – short position in put options.

Table 4. Types of strategies and their symbols used in modelling

| Strategy type | Option price | Participation in portfolio | Exercise price | Delta coefficient | Gamma coefficient |
|---------------|--------------|----------------------------|----------------|-------------------|-------------------|
| Long call | CL call | UL call | XL call | Δ L call | Γ L call |
| Long put | CL put | UL put | XL put | Δ L put | Γ L put |
| Short call | CS call | US call | XS call | Δ S call | Γ S call |
| Short put | CS put | US put | XS put | Δ S put | Γ S put |

Source: own elaboration based on [Dziawgo 2003].

The pay off function of all option strategies may be represented as follows:

- long call = WL call = $\max \{-CL \text{ call}, -CL \text{ call} + (St - XL \text{ call})\}$,
- long put = WL put = $\max \{-CL \text{ put}, -CL \text{ put} + (-St - XL \text{ put})\}$,
- short call = WS call = $\max \{CS \text{ call}, CS \text{ call} - (St - XS \text{ call})\}$,
- short put = WS put = $\max \{CS \text{ put}, CS \text{ put} - (-St + XS \text{ put})\}$,

where St is the USD/PLN exchange rate at option exercise date.

The Garman-Kohlhagen model was used for option valuation. This is a variation of the Black-Scholes model, adapted for use in currency option valuation.

$$\begin{aligned}
 c &= S * e^{-R_f * T} * N(d_1) - X * e^{-R_d * T} * N(d_2); \\
 p &= X * e^{-R_d * T} * N(-d_2) - S * e^{-R_f * T} * N(-d_1); \\
 d_1 &= (\ln(S/X) + (R_d - R_f + zk^2/2) * T) / Zk * \sqrt{T}; \\
 d_2 &= (\ln(S/X) + (R_d - R_f - zk^2/2) * T) / Zk * \sqrt{T};
 \end{aligned}$$

where: c – call option price, p – option sale price, S – spot exchange rate, X – exercise exchange rate, R_f – risk-free rate in the foreign currency country, R_d – risk-free rate in Poland, Zk – exchange rate variability, T – option expiry time, in years, N – normal distribution function.

This model allows for creating an option portfolio, similar to a stock portfolio in the stock market. As a result the objective function will be as follows:

$$\begin{aligned}
 Z = & \text{UL call} * \text{WL call} + \text{UL put} * \text{WL put} + \text{US call} * \text{WS call} + \\
 & \text{US put} * \text{WS put} = \max.
 \end{aligned}$$

One of the primary parameters is the delta coefficient, which informs how the option price will change when the price of an underlying instrument changes by one unit. Therefore it is a derivative of the option price (as is the underlying instrument price). Restrictive conditions:

$$\begin{aligned}
 \Delta \min. \leq & \text{ULcall} * \Delta \text{Lcall} + \text{ULput} * \Delta \text{Lput} + \text{UScall} * (-\Delta \text{Scall}) + \\
 & \text{USput} * (-\Delta \text{Sput}) \leq \Delta \max.
 \end{aligned}$$

In the case of options issued by the company, the delta coefficient has an inverse symbol. The option payoff level is limited to an interval set by the user:

$$X \min. \leq \text{XL call} \leq X \max.$$

$$X \min. \leq \text{XL put} \leq X \max.$$

$$X \min. \leq \text{XS call} \leq X \max.$$

$$X \min. \leq \text{XS put} \leq X \max.$$

Participation of option types in the entire strategy:

$$\text{UL call} + \text{UL put} + \text{US call} + \text{US put} = 1,$$

$$\text{UL call} \geq 0,$$

$$\text{UL put} \geq 0,$$

$$\text{US call} \geq 0,$$

$$\text{US put} \geq 0.$$

Economic growth accompanied by increased competition exposes companies to ever greater risk. Managing this risk is a complex process, however when companies apply mitigation methods and techniques the risk may be reduced considerably [Miciuła 2015]. The effectiveness of risk management is evaluated based on its results. The following factors are assumed to have an influence on the success of risk management:

- results of not avoiding and preventing risk,
- incurred costs related to limiting probable negative events,

- risk management costs incurred by the company,
- balance of results of occurring events (both negative and positive).

If following an analysis of all the factors related to risk management the balance of results is positive, it can be said that risk management is effective. For this reason, developing risk management methods in companies is economically viable.

The theory of finance does not provide a single universal strategy allowing for selecting an optimum method to protect against currency risk in various conditions. Such a single solution does not exist. On the contrary, risk mitigation is a very complex problem and the decision about selecting the appropriate solution depends on a multitude of factors which undergo continuous change following the ever-changing economic situation.

5. Solutions used in shipbuilding enterprises and an evaluation of their effectiveness

The management board of Stocznia Szczecińska "Nowa" S.A. concluded a contract with a bank involving creating an option strategy called "put spread versus call". The contract amount and protection levels are a commercial secret. This strategy is based on the following assumptions [Krakowiak et al. 2011]:

- protection against PLN appreciation,
- reduced initial cost – low option premium or no premium,
- possibility to use a good USD/PLN market exchange rate for selling USD – such a transaction is not obligatory but rather it is permitted to conclude such a transaction (in contrast to forward contracts, where this is an obligation of the seller),
- possibility to sell the strategy with profit before its maturity date in case of PLN appreciation in relation to USD i.e. earlier profit capitalisation.

The "put spread versus call" strategy involves:

- setting L1, L2, L3 protection levels so that $L1 < L2 < L3$,
- issuing a put option with L1 exercise price (short put),
- buying a put option with L2 exercise price (long put),
- issuing a call option with L3 exercise price (short call).

The primary condition is that all options have the same maturity date and the same face value:

- PL1 – put option premium (for options issued by the shipbuilding company),
- PL2 – put option premium (for options bought by the shipbuilding company),
- PL3 – call option premium (for options issued by the shipbuilding company).

If $PL1 - PL2 + PL3 \approx 0$, it is guaranteed that the initial cost incurred by the company will be low or equal to zero. L1 (limit 1) is established based on the current spot exchange rate. L2 is equal to futures price, which depends on the maturity date of the whole strategy. L3 denotes a large depreciation of PLN of about 10%.

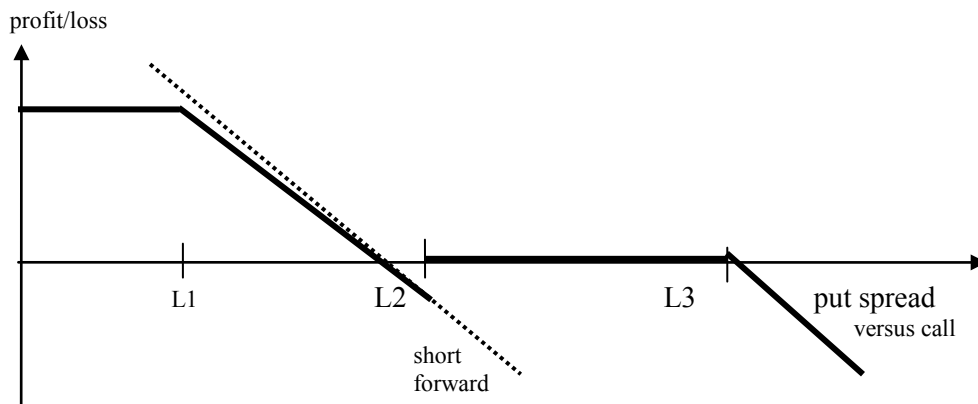


Fig. 2. Risk profile for "put spread versus call" strategy as compared to a forward transaction.

Source: own elaboration, based on [Krakowiak et al. 2011].

The spot exchange rate at the contract conclusion date was 3.73 and the futures price was 3.8610. Let us assume that the protected amount was USD 100,000,000.

Below is a comparison of the results of applying the "put spread versus call" strategy and a standard six-month USD forward contract to the same amount.

Table 5. Comparison of forward strategy and "put spread versus call" strategy

| USD/PLN exchange rate at the date of security maturity | USD forward sales contract PLN profit/loss | Options strategy "put spread versus call" PLN profit/loss |
|--|--|---|
| 3.74 | +12,000,000 $= (3.8610 - 3.7400) * 100,000,000$ | +12,000,000 |
| 3.84 | +2,100,000 | +2,000,000 |
| 3.98 | - 11,900,000 | 0 |
| 4.1 | - 23,900,000 | 0 |
| 4.18 | - 31,900,000 | - 6,000,000 |

Source: own elaboration, based on [Krakowiak et al. 2011].

As shown above, depreciation of PLN above the L2 level but below the L3 level allows the shipbuilding company to sell USD on the market and benefit as an exporter from the depreciation of PLN in relation to USD. Note that in the case of a forward contract the company will incur considerable losses in such a situation. However, a forward contract provides greater profit if the exchange rate drops below the L1 level. Should the National Bank of Poland implement a crawling peg policy for the Polish zloty, the USD exchange rate would increase. This means it would be highly unlikely for the exchange rate to drop below the spot exchange rate over a one-year period. Selling USD at market price will produce a profit if PLN depreciates above L2 i.e. 3.8610 USD/PLN. This is possible until reaching L3

i.e. 4.12. At the same time, a forward contract sets the sales exchange rate at 3.8610 USD/PLN regardless of the market exchange rate at the exercise date.

The effective exchange rate is the exchange rate resulting from the "put spread versus call" option strategy (or the forward contract exchange rate), or the market exchange rate applicable when the option is not used.

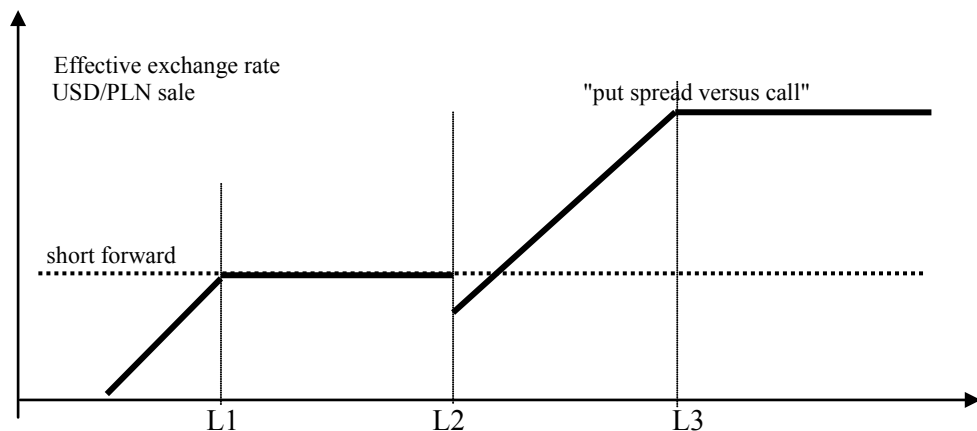


Fig. 3. Effective USD selling exchange rate resulting from the "put spread versus call" strategy and forward contract

Source: own elaboration, based on [Krakowiak et al. 2011].

The suggested option strategy is quite flexible, as levels L1, L2 and L3 are subject to negotiations with the bank. It may be considered that the maturity date risk profile becomes more favourable the more expensive the strategy. A reduction of initial cost may result in incurring considerable cost in the future. The "put spread versus call" option strategy may be modified over time. For example in case of a strong shift of USD exchange rate, some part of the strategy may be sold. If the exchange rate of USD increases considerably (above the L3 level) and the trend indicates that the depreciation of PLN will continue, the short-call strategy may be bought back from the bank to prevent further loss. Similarly, in the case of PLN strengthening (above the L1 level) when this trend is predicted to continue over time, the short-put strategy may be extinguished so as not to block any further increases. The presented methods for protecting against currency risk in shipbuilding companies in Poland are examples of correct, economically viable methods for organising a currency risk management system.

6. Conclusion

Currency risk is an inherent part of commercial exchange with countries using other currencies. The proper organisation of currency risk management methods increases the financial security of a company. Due to their high effectiveness, such

methods are commonly used by numerous companies. In the last few years as new developments in the field have been made, the scope of the services used for this purpose was broadened and the classical methods of protection against currency risk were developed further. Separate organisational units responsible for managing financial risk at companies are an excellent source of information, allowing for describing the economic situation and warn against negative changes. This provides the basis for developing and improving strategies of currency risk prevention and allows for adapting investment project conditions to the existing economic situation, which increases the chances of their success. This article presents the available strategies and methods used for currency risk protection. It also shows the protection methods used by the Stocznia Szczecińska "Nowa" S.A. shipbuilding company in its current projects. Furthermore, it describes the latest solutions in the field of protection against currency risk and elements of financial situation evaluation methodologies which allow for increasing the financial security and effectiveness of investment projects. Based on the solutions presented herein, the following conclusions may be drawn:

1. A condition required for the safe development of a company in the conditions of currency exchange is a system to control and manage currency risk.

2. A company should have at its disposal the appropriate types (methods) of protection as described in section two of this paper.

3. In order to increase the economic benefit and improve the competitiveness of the company, it is required to introduce highly efficient modern strategies and the currency risk management methods related to them, which allow for limiting costs while at the same time providing a higher security level.

4. In order to benefit from exchange rate changes, it is possible to use prediction methods. However, this is somewhat similar to speculation and is not advisable for a production company, even if it has a team of employees responsible for managing financial risk.

5. The Stocznia Szczecińska "Nowa" S.A. shipbuilding company is well protected against currency risk owing to the good organisation of the team responsible for managing currency risk, the employment of modern protective methods and the adaptation of these methods (e.g. option contracts) to its own needs and to the specific character of the company's operations. It is clear that the company has drawn conclusions from the financial difficulties of the past which led to its bankruptcy caused, among other things, by a negative continuous shift in exchange rates. Currency risk is not the reason for the ongoing liquidation of the Szczecin-based company.

6. The methods used for currency risk management allow for planning and controlling the risk by making the best use of the available information.

Undoubtedly, the issue of currency risk protection, similarly to the problem of selecting the best type of securities, will be a subject of further discussion as there is a constant need for developing new solutions in this field.

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