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PLUM PLANTATION VALUE BASED ON REAL OPTION CONTRIBUTION

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SUMMARY

This paper is aimed to stress the modern methods of project value analysis based on valuation of opportunities emerged during the project's life. Traditional appraisal methodology can hardly incorporate option value and quantify management flexibility. Therefore, traditional investment appraisal should be completed with option value evaluation (Real Option). The appliance of option quantification is showed on a model of plum and plum brandy production as an extension activity. Results of traditional NPV analysis for 1 ha of plum production imply to be unacceptable. On the other hand, economic analysis of extended plum brandy production indicates high profitability. It implies that plum plantation has an option calculated using Black-Scholes and Binomial model. Plum production strategic NPV that includes option value is in this case 2 950.54 EUR indicating acceptability of investment.

Key-words: real option, plum, plum brandy

INTRODUCTION

The major prerequisite of successful entrepreneurship venture is quality of decision-making process. Decision in investment is the most important financial decision. It is a part of both long-term business planning process and strategic business definition. Using available investment appraisal methods, entrepreneur should make positive or negative investment decision. Within the development of the economic theory and the practice many of methods made decision-making process rational and gave the practical and scientific base for successful project evaluation.
In practice, there are four major traditional methods of evaluating investment proposals: Payback Period method (PP), Net Present Value method (NPV), Relative Net Present Value (NPV_r) and Internal Rate of Return method (IRR).
The advantage of all these methods is, first of all, simplicity and explicit interpretation of the results. At the same time they have some imperfections, which emerge from the fact that they do not consider enough uncertainty, flexibility and options of the project. Those options should be determined and evaluated because the final project appraisal is a function of the considered project results and all the related future options are valued as well. For the purpose of the option valuation Real Options Models exist as the most popular and accepted methods. Real Option can be defined as "the right, but not the obligation, to undertake some business decision, typically the option to make a capital investment" (Brealey et al, 2006).
The studies about financial and real option emerged during 1970's. In the paper from 1973, The Pricing of Options and Corporate Liabilities, Fischer Black and Myron Scholes published an option valuation formula known as the Black-Scholes model. Robert C. Merton expanded mathematical understanding of the options pricing model and coined the term "Black-Scholes options pricing model". The term "real option" can be attributed to the Stewart Myers who claimed that the value of a firm was not only the present value of its existing assets, but also the present value of the options to make further investments if conditions are favourable at some time in the future. It is important to notice that real option methods are not substitute for traditional investment appraisal methods but their complement that enable wider insight of investment judgment (Dixit and Pyndick, 1995).

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The plum production can be good example of real option calculations because of the multiple usages of this fruit. It can be used not only as a fresh fruit but also as a valuable input in processing industry. Plum juice can be fermented into plum wine; when distilled, this produces a brandy known as the "Rakija Šljivovica". It points that plum production has some additional option value which can affect the strategic plum production appraisal.

METERIAL AND METHODS

Financial options pricing theory can be applied, with a certain parameters conversion, to the valuation of non-financial or "real" investments. The table below summarizes researched example where plum brandy production is considered as an optional production.

Table 1. Parameters analogy – financial and real investment
Tablica 1. Analogija čimbenika financijskih i stvarnih investicija

Financial investment *Financijske investicije*	*Variable* *Varijabla*	Real investment *Stvarne investicije*
Stock price *Cijena dionice*	S	Present Value of cash flows from optional production *Sadašnja vrijednost gotovinskog tijeka opcijske proizvodnje*
Exercise price of the Option *Izvršna cijena dionice*	X	Investment expenditure for optional production *Investicijski troškovi opcijske proizvodnje*
Option's time to expiration *Vrijeme dospijeća opcije*	T	Length of time till optional production *Vrijeme do investiranja u opcijsku proizvodnju*
Risk-free rate of return *Nerizična stopa povrata*	r_f	Bank's deposit interest rate *Kamatna stopa na bankarske depozite*
Variance of returns on stock *Varijanca povrata od dionica*	σ^2	Variance (Risk) of the investment's project *Varijanca investicijskog projekta*

Source: Rovcanin (2004)

The first phase of project strategic value determination is traditional investment analysis by Net Present Value calculation for an investment of *t* periods that is written as:

$$NSV_t = - I + \Sigma SP – SS / (1 + r)^t$$

Where:
NSV_t - Net Present Value (EUR)
I - investment costs (EUR)
SP - total revenue (EUR)
SS - total costs (EUR)
r - interest rate (%)
t - time - number of years

With isolation of cash costs from enterprise budgets the annual cash flows are estimated, representing a basic input parameter for computation of NPV_t.
Following step is option value determination. For the purpose of that, the two most frequently used models are used - Black Scholes Model and Binomial Model.
Finally the strategic project value is determined as the sum of the traditional NPV and the project option value. In this paper strategic value is done by the next equation:

$$Strategic\ NPV_{\ plum\ \ production} = Traditional\ NPV_{\ plum\ production} + call\ option\ value_{\ plum\ brandy}$$

In the following text the basic features of two the most frequently used option valuation models will be referred briefly.

Black-Scholes model

The Black-Scholes model is aimed to calculate a theoretical call price using the five key determinants of an option's price: stock price, strike price, volatility, time to expiration, and short-term (risk free) interest rate. The original formula for calculating option value is as follows:

$$OP = SN(d_1) - Xe^{-rt}N(d_2)$$

$$d_1 = \frac{\ln(\frac{S}{X}) + (r + \frac{v^2}{2})}{v\sqrt{t}}$$

$$d_2 = d_1 - v\sqrt{t}$$

where:
OP - value of the plum brandy production option
v - variance (Risk) of the investment's project
N(x) - standard normal cumulative distribution function
e - exponential term (2.71828)
ln - natural logarithm
Binomial model
Binomial model, using binomial tree, describes price movements over time, where the asset value can move to one of two possible prices (up or down) with associated probabilities. This method consists of the two-step process:

- Underlying asset value tree generation
- Underlying option value tree generation

For the binomial option valuation purpose the next parameters are defined:

- Up and down factors *(u,p)* – factors that indicates move up or down of the underlying asset value. The up and down factors are calculated using the underlying volatility, σ:

  $$u = 1 + \text{upside change} = e^{\sigma}$$

  $$d = 1 + \text{downside change} = \frac{1}{u}$$

- Next period underlying asset price *(V_S)*

  $$V_S\text{up} = V_o \times u$$

  $$V_S\text{down} = V_o \times d$$

- Probability of up and down change of the asset price *(p)*

  $$\text{up change} = p = \frac{e^{rt} - d}{u - d}$$

  $$\text{down change} = 1 - p$$

Binomial option valuation is done by asset and option tree (lattice) projection using all maintained elements. The option valuation begins solving the tree's node value at the latest year and work back to the beginning year through backward induction.
The option on the node resulted by the *n* price increase (u^n) can be calculated by the formula:
$OP(u^n) = \max(Vs(u^n) – X; 0)$
Value of the option in the node d^n can be determined as:
$OP(d^n) = \max(Vs(d^n) – X; 0)$
The calculation of the option value in previous steps goes as:

$$OP(u^{n-1}) = \frac{p\,xOP(u^n) + (1-p)xOP(u^{n-1}d)}{1+r}$$

RESULTS AND DISCUSSION

In the paper authors illustrate the application of the presented methodology in the context of investment in plum plantation with surface area of 1 ha. This creates a call option for investment in plum brandy production which entrepreneur can, but does not have to, exercise in the future. In this way, plum plantation have added, optional value for plum brandy production which raises value of the first project's phase (Odening, 2005).
It is important to stress that extension possibilities depend considerably on plum cultivar. Some of the cultivars are aimed for table consumption only. On the other hand, there are cultivars with processing purpose mostly. In both cases option value is lower. Obviously, the highest option value appears when the plum cultivar combines table and processing role.

Plum production analysis
Net Present Value of the plum plantations is given for the first nine years of the project. NPV calculation is given in Table 2 according to the projected cash flow.

Table 2. Net present value calculation of plum production (EUR)
Tablica 2. Izračun neto sadašnje vrijednosti proizvodnje šljiva (EUR)

Year of project *Godina projekta*	0	1	2	3	4	5	6	7	8	9
Net cash flow *Neto gotovinski tijek*	-5 479	-2 144	-1 440	-1 612	-46	468	928	1 034	1 222	13 936
Present value cash flow *Sadašnja vrijednost gotovinskog tijeka*	-5 479	-1 949	-1 190	-1 211	-31	290	524	531	570	5 910
NET PRESENT VALUE *NETO SADAŠNJA VRIJEDNOST*	- 2 036.18									

Source: Authors' calculations

Because of small plantation surface and low plum selling price, plum production from the analysed case study accomplished unacceptable business performance with negative Net Present Value (NPV = –2 036.18 EUR).

Plum Brandy Production analysis
Plum brandy production can be considered as an extension of plum production and option that owners of plum plantation have. The decision to invest in plum distillery should be made 4 years after of plantation establishment. The calculation is based on the base of previously described 1 ha of plum plantation. The capacity of distillery is, in initial phase, related with the own annual plum production on 1 ha of orchard plus inventories from the previous years. Therefore, initial capacity is 3 000 litres of plum brandy. This provides an additional option of capacity growth if the market conditions are good.
Sampled distillery will be organized within existed family farm facilities. A total investment costs are 26 054.42 EUR. Direct costs projection emerges from the used technology and planned investment expenditure. It includes variable and fixed costs of the plum brandy production. The large share of expenditure is related on production inputs i.e. plum. Plum cost calculation is made as plum production cost price in each year of the project.
Cost price is larger in the starting years of the project because of smaller plum production. Sixth years after establishment, plantation generates stable yields, plum cost price becomes the lowest and constant (0.27 EUR/kg). Next important cost item is package in share of 14% of the total cost. However, the largest share of the cost belongs to Excise duty. It is a special tax on the alcoholic drinks, which is counted in amount respect to the volume of anhydrous alcohol in plum brandy.
There are many different data about plum brandy production and related efficiency of distillation of plum to plum brandy. According to Čmelik et al. (2003) distillation efficiency is 13% indicating that using 100 kilogram of plum can yield by 13 litres of plum brandy. In this example, within six years distillery will achieve the maximum of yearly production, 1 950 litres of plum brandy being 13% of the related plum production. For the income projection the market price of 10 EUR has been used per litre of plum brandy.

Traditional NPV investment appraisal for the plum brandy production is shown in Table 3.

Table 3. Plum brandy production NPV calculation (EUR)
Tablica 3. Izračun NSV u proizvodnji rakije šljivovice (EUR)

Year of project *Godina projekta*	*0*	*1*	*2*	*3*	*4*	*5*	*6*
Net cash flow *Neto gotovinski tijek*	-26 054.42	2 455.62	3 028.85	3 951.80	4 317.36	4 868.08	23 099.41
Present value cash flow *Sadašnja vrijednost gotovinskog tijeka*	-26 054.42	2 273.72	2 596.75	3 137.07	3 173.39	3 313.13	14 556.55
NET PRESENT VALUE NSV	2 996.18						

Source: Authors' calculations

Investment appraisal of plum brandy production indicates acceptable project's performance. NPV in amount of 2 996.18 EUR is considerably better than in case of plum production. Therefore, vertical integration of plum and plum brandy production can be a form of risk management process with lower risk sensitivity and higher added value.

Strategic Real Option Evaluation
All needed elements of plum production strategic real option evaluation with descriptions, values of parameters and Black-Scholes option evaluation are summarized in Table 4.

Table 4. Plum production's real option evaluation
Tablica 4. Realno opcijsko vrednovanje proizvodnje šljiva

PARAMETERS DESCRIPTION *OPIS VARIJABLE*	VALUE *VRIJEDNOST*
Present value of cash flows from optional investment *Sadašnja vrijednost opcijske investicije*	23 061.30 EUR
Investment expenditure *Investicijski troškovi*	26 054.42 EUR
Exponential function *Eksponencijalna funkcija*	2.71828
Risk-free rate *Stopa nerizičnog ulaganja*	5%
Period until investment *Vrijeme do investicije*	3 years
Variance (Risk) of the investment's project *Varijanca (rizik) investicijskog projekta*	30%
BLACK-SCHOLES OPTION EVALUATION	
d1	0.313632948
d2	-0.205982294
Lognormal distribution of d1 *Lognormalna distribucija d1*	0.623100019
Lognormal distribution of d2 *Lognormalna distribucija d2*	0.418402398
Option value of plum production – Black-Scholes Model *Opcijska vrijednost proizvodnje šljiva prema BS modelu*	4 986.72 EUR
Strategic real option value of plum production *Strateška realno opcijska vrijednost proizvodnje šljiva*	2 950.54 EUR

Source: Authors' calculations

Project's variance is the most discussed and problematic option variable which has a very strong influence on the final option appraisal. There are few internet sources that list a data about standard deviation by the business sectors. For the beverages industry sector standard deviation of 30 – 40% is

listed. In the presented case 30% has been used. Strategic real option plum production value in amount of 2 950.54 EUR is calculated as sum of plum production NPV and related option value.

Binomial model option evaluation is done according to equation described in paper's methodology part and parameters from Table 4. As maintained before, binomial model comprises two underlying trees generation – asset and option value tree.

Figure 1. Plum brandy possible asset value tree
Slika 1. Drvo potencijalne vrijednosti proizvodnje rakije šljivovice

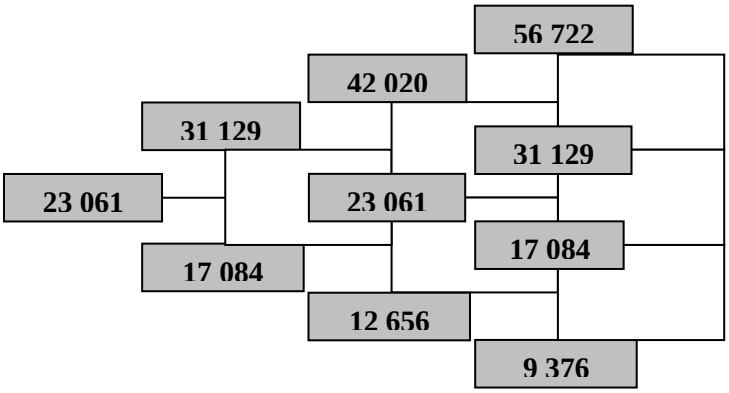
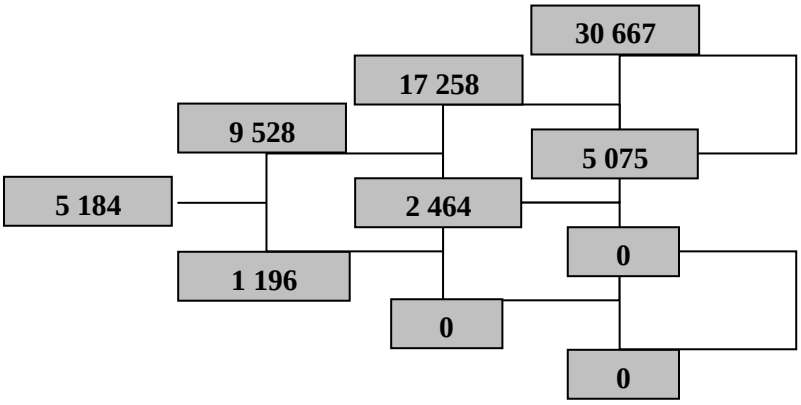


Figure 1 indicates that the possible project value after three years can be ranged 9 376 - 56 722 EUR depending on favourable or unfavourable business circumstances.
The next phase is calculation of the expected option value on the terminal nods and backward induction to the first node. Thereby the next option value lattice is made (Figure 2):

Figure 2. Plum brandy Option Valuation Lattice
Slika 2. Drvo opcijske vrijednosti u proizvodnji rakije šljivovice



Using binomial option valuation determined call value of the distillery investment is 5 184.17 EUR. This is 3.96% more than in case of calculation by Black-Scholes option valuation. If the more price changes were considered, the results would be closer to Black-Scholes model of real option valuation. Finally, strategic project value of plum production based on traditional NPV calculation and binomial option evaluation is 3147.99 EUR.
Real option calculation of NPV adjusted by the next investment option value, gives considerably different results compared to the conventional NPV calculation. While the NPV without option value indicates that plum production is not profitable enough, this extended approach found out that NPV is positive. Therefore, investment in plum production with option of distillery extension should be accepted.

Table 5. Comparison of traditional and real option appraisal

Tablica 5. Usporedba rezultata tradicionalnog i realno opcijskog vrednovanja investicije

	Traditional appraisal *Tradicionalno vrednovanje*	Real option appraisal (BS model) *Realno opcijsko vrednovanje (BS model)*	Real option appraisal (Binomial model) *Realno opcijsko vrednovanje (Binomni model)*
NPV – plum production NSV – *proizvodnje šljiva*	*–2 036.18* EUR	*2 950.54 EUR*	*3 147.99 EUR*
Investment decision *Investicijska odluka*	Not accepted *Neprihvatljivo*	Accepted *Prihvatljivo*	Accepted Prihvatljivo

Source: authors' calculation

CONCLUSION

Traditional methods of investment appraisal cannot evaluate all projects' options and managerial flexibility appropriately. High potential projects, that might turn out to be a valuable part of future project portfolios might be abandoned completely using only a traditional NPV methodology. Therefore, real options theory, needed in such cases, adds that necessary flexibility.

Presented sample has been used for simple understanding of the basic principles of the real option model. In this case a project of the plum production has been tested with traditional and real option methods as well. Traditional methods of plum plantation investment appraisal haven't given acceptable appraisal (NPV = - 2 036.18). Because of the fact that extended production of plum brandy, is offering an acceptable business result, plum plantation value, as the first phase of the brandy production, should be increased by its optional value. Option pricing has been done by Black-Scholes model (BS) and Binomial model of real option valuation. With this new perspective, the plum production investment should be taken because of the positive real option value (2 950.54 EUR by BS model and 3 147.99 EUR by Binomial model).

The main course for faster real option acceptance is its appliance in practical, not only at academics' level. As the prerequisite for developing of the real option approach it is needed to educate a students and entrepreneurs about benefits of the real option methods and to recognize the options in each practical sense.

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VRIJEDNOST NASADA ŠLJIVE TEMELJEM METODA REALNIH OPCIJA

SAŽETAK

Cilj rada je naglasiti suvremene metode analize vrijednosti projekata temeljene na evaluaciji prilika i mogućnosti nastalih tijekom odvijanja projekta. Tradicionalne metode vrednovanja investicija nisu dovoljne

za evaluaciju opcija i kvantificiranje fleksibilnosti menadžmenta, zbog čega je tradicionalnu analizu potrebno upotpuniti opcijskim metodama vrednovanja. Primjena opcijskih modela prikazana je na primjeru proizvodnje šljiva i rakije šljivovice, kao jedne od opcija plasmana šljiva. Tradicionalna ekonomska analiza učinkovitosti proizvodnje šljiva s 1 ha površine ukazuje na neprihvatljivost takve investicije. S druge strane, ekonomski rezultati proizvodnje rakije šljivovice ukazuju na visoku rentabilnost. Iz toga se može zaključiti da, iako neisplativa, proizvodnja šljiva ima određenu opcijsku vrijednost koja je određena Black-Scholesovim (BS) i Binomnim modelom. Ukupna ili strateška neto sadašnja vrijednost (NSV) koja, uz tradicionalno određenu NSV, uključuje i opcijsku vrijednost, iznosi 2 950,54 EUR-a (BS model), ukazujući na prihvatljivost projekta.

Ključne riječi: realne opcije, šljiva, šljivovica

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