VILNIUS TECH
Vilnius Gediminas Technical University

12th International Scientific Conference

BUSINESS AND MANAGEMENT 2022

May 12–13, 2022, Vilnius, Lithuania

ISSN 2029-4441 / eISSN 2029-929X
ISBN 978-609-476-288-8 / eISBN 978-609-476-289-5
Article Number: bm.2022.793
https://doi.org/10.3846/bm.2022.793

FINANCE AND INVESTMENT: NEW CHALLENGES AND OPPORTUNITIES *http://vilniustech.lt/bm*

USE OF DERIVATIVE FINANCIAL INSTRUMENTS FOR RISK MANAGEMENT

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Received 1 March 2022; accepted 7 April 2022

Abstract. The dynamic nature of international financial markets has contributed to a broader use of various financial instruments, ranging from the simplest traditional instruments, such as bonds, to various forms of derivatives. A number of economists argue that derivatives were one of the causes of the global financial crisis, due to speculative behaviour, however others believe that these instruments actually improve the functioning of the market and may reduce risk. Derivative financial instruments are transactions that help bankers, investors, and borrowers to protect themselves against certain financial risks. This paper addresses the issue of how to hedge risks by using derivatives in a correct and appropriate way. Since almost all companies and investors who operate in local or global markets are exposed to some risk, it is important to identify the potential uses of derivatives for risk management.

Keywords: commodity trading, currency exchange rates, derivative financial instruments (derivatives), financial crisis, financial risk, hedging possibilities, interest rates, its causes and consequences.

JEL Classification: G01, G10, G24, G32, M21.

Introduction

As economic conditions improve, the financial market is becoming more diversified and attracting even more investors. While financial markets have experienced severe downturns until recently, investors are increasingly expressing their willingness to invest. The dynamic nature of international financial markets has contributed to a wider use of a broad range of financial instruments, from the simplest traditional financial instruments to various forms of derivatives.

A number of authors have analysed the players and products involved in derivatives trading (Chiu, 2012; Morgan, 2013; Marroni & Perdomo, 2014; United Nations Secretariat, 2019; Chandra, 2020). They have found that derivatives have emerged as a consequence of the changing international financial system. They believe that the use of financial derivatives improves the financial system and encourages users to operate efficiently, provided that risks are managed correctly.

According to the Bank for International Settlements, the global turnover of OTC derivatives amounted to more than USD 640 trillion in 2019 (Bank of International Settlements, 2019). Derivatives have been in the financial market for more than 50 years; however, some financial market participants are wary of these instruments. A number of economists (Lewitt, 2018; Sahoo, 2020) argue that derivatives were one of the causes of the global financial crisis due to speculative behaviour (Poitras, 2002). However, others believe (Culp, 2004; Morgan, 2013; Mishkin, 2015) that, on the contrary, these instruments improve market functioning and can reduce risk.

The paper attempts to address the following issue. It should be noted that almost all companies, as well as investors who operate in a local or global market, are exposed to some risk (Fabozzi & Peterson, 2003; Ramzan, 2018). So what are the opportunities for using derivatives for risk management?

The aim of this paper is to analyse and apply derivatives as methods for risk management.

Main objectives of the paper: to analyse the use of derivatives for risk management; to assess the results and peculiarities of the use of derivatives.

Methods used in the paper: collection, processing, and analysis of statistical data; comparative analysis, variance/covariance method.

Main expected outcome of the paper: analysis of risk and derivatives statistics and, most importantly, clarification of how derivatives can be used for the purposes of risk management.

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1. Methodology for the use of derivatives for risk management

Derivative financial instruments are an effective risk management tool. Investors can choose an instrument that helps them to protect themselves against risk. Derivatives are very helpful in commodity market risk management because they shift risk to reverse market conditions. Moreover, the properties of these instruments improve market efficiency (Bajracharya, 2009; Morgan, 2013; Beckley, 2017). Thus, this section will present a methodology that will focus on the analysis of derivatives and study of their application in order to manage certain risks.

Financial instruments such as forwards, futures, options, and swaps are highlighted as the most important derivatives used by managers of financial institutions to mitigate risks (Culp, 2004; Mishkin, 2015; Chapelle, 2019; Eurostat, 2020). Forwards are more commonly used in currency and tangible asset transactions, as they are non-standardised. Meanwhile, futures can also be used quite often in equity markets, but again this is not the most efficient way to hedge, unless one wants to accurately forecast future cash flows (ECB Europa, 2014). Each individual derivative instrument protects against or mitigates a particular risk.

1.1. Methodology for the adaptation of derivatives for risk management

Risk management of derivatives will be governed by a risk management model, which consists of risk identification, risk measurement, hedging selection and determination of the effectiveness of hedging instruments for risk management (Fantini, 2014; Deloitte, 2018). The same management model will be used to manage each risk.

The first stage of risk management is risk identification. In the course of the risk identification process, a market participant assesses which risks are likely to affect the achievement of its objectives. Some of the main approaches to risk identification are information gathering, document review and charting (Dinu, 2012; Gemzik-Salwach & Perz, 2013; Lewitt, 2018; Martinkutė-Kaulienė & Stasytytė, 2018).

Once potential risks have been identified, it is important to measure them. The value at risk is defined as the maximum loss in market value that a given institution is exposed to over time and with defined confidence (Morgan, 2013; Biais et al., 2016).

The variance/covariance method is commonly used to measure risk (Dinu, 2012; Deloitte, 2018). It is based on two main assumptions: it is assumed that the appreciation of all risk factors in a bank's portfolio is normally distributed and that changes in the value of the portfolio, with the exception of option instruments, are directly related to changes in these risk factors. The combination of these two assumptions leads to the limit theorem of this approach, which states that the distribution of variation in a diversified bank portfolio is Gaussian distribution (Palve, 2016). Given the common assumption of a financial time series distribution, this is not always confirmed in practice, yet this approach is widely used and even recommended to banks by their supervisory institutions (Rao, 2012; Gemzik-Salwach & Perz, 2013; Sahoo, 2020).

The variance-covariance method is a parametric approach that calculates the value-at-risk of financial instruments by assuming that the market risk factors of these financial instruments and the return (loss) on a portfolio of these instruments are distributed according to a normal distribution (Kornél, 2014). The variance/covariance method requires historical data for calculations (Board of the Bank of Lithuania, 2002; Deloitte, 2018; Bank of Lithuania, 2019, 2020).

The variance-covariance method would first require the calculation of the arithmetic mean. The formula for the arithmetic mean is expressed as the sum of the values of all quantitative variables divided by the number of values (Varmuza & Filzmoser, 2016; Bian, n.d):

$$X = \frac{\left(x1 + x2 + ... + xn\right)}{n}, \quad (1)$$

where: X – the mathematical mean; x – the value of the quantitative variables; n – the number of values.

Variance is a statistical property of a sample that reflects the most likely deviation of an ordinal measurement value from the arithmetic mean (Varmuza & Filzmoser, 2016; Bian, n.d.). The variance and standard deviation indicate the degree of dispersion of the possible values of a random variable around its mean. The variance is used to calculate the quality and reliability of measurement results, but it also reflects the properties of the object or phenomenon under study and (just like the mean) can be considered as a result of the research. Variance is calculated according to the formula (Varmuza & Filzmoser, 2016; Bian, n.d.):

$$\sigma^2 = \frac{1}{n}\sum_{i=1}^{n}(x_i - X)^2. \quad (2)$$

Standard deviation – usually denoted *s* or *SD*. It is a description of the dispersion of values of the property under study, defined as the average of the sum of the squares of differences between the values of the property and the mean. Statistical deviation indicates how far values deviate from the mean on average (Varmuza & Filzmoser, 2016; Bian, n.d.):

$$SD = \sqrt{\sigma^2}. \quad (3)$$

The larger the standard deviation, the wider the range of expected results. A standard deviation equal to zero indicates the absence of risk (Varmuza & Filzmoser, 2016).

The next step is the selection of hedging instruments (Venables, 2014; Vuillemey, 2014). The choice of a hedging instrument depends not only on the type or magnitude of the risk itself, but also on the objectives

and outcomes set by a market participant. The derivatives under consideration help to protect against risks. The choice of the most appropriate derivative financial instrument should take into account the investor's objective, whether it is only to hedge potential risks or also to benefit from a potential favourable market situation. Once the choice of instruments protecting against risk has been made, it is important to determine the cost of the instrument and to make a decision on its adoption and application. At this stage, the cost of the selected transactions is determined and a decision is made as to which instrument is the most appropriate for hedging risks (Varmuza & Filzmoser, 2016; Bian, n.d.).

1.1.1. Interest rate-related risk management methods

Companies with different ratings can borrow funds at different fixed and floating interest rates (Valakevičius, 2019).

Forward and futures hedging

A forward is defined as a means of hedging interest rate risk (Mishkin, 2015; Valakevičius, 2019). It is a contract based on an agreement between two parties to exchange interest at a specified date in the future, based on the difference between two defined interest rate thresholds, namely, the FRA contract rate and the market rate.

The interest rate set by a forward is calculated according to the following formula (Chandra, 2020):

$$FR = \frac{(1+r_a)^{t_a}}{(1+r_b)^{t_b}} - 1, \quad (4)$$

where: r_a – the interest rate with long-term maturity t_a; r_b – the interest rate with short-term maturity t_b.

The amount of the interest rate forward contract payment is calculated according to the following formula (Chandra, 2020):

$$FRAP = \left(\frac{(R - FRA) \times NP \times P}{Y} \right) \times \left(\frac{1}{1 + R \times \left(\frac{P}{Y} \right)} \right), \quad (5)$$

where: *FRAP* – the interest rate forward contract payment; *FRA* – the fixed forward interest rate; *R* – the floating interest rate; *NP* – the amount of the loan; *P* –loan duration in days; *Y* – number of days per year (e.g. 360 days).

Option hedging

Options can be used to hedge interest rate risk (SEB, 2019):

$$Vopt. = NP \times (P - R) \times t / 360, \quad (6)$$

where: *Vopt* – interest rate option offset; *R* – the forward interest rate set by the option; *P* – the floating interest rate; *NP* – the amount of the loan; *t* – loan duration in days.

Swap hedging

A bank can hedge its risk through the use of interest rate swaps. It signs an agreement to maintain a fixed interest rate for a certain period in exchange for volatile interest income. Interest rate swaps, by exchanging floating-interest payments for fixed-interest payments, help to match the duration of the investor's assets and liabilities and enable the mitigation of interest rate risk (Varmuza & Filzmoser, 2016; Bian, n.d.). The investor hedges against the risk of interest rate volatility by paying interest at a fixed rate based on liabilities and receives variable interest cash flows on assets. This is the most popular interest rate swap, a "plain vanilla".

The value of a swap can be expressed using the following formula (Beckley, 2017):

$$V = B_1 - B_2, \quad (7)$$

where: *V* – the value of the swap; B_1 – the value of a fixed-rate asset; B_2 – the value of a floating-rate asset.

The value of a swap is zero at inception and expiry and can take on a positive or negative value while the swap is in effect.

The interest rate of a swap is calculated according to the following formula (Beckley, 2017):

$$Vswap = (NP \times P \times t/360) - (NP \times R \times t / 360), \quad (8)$$

where: *Vswap* – interest rate swap payment; *R* – the interest rate set by the swap; *P* – the floating interest rate; *NP* – the amount of the loan; *t* – loan duration in days.

1.1.2. Price volatility risk management methods

Market price volatility risk arises from developments in respect of market variables such as interest rates, exchange rates, and commodity prices, which create a risk of loss.

Futures hedging

The price of a commodity in a futures contract can be found using the following formula (Beckley, 2017):

$$F = Se^{((r + s - c) \times t)}, \quad (9)$$

where: *F* – the price of the futures commodity; *S* – the spot price; *e* – a constant of approximately 2.718; *r* – the risk-free interest rate; *s* – the cost of storage (if agreed); *c* – the differential between interbank rates; *t* – the number of days in a year.

The risk-free rate is usually measured by the yield on a government bond (ECB Europa, 2014).

Forward hedging

An investor can use forwards to hedge against the risk of price volatility and thus protect itself against potential risks (Marroni & Perdomo, 2014). The following formula is used to calculate the forward price (Citibank, n.d.):

$$F = S(1 + RT), \quad (10)$$

where: *F* – the forward price; *S* – the spot exchange price; *R* – the interest rate; *T* – time period.

Option hedging

Options are used for arbitrage or speculative profit and hedging purposes (Summers, 2010; Ramzan, 2018).

Swap hedging

(Citibank, n.d.): Commodity price swap points are calculated in the same way as currency swap points, except that the price of the commodity is used instead of the exchange rate (Citibank, n.d.):

$$SR = (S \times (N - P) \times t / 360) \div (1 + (P \times t / 360)), \quad (11)$$

where: S – the spot exchange price; A – the swap price expressed in points; P – the interest rate of the base currency; N – the interest rate of the second currency; T – the time period from the trade date to the settlement date expressed in years.

The other terms of the transaction are the same as those of a currency swap, except that the transaction is linked to a specific commodity.

The final stage of risk management is determination of the effectiveness of the chosen hedging instruments, that is, whether the chosen instrument has adequately managed the risk and mitigated potential adverse effects.

2. Use of research methods in relation to derivatives for risk management

2.1. Use of the interest rate-related risk management method

Interest rates are set by banks depending on the prevailing market situation. When taking out a loan, it is important to decide whether to opt for fixed or variable interest rates. This will determine the interest paid on the loan. When taking out a home loan, EURIBOR variable rates are the most common. This indicator shows how the amount of interest will develop. If the EURIBOR rate increases, the amount of interest on the loan will also increase, and if the EURIBOR value is negative, it will be considered to be equal to zero.

Using IBORate's historical interbank interest rate data and plotting it on a graph (Figure 1), it is possible to analyse how the EURIBOR rate has developed.

We can see that the EURIBOR rate has fluctuated significantly over the ten-year period and even turned negative in 2015, with a further downward trend. This development in the EURIBOR rate is attractive for loan holders, as they will pay less to a bank. However, we can see that EURIBOR rates rose in 2010 and 2011, so this development was not favourable for borrowers who had opted for a loan with variable interest rates. However, derivatives can also be used to hedge against the volatility of these interest rates.

The situation chosen for the study on interest rate risk management was that of a market participant who, in order to buy a dwelling, i.e. real estate, and lacking equity, decided to take out a loan in the amount of EUR 50 000 from a bank. The loan was concluded for a period of ten years, i.e. 2009–2019. After signing the loan agreement with the bank, the debtor is obliged to pay the amount of the interest to the bank on a monthly basis within a fixed period. Banks offer a choice of three-, six- and twelve-month variable interest rates. In the case under the analysis, the borrower undertakes to pay interest at a rate that will be reset every six months.

Before entering into a loan agreement, a client may wish to study the volatility of the EURIBOR rate and the possible risks associated with possible fluctuations. To measure the interest rate risk, a half-yearly standard deviation measure has been calculated. The results can be seen in Table 1.

Table 1. Interest rate risk (source: developed by the author)

Period	Variance	Standard deviation	Period	Variance	Standard deviation
H1 2009	0.00312	0.559%	H2 2014	0.00004	0.061%
H2 2009	0.00014	0.118%	H1 2015	0.00002	0.045%
H1 2010	0.00000	0.019%	H2 2015	0.00001	0.036%
H2 2010	0.00007	0.081%	H1 2016	0.00002	0.042%
H1 2011	0.00040	0.199%	H2 2016	0.00000	0.015%
H2 2011	0.00002	0.043%	H1 2017	0.00000	0.012%
H1 2012	0.00067	0.259%	H2 2017	0.00000	0.002%
H2 2012	0.00048	0.218%	H1 2018	0.00000	0.003%
H1 2013	0.00001	0.028%	H2 2018	0.00000	0.009%
H2 2013	0.00000	0.004%	H1 2019	0.00000	0.009%
H1 2014	0.00000	0.021%	H2 2019	0.00002	0.043%

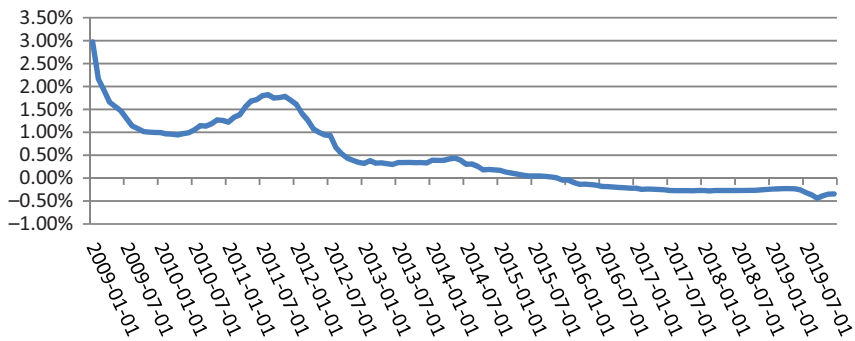

Figure 1. Development of 6 month EURIBOR interest rate (source: developed by the author based on data of Bank for International Settlement, 2019; Bank of International Settlements, 2019; IBORate, 2020)

Based on calculations, the results show that the most pronounced developments occurred in 2009 and 2012. In the other years, the EURIBOR interest rate showed only a slight development. However, the risk remained. The debtor could have used derivatives to avoid the potential risk associated with interest rate volatility. The most commonly offered derivatives are interest rate swaps and interest rate options.

Swap hedging

In principle, an interest rate swap is very similar to an interest rate forward in that a bank swaps interest rate differentials with a client. However, if the client opts for an interest rate swap, the client and the bank agree on the terms of the transaction, i.e., the frequency at which the interest will be reset and the fixed interest rate. Moreover, in an interest rate forward contract, both parties commit to swap the interest rate differential on a fixed date in the future. However, it is worth noting that if the floating interest rate is negative on the fixed interest reset date, the interest rate is considered to be 0. Thus, by calculating the fixed forward interest rate of an interest rate swap, it is also possible to calculate the amount of the interest rate differential. The results are shown in Table 2.

The results show that due to a fall in the EURIBOR rate, it would not benefit a financial market participant to enter into an interest rate forward contract, as the client would have to pay the difference in interest. A swap only benefited the client in the first half of 2009 and the second half of 2011, when the EURIBOR rates were rising.

Option hedging

The interest rate on an option is calculated in the same way as on a forward. The main difference is that on the interest rate reset date, the difference is only paid by a bank to a client if the EURIBOR price on the market exceeds the fixed price. The resulting differential can thus be seen in Table 3:

The results show that, although a client does not pay the difference to a bank when entering into an interest rate option, the reduction in interest rates could have saved the client's money if he had taken out a conventional housing loan. Comparing the fixed interest rate with the EURIBOR interest rate, it can be seen that the interest rate option was only favourable in 2009–2011, when the interbank interest rate was higher than the fixed interest rate. During this period, the difference in interest would be paid to the client by the bank.

Table 2. Interest flows of an interest rate swap (source: developed by the author)

Date	EURIBOR 6 months	Fixed forward interest rate	Differential	Date	EURIBOR 6 months	Fixed forward interest rate	Differential
2009.01.01	2.97%	1.55%	349.682	2014.07.01	0.31%	1.55%	–310.395
2009.07.01	1.14%	1.55%	–103.038	2015.01.01	0.13%	1.55%	–354.136
2010.01.01	0.97%	1.55%	–145.67	2015.07.01	0.05%	1.55%	–375.531
2010.07.01	1.15%	1.55%	–101.045	2016.01.01	0%	1.55%	–387.873
2011.01.03	1.33%	1.55%	–54.759	2016.07.01	0%	1.55%	–387.873
2011.07.01	1.82%	1.55%	66,52119	2017.01.02	0%	1.55%	–387.873
2012.01.02	1.41%	1.55%	–35,3743	2017.07.03	0%	1.55%	–387.873
2012.07.02	0.66%	1.55%	–221.139	2018.01.02	0%	1.55%	–387.873
2013.01.01	0.38%	1.55%	–292.318	2018.07.02	0%	1.55%	–387.873
2013.07.01	0.34%	1.55%	–302.359	2019.01.02	0%	1.55%	–387.873
2014.01.01	0.39%	1.55%	–290.561	2019.07.01	0%	1.55%	–387.873

Table 3. Interest flows of an interest rate option (source: developed by the author)

Date	EURIBOR 6 months	Fixed interest rate on options	Differential	Date	EURIBOR 6 months	Fixed interest rate on options	Differential
2009.01.01	2.97%	1.55%	354.8765	2014.07.01	0.31%	1.55%	–310.873
2009.07.01	1.14%	1.55%	–103.623	2015.01.01	0.13%	1.55%	–354.373
2010.01.01	0.97%	1.55%	–146.373	2015.07.01	0.05%	1.55%	–375.623
2010.07.01	1.15%	1.55%	–101.623	2016.01.01	0%	1.55%	–387.873
2011.01.03	1.33%	1.55%	–55.1235	2016.07.01	0%	1.55%	–387.873
2011.07.01	1.82%	1.55%	67.12653	2017.01.02	0%	1.55%	–387.873
2012.01.02	1.41%	1.55%	–35.6235	2017.07.03	0%	1.55%	–387.873
2012.07.02	0.66%	1.55%	–221.873	2018.01.02	0%	1.55%	–387.873
2013.01.01	0.38%	1.55%	–292.873	2018.07.02	0%	1.55%	–387.873
2013.07.01	0.34%	1.55%	–302.873	2019.01.02	0%	1.55%	–387.873
2014.01.01	0.39%	1.55%	–291.123	2019.07.01	0%	1.55%	–387.873

The study on interest rate risk management through forward financial instruments has shown that, in the case under analysis, a financial market participant wishing to take out a mortgage loan from a bank would only be able to choose between interest rate swaps and options. However, the results show that neither an interest rate swap nor option would benefit the financial market participant. Although the interest rate fixed until 2011 was lower than the EURIBOR rate, the interest rates fixed during the rest of the period under analysis would be unfavourable to the bank's customer. The analysis thus suggests that it would not be possible to enter into interest rate derivative contracts during the period under analysis, nor to hedge against potential risks due to the decrease in interbank interest rates at the end of the period in question.

2.2. Use of price volatility risk management methods

One of the main types of market risks is price volatility risk. Just like other market risks, it is dependent on the situation in the market and the economy. The oil price, which is currently the most volatile, was chosen for the study and for the price risk identification. As is known from economic theories, the price of oil is mainly influenced by economic and political developments, as well as demand and supply. The whole world is currently under quarantine, with countries having closed their borders, which has led to a reduction in the number of trips, although the situation is expected to improve.

The Figure 2 below shows the development of the price (in GBP/BBL) for oil produced in Great Britain. As a result of the 2014 OPEC agreement not to limit oil production, oil prices fell sharply worldwide in 2015 due to oversupply. However, OPEC decided in 2016 to limit oil production due to the then situation, and this has had an impact on the rise in oil prices worldwide. A sharp drop in the oil price is also visible in 2018. This change could have occurred due to the sanctions imposed by the U.S. on Iran and the U.S. President's call for OPEC to reduce prices taking account of the supply and demand of this resource. Looking at the subsequent period, it can be seen that, due to the drop in demand, the oil price on the market dropped sharply in late 2019 and early 2020.

Fluctuations in prices of oil and oil products could be unfavourable to suppliers and buyers of oil products. In purchasing oil and petroleum products, governments and businesses seek to get the best deal possible from oil suppliers. Buyers enter into financial derivatives on energy products to hedge themselves against the risk of oil price volatility. The following section will examine which derivative may have been the most favourable in the period 2015–2019.

In the case under consideration, enterprise X, a producer of petroleum products, buys oil from the United Kingdom. In this case, it is assumed that enterprise X operates in pounds sterling and is therefore not exposed to exchange rate risk. Enterprise X purchases oil on a semi-annual basis and settles with the supplier within 30 days of receipt of the products. The buyer considers that it may be exposed to price volatility risk.

Having identified the risk, the next important step is to measure it. The risk is measured using the measure of standard deviation. The results of risk measurement can be seen in Table 4.

Table 4. Price volatility risk (source: developed by the author)

Period	Variance	Standard deviation
H1 2015	1.06	10.27%
H2 2015	0.91	9.53%
H1 2016	0.60	7.73%
H2 2016	0.51	7.12%
H1 2017	0.25	5.03%
H2 2017	0.04	2.00%
H1 2018	0.25	4.98%
H2 2018	1.51	12.27%
H1 2019	0.48	6.93%
H2 2019	0.35	5.95%

As can be seen, the results show that the price fluctuated the most in the first half of 2015 and the second half of 2018. However, the risk of price volatility was also prevalent in the other periods. The results of the risk calculation show that the risk of price volatility during the period under consideration is higher than, for example, in the previous exchange rate and interest rate surveys.

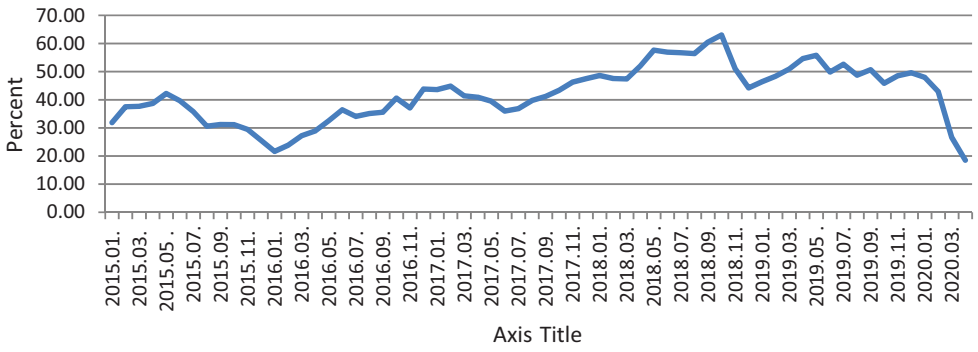

Figure 2. Development of the oil price (in GBP/BBL) (source: developed by the author based on data of Bank for International Settlement, 2019; Bank of International Settlements, 2019; Word Bank, 2020)

This only further demonstrates the fact that the risk of price volatility is affected both by exchange rate and interest rate developments in the market.

The following section will examine what the situation would have been if enterprise X had used derivatives to hedge against price risk.

Futures hedging

As is well known, futures contracts are usually entered into by market participants who are not sure how the price of a product will develop and want to protect themselves against possible fluctuations. Enterprise X would pay on a fixed date a fixed futures price, which depends on interbank interest rates and a risk-free investment rate, which in this case is used as the yield on government bonds. The enterprise enters into a futures contract every six months. Thus, by comparing the current and the future oil price, it is possible to analyse whether this transaction was favourable to enterprise X.

Table 5 shows that an enterprise would benefit from a futures contract, as only three payments out of 11 would result in a loss for the enterprise. And the negative interbank interest rates would have made the price agreed by the enterprise in January 2017 almost half the market price.

The results show that, overall, a swap would be favourable to the enterprise during the period under analysis.

Forward hedging

In other cases, enterprise X may choose to use a forward to control cash flows. Forwards are also favourable to investors who are prone to speculation. Thus, when entering into a forward contract, enterprise X pays a fixed price on the agreed date, but can profit from the price differential due to a favourable market situation. The situation for the choice of a forward during the period in question can be seen in Table 6.

The results show that an enterprise would have suffered a loss in the first year only. The higher transaction price in the first year is due to positive interbank interest rates. However, in 2016–2019, a volatility forward would have been favourable to the enterprise due to the significant differential. The lower transaction prices were due to euro interbank rates. Taken together, the results suggest that a volatility forward would be favourable to the enterprise.

Table 5. Futures price cash flows (source: developed by the author)

Period	Oil price	GBP LIBOR	EUR LIBOR	Risk-free rate	Risk-free futures price	Futures price differential
01.2015	31.90	0.6849	0.14286	0.857	31.1907	0.71
07.2015	35.76	0.7328	0.05786	0.857	31.79118	3.97
01.2016	21.62	0.7503	–0.04	0.76	17.78225	3,84
07.2016	34.07	0.6291	–0.18729	0.76	28.21468	5.86
01.2017	43.64	0.5361	–0.228	0.08	24.45533	19.18
07.2017	36.85	0.4634	–0.30543	0.08	38.35225	–1.50
01.2018	48.61	0.4965	–0.40543	0.08	50.59397	–1.98
07.2018	56.72	0.6923	–0.40014	0.08	59.03021	–2.31
01.2019	46.44	0.7306	–0.42014	–0.01	46.21236	0.23
07.2019	52.64	0.7115	–0.42586	–0.01	52.37748	0.26
01.2020	47.96	0.8724	–0.3659	–0.01	47.72158	0.24

Table 6. Volatility forward cash flows (source: developed by the author)

Period	Oil price	GBP LIBOR	EUR LIBOR	Forward price	Forward differential
01.2015	31.90	0.6849	0.14286	34.17782	–2.28
07.2015	35.76	0.7328	0.05786	36.79699	–1.03
01.2016	21.62	0.7503	–0.04	21.18615	0.43
07.2016	34.07	0.6291	–0.18729	30.88216	3.19
01.2017	43.64	0.5361	–0.228	38.66287	4.97
07.2017	36.85	0.4634	–0.30543	31.22126	5.63
01.2018	48.61	0.4965	–0.40543	38.75631	9.85
07.2018	56.72	0.6923	–0.40014	45.3687	11.35
01.2019	46.44	0.7306	–0.42014	36.68749	9.76
07.2019	52.64	0.7115	–0.42586	41.43136	11.21
01.2020	47.96	0.8724	–0.3659	39.1873	8.77

Option hedging

The price of an option is calculated in the same way as for a forward, but the terms of the contract itself differ. By entering into a volatility option, enterprise X can exercise the option if the forward price during the purchase period is favourable to it. If the enterprise does not exercise the option, it will have to pay the counterparty a percentage premium on the option. The option price and the current oil price are compared in Table 7.

The results show that it would be favourable for an enterprise to enter into an option contract. It is only in 2015 that the current oil price was lower than the option price. In 2015, the enterprise could take a decision as to whether to exercise the option price, but it should consider whether it would be more profitable to exercise a price higher than the current price or to pay an option premium to the counterparty for the unexercised option price.

Swap hedging

A swap can also be used to reduce the risk of price volatility. When an enterprise enters into such a contract, it exchanges commodities and cash flows on a fixed date. The swap points will determine the price of the swap. The results and differentials between the current price and the swap price can be seen in Table 8.

As can be seen from Table 8, the results show that the price of a swap exceeded the current price over the entire period under analysis. In this case, the swap would be loss-making for enterprise X. The results show that it would be unfavourable for the enterprise to enter into a swap contract.

Thus, the study on price volatility risk management by means of derivative financial instruments has shown that not all derivatives can avoid the potential risk of price volatility. According to the findings, the most unfavourable option during the period under analysis would be to enter into a price swap. If the enterprise had opted for this transaction, it would have suffered a loss. However, the use of other derivatives such as futures, forwards, and options would have been favourable, as the findings of the study have shown that only at the beginning of the analysis period would the prices of transactions be higher, and afterwards they would fall sharply, such as in the case of forwards or options. The results thus suggest that the most risk-averse option would be a forward or an option.

Table 7. Volatility option cash flows (source: developed by the author)

Period	Oil price	GBP LIBOR	EUR LIBOR	Option price	Option differential
01.2015	31.90	0.6849	0.14286	34.17782	–2.28
07.2015	35.76	0.7328	0.05786	36.79699	–1.03
01.2016	21.62	0.7503	–0.04	21.18615	0.43
07.2016	34.07	0.6291	–0.18729	30.88216	3.19
01.2017	43.64	0.5361	–0.228	38.66287	4.97
07.2017	36.85	0.4634	–0.30543	31.22126	5.63
01.2018	48.61	0.4965	–0.40543	38.75631	9.85
07.2018	56.72	0,6923	–0.40014	45.3687	11.35
01.2019	46.44	0.7306	–0.42014	36.68749	9.76
07.2019	52.64	0.7115	–0.42586	41.43136	11.21
01.2020	47.96	0.8724	–0.3659	39.1873	8.77

Table 8. Volatility swap cash flows (source: developed by the author)

Period	Oil price	GBP LIBOR	EUR LIBOR	Swap points	Swap price	Differential
01.2015	31.89925	0.6849	0.14286	1.423937	33.32	–1.42075
07.2015	35.76239	0.7328	0.05786	2.001803	37.76	–1.99761
01.2016	21.61852	0.7503	–0.04	1.428521	23.05	–1.43148
07.2016	34.07292	0.6291	–0.18729	2.354819	36.43	–2.35708
01.2017	43.63755	0.5361	–0.228	2.832437	46.47	–2.83245
07.2017	36.84859	0.4634	–0.30543	2.422518	39.27	–2,42141
01.2018	48.61035	0.4965	–0.40543	3.781351	52.39	–3.77965
07.2018	56.71584	0.6923	–0.40014	5.341327	62.06	–5.34416
01.2019	46.44397	0.7306	–0.42014	4.615335	51.06	–4.61603
07.2019	52.64	0.7115	–0.42586	5.172793	57.81	–5.17
01.2020	47.96076	0.8724	–0.36586	5.104622	53.07	–5.10924

Conclusions

The present study on the use of derivatives for risk management has shown that derivatives help to avoid potential risks. The study has also shown that, depending on the type of risk, each derivative protects against potential risks differently. From the findings of the study it can be seen that some derivatives are not able to fully protect against potential risks, or even on the contrary, make the situation worse. Thus, the analysis of the use of derivatives for risk management has shown that, in order to protect oneself against certain risks, it is necessary to make a responsible choice as to which derivative to use.

When faced with interest rate risk, an investor would be well advised to opt for a swap under which it would pay a fixed interest rate and would benefit from an increase in interest rates, as it would receive a floating (rising) interest rate in return. However, if the investor is not sure whether it will have a better opportunity in the future, it could choose an interest rate option. Thus, for those wishing to take out a loan from a bank, local banks offer only a swap and an interest rate option.

The findings of the study on interest rate risk management show that it would not be profitable to enter into these transactions in the event of a fall in the Euro Interbank Offered Rates (EURIBOR). A financial market participant would have to pay the difference to a bank rather than the other way around, which is not in the financial market participant's interests.

In the case of price risk, investors, or rather speculators, tend to opt for options as they can choose when to buy or sell an asset and also, if they are lucky, make a profit. In contrast to options, forwards and futures reduce the risk of loss by means of hedging but also reduce the likelihood of profit. The analysis of the findings of the study on price variation risk management suggests that during the period analysed, it is most unprofitable for a participant to enter into a swap, as the financial market participant would suffer a loss. An option would be the most appropriate way to manage this risk, as the participant would be able not to use the forward price due to an unfavourable market situation and would still benefit after paying a premium to the bank.

One of the characteristics of derivatives is dependence of their price on the price of the linked asset, and this study has only further demonstrated that the fixed price of a derivative contract may not always be favourable if the price of the chosen asset, the rate, changes in an unfavourable direction.

The study has shown that derivatives are not always able to avoid potential risks. Market participants wishing to use derivatives in their own activities should first carefully analyse the derivatives themselves and weigh up their pros and cons. It is only possible to second the economists and financial experts claiming that the application of these financial instruments is not straightforward and that market participants should be familiar with the specificities of these instruments or seek advice from specialists in these instruments.

References

Bajracharya, S. B. (2009). *Are derivatives the cause of a financial crisis?* (Money and Banking Research Paper). https://www.researchgate.net/publication/284174149_Are_derivatives_the_cause_of_a_financial_crisis

Bank for International Settlement. (2019). *Global OTC derivatives market*. https://stats.bis.org/statx/srs/table/d5.1

Bank of International Settlements. (2019). *OTC derivatives statistics*. https://www.bis.org/publ/otc_hy1911.htm

Beckley, J. (2017). *Interest rate swaps. Society of Actuaries*. https://www.soa.org/globalassets/assets/Files/Edu/2017/fm-interest-rate-swaps.pdf

Biais, B., Heider, F., & Hoerova, M. (2016). Risk-sharing or risk-taking? Counterparty risk, incentives, and margins. *The Journal of Finance, 71*(4), 1669–1698. https://doi.org/10.1111/jofi.12396

Bian, H. (n.d.). *Basic statistics I*. Office for Faculty Excellence.

Chandra, P. (2020) *Strategic financial management – managing for value creation* (2nd ed.). McGraw-Hill Education.

Chapelle, A. (2019). *Operational risk management – best practices in the financial services industry.* John Wiley & Sons Ltd. https://doi.org/10.1002/9781119548997

Chiu, M. (2012). *Derivatives markets, products and participants: an Overview*. Switzerland. Bank for international Settlement.

Citibank. (n.d.) *F/X swap*. https://www.citibank.co.kr/cgrp_pjt/jsp/en/fed/fed040020v.jsp?gnbname=fed#citibank

Culp, C. L. (2004). *Risk transfer: Derivatives in theory and practice.* John Wiley & Sons Inc.

Deloitte. (2018). *Commodity price risk management a manual of hedging commodity price risk for corporates.* https://www2.deloitte.com/content/dam/Deloitte/in/Documents/risk/in-risk-overview-of-commodity-noexp.PDF

Dinu, A. (2012). Modern methods of risk identification in risk management international. *International Journal of Academic Research in Economics and Management Sciences, 1*(6). http://hrmars.com/admin/pics/1296.pdf

ECB Europa. (2014). Euro area risk-free interest rates: Measurement issues, recent developments and relevance to monetary policy. *ECB Monthly Bulletin, July 2014.* https://www.ecb.europa.eu/pub/pdf/other/art1_mb201407_pp63-77en.pdf

Eurostat. (2020). *Financial derivatives and employee stock options, by sectors – annual data, million units of national currency.* https://ec.europa.eu/eurostat/databrowser/view/tipsii19/CustomView_1/bar?lang=en

Fabozzi, F. J., & Peterson, P. P. (2003). *Financial management and analysis.* John Wiley & Sons Ltd.

Fantini, G. (2014). *Financial derivatives usage by UK & Italian SMEs. Empirical evidence from UK & Italian non-financial firms.* University of Ferrara. Italy.

Gemzik-Salwach, A., & Perz, P. (2013). *Estimating value at risk for interest rate risk using the variance covariance method.* https://www.researchgate.net/publication/319653443_Estimating_Value_at_Risk_for_Interest_Rate_Risk_Using_the_Variance_Covariance_Method

IBORate. (2020). *Libor current and historical data.* http://iborate.com/gbp-libor/

Kornél, T. (2014). *The effect of derivative financial instruments on bank risks, relevance and faithful representation: Evidence from banks in Hungary.* Department of Finance and Controlling, Faculty of Economics and Business Administra-

tion, University of Debrecen, Debrecen, Hungary. https://poseidon01.ssrn.com/delivery.php?ID=345071025031102096102014094007077066105031089055030062103114120025003103106092026124126000024009054122012124125094120073118111018038048082088074089099020073003030019005053004117066114104066122090066018084119127111095095089112026116104126103124087096064&EXT=pdf

Lewitt, M. (2018). *Financial Crisis 2.0: Beware of derivatives*. https://www.forbes.com/sites/michaellewitt/2018/10/08/financial-crisis-2-0-beware-of-derivatives-for-dummies/#71a54fbe5816

Lietuvos Bankas [Bank of Lithuania]. (2019). *Ketvirčio ataskaitos formos b-09-01 „Ataskaita mokėjimų balansui sudaryti" pildymo paaiškinimai* [Explanatory notes for completing Quarterly Reporting Form B-09-01 "Compilation of the Balance of Payments"].

Lietuvos Bankas [Bank of Lithuania]. (2020). *Užsienio valiutų pirkimas ir pardavimas negrynaisiais pinigais* [Buying and selling foreign currencies in non-cash transactions]. https://www.lb.lt/lt/uzsienio-valiutu-pirkimas-ir-pardavimas-negrynaisiais-pinigais?ff=1&TERM_UVR%5B0%5D=D8&EK_ERDVE_UVR=12&PRIESINGA_SALIS=22

Lietuvos banko valdyba [Board of the Bank of Lithuania]. (2002). *Nutarimas dėl metodinių rekomendacijų bankams dėl vidinių rinkos rizikos vertinimo modelių taikymo.* [Resolution on methodological guidance to banks on the use of internal market risk assessment models].

Marroni, L., & Perdomo, I. (2014). *Pricing and hedging financial derivatives. A guide for practitioners*. John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118773215

Martinkutė-Kaulienė, R., & Stasytytė, V. (2018). *Rizikos valdymas* [Risk management]. Technika.
https://doi.org/10.20334/2018-008-S

Mishkin, S. F. (2015). *The economics of money, banking, and financial markets.* The Pearson Series in Economics.

Morgan, J. P. (2013). *National association of pension funds limited derivatives and risk management made simple.* National Association of Pension Funds.

Palve, S. (2016). *Risk management through equity derivatives*. https://shodhganga.inflibnet.ac.in/bitstream/10603/199656/15/11_chapter2.pdf

Poitras, G. (2002). *Risk management, speculation, and derivative securities*. https://books.google.lt/books?hl=en&lr=&id=bCEb0VwD8nUC&oi=fnd&pg=PR15&dq=risk+management+derivative&ots=Yv70FgHzuY&sig=MhHBidXtSV8KGy4yaeXkrrOt8no&redir_esc=y#v=onepage&q=risk%20managemenn t%20derivative&f=false

Ramzan, I. (2018). *Role of financial derivatives in risk management.* Kadir Has University, Graduate School of Social Science, Banking & Finance.
https://doi.org/10.2139/ssrn.3264962

Rao, D. G. (2012). Derivatives in risk management. *International Journal of Marketing Studies, 1*(4), 55–60.

Sahoo, A. (2020). Derivative and risk management: A new dimension of Indian financial market. *Asian Journal of Technology & Management Research, 5*(2). http://www.ajtmr.com/papers/Vol5Issue2/Vol5Iss2_P1.pdf

SEB. (2019). *Finansinių priemonių rizikos aprašymas* [Description of Risks of Financial Instruments]. https://www.seb.lt/sites/default/files/web/pdf/finansiniu_priemoniu_rizikos_aprasymas.pdf

Summers, G. (2010). *Why derivatives caused financial crisis. Market outlook.* https://seekingalpha.com/article/198197-why-derivatives-caused-financial-crisis.

United Nations Secretariat [Jungtinių Tautų sekretoriatas]. (2019). *Managing commodity price risk in commodity dependent developing countries*. https://unctad.org/meetings/en/SessionalDocuments/cimem2d46_en.pdf

Valakevičius, E. (2019). *Investavimas finansų rinkose* [Investing in financial markets]. Technologija. https://doi.org/10.5755/e01.9786090216552

Varmuza, K., & Filzmoser, P. (2016). *Introduction to multivariate statistical analysis in chemometrics.* CRC Press.
https://doi.org/10.1201/9781420059496

Venables, A. J. (2014). Understanding international commodity price fluctuations. *Journal of International Money and Finance, 42*, 1–8.
https://doi.org/10.1016/j.jimonfin.2013.08.002

Vuillemey, G. (2014). *Derivatives and interest rate risk. Management by commercial banks. Job market paper.* University of Lausanne. https://doi.org/10.2139/ssrn.2644681

Word Bank. (2020). *Commodity markets. Commodity prices.* https://www.worldbank.org/en/research/commodity-markets