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Options in Corporate Finance Management

Abstract: Although there are many opinions critical of options, especially after the 2008 scandal, they are becoming increasingly popular in Poland again. Therefore, issues connected with options are not only the subject of interest in academic circles again but also arouse interest of economic entities, allowing enterprises to assess a variety of action strategies. Those instruments enable planning safeguards to protect against various negative future scenarios. Hence, it comes as no surprise that there has been an increase in the number and variety of enterprises that have accepted options as a way to plan for their future. The article provides a brief presentation of options. It also describes one of their pricing methods. Light of the foregoing has been hypothesized that 'valuation of options using mathematical calculators using the binomial model is an effective tool for supporting management positions in futures instruments'.

Key-words: corporate finance, derivative instruments, options, binomial model.

Introduction

More and more companies are facing a dilemma about how to effectively manage their corporate finance. There is an increasing number of investment solutions. Thus, it takes longer to get one's bearings on the market and choose the right offer. Challenges met by financial directors require vast knowledge and skills as decisions made mostly by financial departments greatly affect results of an enterprise's activities. Therefore, effective corporate finance management is of significant importance to operations of an enterprise. Successful corporate finance management, however, requires knowledge of basic financial market instruments. Advanced instruments of that market allow to manage specific future risks. Derivative instruments may safeguard the investor against a decrease in the portfolio value or enable to protect against the risk of adverse changes in a given exchange rate. Such instruments include standard options. The aim of the article is to present options as one of many possibilities to manage corporate finance and, in particular, corporate foreign exchange risk. Although the article is of an exclusively theoretical character, it contains a lot of information about options, presents one of their pricing models and points to some of their benefits for enterprises.

Financial Instruments

Financial instruments should be treated as a separate specific form of money or as a separate contract between parties regulating their bilateral payments. According to the simplest definition, it can be said that financial instruments are liabilities to one enterprise and assets to the other. They can be a kind of "I owe you" or a share in the property of another economic entity operating on the market. Hence, in any case, financial instruments are liabilities of their issuer to their holder. They can be grouped according to various criteria, for example [<http://g.m.statystyk.w.interia.pl/stock/instr.html>]:

Applying the ownership criterion, they are categorized into *debt* and *equity* instruments such as: bank deposits, bills of exchange, asset backed bonds and shares.

Using the income generation criterion, instruments are divided into: *generating fixed income* (e.g. bonds) and *generating variable income* (shares).

In turn, according to the criterion of time, they can be classified into: *short-term* (of the initial maturity term up to 1 year), *medium-term* (of the initial maturity term from 1 year to 5 years) and *long-term* (of the initial maturity term over 5 years).

Taking into account the character of their issuer, they are divided into: *direct* (issued by non-financial economic entities, local authorities, state authorities, governments) and *indirect* (issued by all financial institutions).

Another type of financial instrument is the so called derivative instrument that should be understood as a financial instrument created based on structural characteristics of a specific underlying instrument which, through its market value, determines the value of the derivative instrument. Such instruments are also called *derivatives* or *off balance sheet instruments*. Thus, they are financial instruments whose price directly or indirectly depends on, or "derives from", the price of securities (shares, bonds) or other instruments (exchange rates, stock exchange indices) [Tarczyński, Zwolankowski 1999, p. 182].

Options

An option is a contract conferring on its holder the right to take a specific action within specific time. It is the right to buy or sell shares or another financial instrument at a certain price [Koch 1997, p. 165].

In general, options are divided into [Kolb 1997]:

- call options, i.e. the right to buy a share or another asset at a specified price in the future. Hence, they enable the holder to buy shares at a specified price within specified time.
- put options, i.e. the right to sell a share or another financial instrument at a specified price within certain time, providing protection in the event the value of that instrument declines. Thus, they allow the holder to sell shares at a specified price within specified time when it is profitable. Making use of that right is called "exercising" or "settling" an option and is the right of the holder of the option, whereas issuing an option entails undertaking an obligation [Jajuga, Jajuga 1996, p. 181].

Therefore, an option is a kind of a contract between two parties, i.e. the holder and the issuer of the option. It should, however, be mentioned that it is an asymmetrical contract, which means that rights and duties of the buyer and seller are not identical. It is simultaneously the right, but not the duty, to buy or sell the whole package, e.g. shares at a price specified in advance, due to which the value of an option is always non-negative [Siegel 1997, p. 452]. The exercise (strike) price of an option is also connected with an additional premium if prices of exercising call options are close to the value of shares [Soroczyński, Stachowicz 1997, p. 55]. Thus, share options can be defined as a financial instrument that grants the holder the right to buy or sell shares within specified time and at a specified price, or possibly the right to get an amount being the settlement of a difference between the value of shares on the option exercise date and the price specified in the contract, while the holder of the option is obligated to make a payment for the gained right, called an option premium, to the issuer of the option who is obligated to exercise the option at the request of the holder [Zarębska 2005 quoting: Olik 2002, p. 137].

Although options are often presented as instruments that carry very high risk, one has to concede that they allow to invest very safely but may also serve to create extremely risky strategies. However, it is not options that should be blamed but a specific investor who makes a choice. In general, it is assumed that derivative instruments, including options, are very flexible instruments and do not need to involve high risk at all.

Types of Options

Applying the criterion of option exercise time, Giruć divides them into three types [Giruć 2000, p. 255, Hull 1994]:

1. American options – the right to obtain the underlying instrument can be exercised at any time from the time of buying the option to its expiry,
2. European options – the right to obtain the underlying instrument can be exercised only on the option expiry day,
3. Asian options – the settlement price is the mean price of an asset within a certain time period (it usually applies to goods).

In turn, Mitreğa distinguishes between [Mitreğa 2000, p. 34]:

1. share options – where the underlying instrument is a share,
2. currency (FX) options – where the underlying instrument is the currency of another country,
3. interest rate options – where the underlying instrument is an interest-bearing security, e.g. bond,
4. index options – where the underlying instrument is a market index. That means that on the exercise date no physical delivery of the underlying instrument, i.e. a market index, can be made. The holder of an index call option, in the case of its exercise, gets a sum of money proportionate to the difference between the value of the index at the exercise time and the strike price. In turn, the holder of an index put option, in the case of its exercise, gets a sum of money proportionate to the difference between the strike price and the value of the index at the exercise time. Thus, an

option, if it is a call option, will be exercised when the value of an index is higher than the strike price and, if it is a put option – when the value of an index is lower than the strike price.

When listing various kinds of options, it is also worth mentioning commodity options occurring on commodity markets, and in particular, on commodity exchanges. The principle of their operation is the same as that of financial instrument options.

Along with financial options, Jajuga also mentions real options [Jajuga 2002, p. 75]. They are established on capital investments or assets that comprise them, and thus are connected either with assets, and most often make the operation of an enterprise more flexible, which is usually associated with the increased value of the enterprise, or with liabilities, and affect the cost of an enterprise's capital, and thus its value.

Classic examples of real options are [Amram, Kulatilaka 1999, p. 95]:

Deferment option is connected with the choice of the time to start an investment project. When deferring carrying out an investment project, it is possible to find out how factors affecting the value of the investment project change. If the investment project is to be successful, a delay means deferment of first proceeds. On the other hand, waiting may prevent making a mistake when the possible undertaking fails.

Growth option allows to expand operations. In that case it is necessary to carry out an initial investment project in order to be able to expand operations by adding new products in the future.

Exit option consists in considering, in one's calculations, possibility to sell a functioning undertaking or fixed assets used in an undertaking if the situation turns out to be unfavourable.

Staging option is associated with carrying out a consistent undertaking where each stage is dependent on the preceding one.

Flexibility option allows to take advantage of changing economic conditions and changes in cost relations among different regions or countries, as well as adjust output to the needs of the local market.

Operating option is connected with starting an activity, e.g. production. Setting up a plant, however, also generates an option to expand production as well as a flexibility option or option to abandon production.

Learning option is associated with possibility to undertake a project in stages and make decisions on further actions based on earlier collected data.

Option Value

An important issue in investing in options is to determine their value. The value is affected by the following factors [Jajuga, Jajuga 1996, p. 189]:

1. exercise (strike) price,
2. price of an underlying instrument,
3. time period to an option expiry date,
4. volatility of prices of an underlying instrument,
5. risk-free rate of interest.

In the case of a call option, the exercise price negatively affects the option value; hence, the higher the exercise price, the lower the option value.

A higher exercise price simply means a lower yield for the option holder at the exercise time. It is the other way round for put options.

The price of an underlying instrument, *ceteris paribus*, positively affects a call option value but negatively affects a put option value. In the case of a call option, an increase in the price of the underlying instrument means standing a better chance that the current price of the underlying instrument on the market will be higher than the strike price at the exercise time. Then, the option will be exercised and will produce a yield for the holder. On the other hand, in the case of a put option, an option will be exercised and will produce a yield for the holder, when the price of the underlying instrument falls, which will increase a chance that the current price of the underlying instrument on the market will be lower than the strike price at the exercise time.

The duration of the time period to the option expiry date, *ceteris paribus*, positively affects the value of both a call and put option as the longer the time to the option expiry date, the better the chance that it will be exercised at the price at the given time, i.e. it will simply become profitable.

The volatility of prices of an underlying instrument, *ceteris paribus*, positively affects the value of both a call and put option as high volatility means that there occur prices considerably higher (in the case of a call option) or considerably lower (in the case of a put option) than the mean price of the instrument, which will increase the yield of the option holder in both the cases.

The risk-free rate of interest, *ceteris paribus*, positively affects the value of a call option and negatively affects the value of a put option. A rise in the risk-free rate of interest has an effect similar to a fall in the exercise price because when the interest rate rises the current, i.e. adjusted or discounted, value of the exercise price falls, which means an increase in the call option value and a decrease in the put option value.

There are also several other factors that influence the value of an option. One of those can be a dividend. A rise in the dividend results in a fall in the call option value and a rise in the put option value because, e.g. payment of the dividend decreases the value of the share and has the same impact on the option value as a fall in the price of the share [Zarębska 2005].

Options Pricing Methods

A very important element in investing in options is their pricing that allows to receive a true value.

The estimation of the option value is a vital step for the investor, considering the rationality of decision-making. Developed models and methods can be of assistance in that scope. Along with the Black-Scholes model known to everyone, the specialist literature mentions many other methods and models used in option pricing. Those are, for example: binomial method, finite difference method, Monte Carlo method, recursive method or method of mirror images. Due to the length of the article, the first of the listed methods will be presented, i.e. the binomial model. It is one of the simplest ways of option pricing. An instruction how to build the (Jarrow and Rudd (JR)) model was

provided in a quite detailed manner in an article entitled *Option pricing according to the binomial tree algorithm* [Controlling 10/2010].

Diagram 1. Binomial tree model

Source: [Controlling 10/2010].

The model is based on an assumption that both a fall and a rise are possible with equal likelihood, i.e. 50%. Values of rises and falls are described by multipliers defined as follows:

$$w = e^{((r-q-0,5\sigma^2)k+\sigma\sqrt{k})}$$

$$s = e^{((r-q-0,5\sigma^2)k-\sigma\sqrt{k})}$$

Where:

w-rise

s-fall

r-market interest rate

q-expected rate of dividend on a share

σ -price volatility

k-step size in years (option lifespan divided by the number of analysis steps)

While analysing a single path to arrive at a result in 9 steps, we can receive a result being the product of the initial value of nine falls or rises and nine likelihood ratios. For example, a path leading to the maximum value will be equal to the price of a share at the current time multiplied by the rise multiplier (w) raised to the 9th power and rise likelihood (always 0.5 for JR), also raised to the 9th power.

The author advises that, when analysing a binomial tree, all possible paths to arrive at a specific result should be explored. The paths can be defined as a combination of the number of rises in the number of steps. Thus, the following ought to be considered in the above manner:

- a. gain resulting from 9 consecutive rises as in the example above,
- b. gain (loss) resulting from 8 rises and 1 fall,
- c. gain (loss) resulting from 7 rises and 2 falls,
- d. gain (loss) resulting from 6 rises and 3 falls,
- e. gain (loss) resulting from 5 rises and 4 falls,
- f. gain (loss) resulting from 4 rises and 5 falls,
- g. gain (loss) resulting from 3 rises and 6 falls,
- h. gain (loss) resulting from 2 rises and 7 falls,
- i. gain (loss) resulting from 1 rise and 8 falls,
- j. gain (loss) resulting from 9 consecutive falls.

While there is only one path leading to extreme results (only falls or only rises), combinations of paths lead to the other results, e.g. 126 different paths lead to result (e). Their number is computed based on the formula for the combination of k-element subsets in the n-element set (l):

$$l = \frac{n!}{k! \cdot (n - k)!}$$

Hence, it is possible to determine the likelihood of occurrence for each of the expected results as the product of the number of paths (combinations) and the likelihood raised to the 9th power. Knowing the expected results (gains or losses) and their likelihoods, we receive the random variable distribution. Assuming that the expected value of such distribution is the sum of the products of the expected result and its corresponding likelihood, finally, the expected gain should be discounted as at the present day, taking into account constant capitalisation, to receive the price of an option to be appraised.

The author also gives an example of European option JR pricing in an MS Excel spreadsheet [Controlling 10/2010]:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	EUROPEAN OPTION JR* PRICING													
2	*) Jarrow Rudd model													
3														
4														
5	Current share price	500,00		Number of tree steps		9								
6	Exercise price	480,00		Option lifespan [in years]		0,5								
7				Step size		0,05556								
8														
9	Divident	2,00%		Rise		1,0483								
10	Interest rate	3,98%		Fall		0,9539								
11														
12	Price variability	20,00%		P1 (Rise)		0,5								
13				P2 (Fall)		0,5								
14				P* - Likelihood										
15														
16														
17	Option type	Call		Pricing		40,85								
18														
19														
20														
21	No	0	1	2	3	4	5	6	7	8	9	Profit	Prob.	
22	9										764,2	284,16	0,002	
23	8									729,0	695,4	215,40	0,018	
24	7								695,4	663,4	632,8	152,84	0,070	
25	6							663,4	632,8	603,7	575,9	95,90	0,164	
26	5					632,9	603,7	575,9	549,4	524,1	44,08	0,248		
27	4				603,7	575,9	549,4	524,1	500,0	476,9	0,00	0,248		
28	3			575,9	549,4	524,1	500,0	476,9	455,0	434,0	0,00	0,164		
29	2			549,4	524,1	500,0	477,0	455,0	434,0	414,0	395,0	0,00	0,070	
30	1		524,1	500,0	477,0	455,0	434,0	414,0	395,0	376,8	359,4	0,00	0,018	
31	0	500,0	477,0	455,0	434,0	414,1	395,0	376,8	359,4	342,9	327,1	0,00	0,002	

Input data concerning parameters of the analysed share are introduced to the E5, E6, E9, E10, E12 cells. The number of steps of the analysis (9 in this case) and the time period after which the option is exercised (half a year in this case, i.e. 0.5) are introduced to the M5 and M6 cells.

The M12 and M13 cells contain likelihoods of a rise and a fall in the share price, which, for the JR model, are always 0.5.

Rise and fall multipliers are described by MS Excel functions, according to the earlier presented formulas:

$$W=M9=(\text{EXP}((\$E\$10-\$E\$9-0.5*\$E\$12^2)*\$M\$7+E12*\text{SQRT}(\$M\$7)))$$

$$S=M10=(\text{EXP}((\$E\$10-\$E\$9-0.5*\$E\$12^2)*\$M\$7-E12*\text{SQRT}(\$M\$7)))$$

The EXP function (i.e. e to the nth power) and the "SQRT" function, giving the value of the square root, should be used.

The calculation is performed in the matrix determined by the range of the C30:L21 cells, where consecutive columns are consecutive steps of the analysis (tree), while rows are the number of rises in share prices. The analysis starts in the C30 cell where reference to the current price of the share on the market (E5) should be introduced. The formula used in the spreadsheet should calculate the value of the price in such a way so that, as a result of a horizontal shift to the right, it considers a fall in the price and, as a result of a diagonal shift upwards, it considers a rise in the share price.

No	Steps of analysis									Profit	Prob
	0	1	2	3	4	5	6	7	8		
9									784,2	284,16	0,002
8									729,0	694,0	0,018
7									685,4	665,4	0,070
6									632,8	603,7	0,164
5									575,9	549,4	0,246
4									524,1	500,0	0,246
3									476,9	455,0	0,164
2									434,0	414,0	0,070
1									395,0	376,8	0,018
0									342,9	327,1	0,002

As for the selected three example paths: the A path leads solely through falls, the B path – solely through rises, and the C path – through one rise (0,0) to (1,1), one fall (1,1) to (1,2) and 7 consecutive rises. In order to describe the above with one MS Excel function, the following notation should be used:

Function	Description
=JEŻELI(\$B30<D\$20;	If the number of steps exceeds the number of rises
\$M\$10*PRZESUNIĘCIE(D30;0;-1);	Calculate the price as the product of the fall multiplier and the price in the preceding step
JEŻELI(\$B30=D\$20;	If not, check whether the number of steps equals the number of rises
\$M\$9*PRZESUNIĘCIE(D30;1;-1)	If so, calculate the price as the product of the rise multiplier and the price in the preceding step before the fall – a shift of an index downwards and to the left by one index
;"")	Enter an empty field in other cases

In such a way, we define the matrix algorithm with the function. The same function can be used for a matrix with a bigger number of steps. Then, the result will be more precise. In the above example, it was assumed that, within the lifespan of the option, it will only come true nine times whether its price rose or fell.

According to the above example, the status in the L column after nine steps, i.e. at the option exercise time, is important. It ought to be determined whether there is a gain or not. We do not report a loss – we identify such a possibility as 0.

Now, an additional parameter should be introduced, i.e. identification whether we calculate a put or a call option. The selection field is defined in the E17 cell, using data correctness analysis.

Depending on the option type, we categorize a gain differently. For a call option, a gain will always occur if the share price exceeds the option exercise price; for a put option – always when the share price is lower than the option exercise price. To make gain calculation depend on the parameter in cell E17, we use the following formula in the M column:

`=IF($E$17="Call";MAX(L21-$E$6;0);MAX($E$6-L21;0))`

Thanks to that, we will get a series of expected gains in column M, depending on whether we examine a call or a put option. Assuming earlier that the option price is the expected value of the random variable, we need to assign likelihood parameters to each result. In column N, we use the following function for the combinations and product of nine consecutive likelihoods:

`=$M$12^$M$5*COMBIN($M$5;B21)`

For example, for the result in the L21 cell, to which one path leads, the likelihood value will be the lowest – equal to the product of nine consecutive likelihoods (p to the 9th power) and the number of combinations that equals 1.

Finally, in order to calculate the option price, we need to use the “SUMPRODUCT” function to compute the expected value of the random variable (the value of the expected gain) and discount that value as at the present day using the discount factor:

$$\text{disc} = e^{-r \cdot t}$$

Where:
 r – discount rate
 t – option lifespan

As the Excel “Option Pricing” function, it takes the following form:

`=SUMPRODUCT(M21:M30;N21:N30)*EXP(-$E$10*$M$6)`

As already mentioned, the binomial method is applied in the pricing of most derivative instruments that rely on shares whose prices change according to the binomial model. In practice, it is used, in particular, in option pricing. It should be assumed, however, that option pricing employing the binomial model regrettably provides approximate values of the future price.

Reasons for and Advantages of Using Options

Running one's own firm is often associated with making transactions in foreign currencies. That, in turn, entails significant risk. Practice shows that options rank second, following forward contracts, as an instrument applied to limit foreign exchange risk. Depending on the size of an enterprise, different

motives behind options use are specified [See. Cuthbertson, Nitzsche 2006, p. 19–21]. For smaller enterprises, it is a psychological motive (striving to minimize the owner's risk), for larger ones – more of an economic motive (limiting operating result fluctuations). Research proves that the bigger the enterprise, the higher the likelihood of risk estimation and management. It is also connected with reduced financial limitations and reduced cash flow available to the enterprise. Likelihood of using options is also higher for exporting enterprises [Tymoczko 2009, p. 71, 86–88].

Enterprises applying that kind of instruments see that the possibility to invest in derivative instruments offers even greater opportunities to create diversified investment strategies. All strategies connected with a call or put option can be used to improve financial leverage, protect against risk or increase rate of return. That can be achieved through the skilful issuing of call options. Additionally, buying put options can serve to safeguard against the loss of unrealized gains from invested capital [Zarebska 2005].

Summary

Money resources of an enterprise may occur in such forms as: amounts in cash in the company (it is the most liquid item but it yields no gain); cash in current bank accounts on which banks pay low interest usually below the inflation rate; term bank deposits allowing to get higher interest which can be considerably reduced if the deposit is prematurely terminated.

Management of resources in those forms often hinders the ability to effectively manage money resources of an enterprise. Most of those limitations can be avoided by using the so called options. They can provide a perfect tool in managing, especially, foreign exchange risk. It should be emphasized, however, that their improper use may result in financial disasters as investing in forward contracts, options in that case, is also associated with risk, especially in the first period of trading in options, where liquidity risk may occur. Low activity and low involvement of market participants can make bigger transactions impossible or entail a significant change in rates. Another threat can be market risk increased by the financial leverage effect. That may result from the fact that the initial investment value is low as compared to the value of an underlying instrument. Other examples are risks associated with the passage of time and transaction costs. That is explained by the fact that an option price depends, among others, on time that remains to the option expiry and thus, as the option expiry date gets closer, the option value may decrease even if the price of the underlying instrument does not change, which means that the passage of time acts to the disadvantage of call option buyers and put option buyers.

Despite the listed risks, derivative instruments, options included, are increasingly used by corporate managers who perceive the instrument of an option as a kind of policy.

Bibliography:

Allayannis G., Oflek E. (2001), *Exchange Rate Hedging Financial versus Operational Strategies*, T., The American Review", Vol 91, No.2.

Amram M., Kulatilaka N. (1999), *Disciplined Decisions – Aligning Strategy with the Financial Markets*, Harvard Business Review, Jan–Feb.

Borsum Ødegaard B.A. (2005), Currency hedging in Norwegian non-financial firms, *Economic Bulletin*, Q3.

Cassidy D. L. (2000), *Kiedy sprzedawać akcje*, ABC, Warszawa.

Cuthbertson K., Nitzsche D. (2006), *Financial engineering derivatives and risk management*, Wiley & Sons, Chichester.

Dusza M. (1999), *Rynek kapitałowy w Polsce*, Biblioteka Menedżera i Bankowca, Warszawa.

Ford D. (1997), *Opcje giełdowe*, Wydawnictwo Liber, Warszawa.

Giruć P. (2000), *Rynki kapitałowe, cz. II, "Instrumenty pochodne na giełdzie towarowej w Polsce"*, Materiały, Konferencje, WNUS, Szczecin.

Hull J. (1994), *Instruction to futures and option markets*, Prentice Hall International, Toronto.

Jajuga K., Jajuga T. (1996), *Inwestycje*, Wydawnictwo Naukowe PWN, Warszawa.

Jajuga T. (2002), *Strategiczne zarządzanie ryzykiem przedsiębiorstwa a opcje rzeczywiste*, Uniwersytet Szczeciński, Szczecin.

Koch R. (1997), *Słownik zarządzania i finansów*, Wydawnictwo Profesjonalnej Szkoły Biznesu, Kraków.

Kolb R. (1997), *Wszystko o instrumentach pochodnych*, WIG-Press, Warszawa.

Koźuch B. (2009), *Nauka o organizacji*, CeDeWu.pl Wydawnictwo fachowe, Warszawa.

Mitrega K. (2000), *Rynek instrumentów pochodnych*, w: *Rynek pieniężny i kapitałowy*, pod red. I. Pyka, Wydawnictwo Uczelniane Akademii Ekonomicznej im. Karola Adamieckiego w Katowicach, Katowice.

Olik N. (2002), *Polski rynek kapitałowy w obliczu wprowadzenia opcji na akcje*, w: *Rynek finansowy*, pod red. W. Przybylskiej – Kapuścińskiej, Wydawnictwo Akademii Ekonomicznej w Poznaniu, Poznań.

Roth P. (2000), *Rynki walutowe i pieniężne*, Dom Wydawniczy ABC, Warszawa.

Siegel J. G., Shim J. K., Hartman S. W. (1997), *Przewodnik po finansach*, Wydawnictwo Naukowe PWN, Warszaw.

Soroczyński S., Stachowicz J. (1997), *Kontrakty futures i opcje*, Kantor Wydawniczy „Zakamycze”, Warszawa.

Tarczyński W., Zwolankowski M. (1999), *Inżynieria finansowa*, A.W. Placet, Warszawa.

Zarebska A. (2005), *Opcje*, w: *Wybrane usługi finansowe*, Wydawnictwo: Piotr Nowak, Stowarzyszenie Nowych Adeptów Nauki, Toruń.

<http://g.m.statystyk.w.interia.pl/stock/instr.html>

<http://www.magazyncontrolling.pl/artykul/wycena-opcji-wg-algorytmu-drzewa-dwumianowego/146>