UDC: 336.763.36:339.944.2

PROBLEMS OF CONVERTIBLE BONDS VALUATION IN IMPLEMENTATION OF INTERNATIONAL BUSINESS PROJECTS

ПРОБЛЕМИ ОЦІНКИ ВАРТОСТІ КОНВЕРТОВАНИХ ОБЛІГАЦІЙ ПРИ РЕАЛІЗАЦІЇ МІЖНАРОДНИХ БІЗНЕС-ПРОЕКТІВ

ПРОБЛЕМЫ ОЦЕНКИ СТОИМОСТИ КОНВЕРТИРУЕМЫХ ОБЛИГАЦИЙ ПРИ РЕАЛИЗАЦИИ МЕЖДУНАРОДНЫХ БИЗНЕС-ПРОЕКТОВ

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Abstract. *The article analyzes the main approaches to estimating the value of convertible bonds, considering the factors of the event time and investor behavior. In the process of project implementation, there is often a need to finance costs that will ultimately contribute to increased cash flow. For an investor, there is a risk that he may not receive coupon payments or bond denomination on a timely basis or may not receive them partially or at all. For this purpose, a convertible bond offers a mechanism for the acquisition of a portion of the authorized capital of a project company by exchanging a specified number of bonds for the definite number of shares in proportion to the conversion rate. Right, but not obligation, gives the investor the flexibility to make the right strategic decision: get passive coupon revenue or participate in corporate governance. Such a decision should be properly evaluated and mathematically justified as it depends on the level of profitability and risk of the investor.*

Keywords: *convertible bond; hybrid financial instrument; business project; conversion; risk-neutral probability.*

Анотація. *У статті проаналізовано основні підходи до оцінки вартості конвертованих облігацій з урахуванням факторів часу події та поведінки інвестора. У процесі реалізації проекту часто виникає необхідність фінансування витрат, які у підсумку сприятимуть збільшенню грошових потоків. Для інвестора існує ризик того, що він, придбаваючи облігацію, може не отримати вчасно купонні платежі чи номінал облігації, або не отримати їх частково чи взагалі. З цією метою конвертована облігація пропонує механізм можливості придбання частини статутного капіталу компанії, що реалізує проект, шляхом обміну визначеної кількості облігацій на кількість акцій, пропорційну коефіцієнту конверсії. Право, а не зобов'язання дає інвестору гнучкість у прийняття правильного стратегічного рішення: отримувати пасивний купонний дохід чи брати участь в управлінні корпорацією. Таке рішення має бути належне оцінене та математично обґрунтоване, оскільки від нього залежить рівень доходності та ризиків інвестора.*

Ключові слова: *конвертована облігація; гібридний фінансовий інструмент; бізнес-проект; конвертація; ризик-нейтральна ймовірність.*

Аннотация. *В статье проанализированы основные подходы к оценке стоимости конвертируемых облигаций с учетом факторов времени события и поведения инвестора. В процессе реализации проекта часто возникает необходимость финансирования расходов, в итоге будут способствовать увеличению денежных потоков. Для инвестора существует риск того, что он, приобретая облигацию, может не получить вовремя купонные платежи или номинал облигации, либо не получить их частично или вообще. С этой целью конвертируемая облигация предлагает механизм возможности приобретения части уставного капитала компании, реализующей проект, путем обмена определенного количества облигаций на количество акций, пропорциональное коэффициенту конверсии. Право, а не обязательство дает инвестору гибкость в принятии правильного стратегического решения: получать пассивный купонный доход участвовать в управлении корпорацией. Такое решение должно быть надлежащее оценено и математически обоснованное, поскольку от него зависит уровень доходности и рисков инвестора.*

Ключевые слова: *конвертируемая облигация; гибридный финансовый инструмент; бизнес-проект; конвертация; риск-нейтральная вероятность.*

Introduction. Financing of international business projects often occurs in several stages that are stretched over time, and this circumstance causes a constant search for new investors. Debt fundraising requires new forms of investor incentive in order to ensure their interest throughout the life cycle and stimulate not only financial but also managerial efforts to increase the value of the project. Such a problem can be solved by issuing convertible bonds, which contain an option for investor participation in the share capital of the company. At the same time, when deciding to issue convertible bonds, the manager must evaluate the terms of such contracts and calculate the final benefits for the project. On the one hand, the investor is interested in receiving coupon payments on such bonds, and on the other - in the opportunity under the contractual terms, to become a co-owner of the project in order to directly influence the cash flow management process. In this context, a converted bond should receive a proper assessment of the economic benefits to the participants of the project's cash flows.

The purpose of research. The purpose of research is to show the ways of convertible bonds valuation by implementing international business projects in order to attract investors.

Analysis of the latest publications. Many authors try to find the optimal approach to convertible bonds valuation; however, it is necessary to take into consideration a great majority of factors of conversion to make a model precisely defined and more available in real economic life. The most actual models for assessment of convertible bonds we can find in Solvency II and the Swiss Solvency Test [Convertible Bond Pricing, 2015], where different key factors and parameters of conversion are performed. Some issues suggest actual statistics on convertible bonds [UBS Convertibles Marketing, 2019], [RWC, 2019], [Putnam Convertible Securities Fund, 2019], that allows to provide qualitative and quantitative analysis of these financial instruments. Also, Ukrainian researcher Mykhalchyshyna [Mykhalchyshyna, 2015] considers convertible bonds from an accounting position. At the same time, the application of convertible bond valuation in international investment projects is fragmented, so in this article we'll focus on this aspect.

The important research results.

Historically, for the first time, financial innovations have been presented in scientific papers as a combination of elementary, derivative, elementary and derivative financial instruments. The meaning of the combination was to find the optimal contractual solutions, the essence of which was to determine the set of rights and obligations for the parties to the contract. The combination allows, on the one hand, to combine the properties of individual instruments, which are based on cash flows, and on the other hand – to create a precedent for the use of the most typical terms of the contract and combine them into a single financial product.

A convertible bond is a type of hybrid financial instrument based on the technology of debt and equity combining, which determines the investor's right under pre-determined conditions to co-

own a corporation or investment project by exchanging a certain number of bonds for a certain number of shares in a given proportion.

Dutch scientist Ian Giddy specifies the components of hybrids and identifies the most important: bonds; forward contracts; options. In addition, he describes a group of factors that underlie the creation of a hybrid financial instrument: regulatory restrictions; the level of tax burden; transaction costs and R&D costs; market segmentation; restrictions imposed by internal contracts or orders of the firm. Thus, the process of combining according to Giddy acts not only as a combination of a set of tools, but also factors that affect the quality of the future financial product [Офіційна Інтернет-сторінка; Ian H. Giddy, 1994].

American scientist Bidyut Sen classifies hybrids by types of markets; by types of payments; by the form of construction of the financial instrument; by sales method. Considering the division of components - the underlying assets - at the heart of hybrids quite conditional, Sen opens the way for the latter to unlimited development and improvement. This is the innovative meaning of modification. The only limitation is the law of supply and demand in the world market of financial products. [Маршалл, 2006: 784; ***Crawford, 1996: 222***].

The main purpose of this tool is to manage the risk of financing an international project. As a rule, the issue of convertible bonds is resorted to in the initial stages of project implementation, trying to raise capital at a relatively low level of return, but with a high probability of increasing the strategic value of the international company in the nearest future.

The main problem for the investor is that the tool for determining the value of early-stage projects in the world simply does not exist. This creates for the investor the uncertainty that he is trying to overcome by buying the so-called call option to buy stocks at a future unknown value to him.

To do this, the investor must determine:

1) risk-neutral distribution of stock prices;

2) the conditions under which conversion may occur;

3) the value of the conversion right for one bond and its total value.

Let one of the international companies plan the project and attract some of the financial resources by issuing convertible bonds.

The basis for the issue of convertible bonds is the adoption by the general meeting of shareholders of a decision that defines the basic conditions for the issue of the following types of bonds:

• the maximum share of the authorized capital that will be formed through the issue and conversion of bonds;

• the number of convertible bonds, their par value, the total issue amount, the price of the converted bonds and the methods of its calculation (if the conversion is carried out at market value, then the price of the converted bond will be equal to the amount of nominal value and interest income for the period);

• the type of shares to which the bonds will be converted;

• registered, preferred or ordinary, the total number of shares, their par value, the price of the stock and the method of its calculation, the number of shares attributable to one bond, or the conversion price (since the par value of the share may not exceed the nominal value of the bond);

•　　the maturity of the convertible bonds and possible dates for the conversion of the bonds into shares. [Mykhalchyshyna, 2015: 1140]

For calculating the profits for investor, first, we need to define the capital parameters of convertible bonds.

Let us indicate the amount of converted bonds by ***V***. Such bonds are nominal, non-documentary, non-repayable, non-secured assets and without right of early redemption. Par value is ***M***, the issue period is ***3 years***, and the coupon rate is ***k***. Let the contract spell out a conversion rate of ***1/t***, where ***t*** is the number of ordinary shares for which one bond can be exchanged. The stock denomination is ***L*** and its stock quotation is currently ***N***. The standard deviation of returns is ***σ***. For simplicity of the problem, suppose the rate of increase / fall of shares every year is unchanged, and denote it ***u = e^σ, d = 1/u***. The risk-free rate is known and is ***R_f***.

To let investor know, whether he should exercise the right of conversion or not, it is necessary to first determine the probabilities of rising or falling stocks in each chain of the decision tree.

The risk-neutral probabilities will be respectively:

$$P_u = \frac{(1+R_f)-d}{u-d} \tag{1}$$

$$P_d = 1 - P_u \tag{2}$$

We construct a three-stage binary decision tree for the issue of ordinary shares. The arrows in the figure indicate the directions of rising or falling stocks by the corresponding ratios *u* and *d* with the corresponding risk-neutral probabilities.

The investor is interested in the result of the 3-rd year, when he will decide on the conversion. So with probability $(P_u)^3$ the share price will be $N*u^3$; with probability $3*((P_u)^2)*(P_d)$ will be $N*u$; with probability $3*(P_u)*(P_d)^2$ will be $N*d$; $(P_d)^3 - N*d^3$. So, we've got 8 scenarios, and 4 of them are common (Fig. 1).
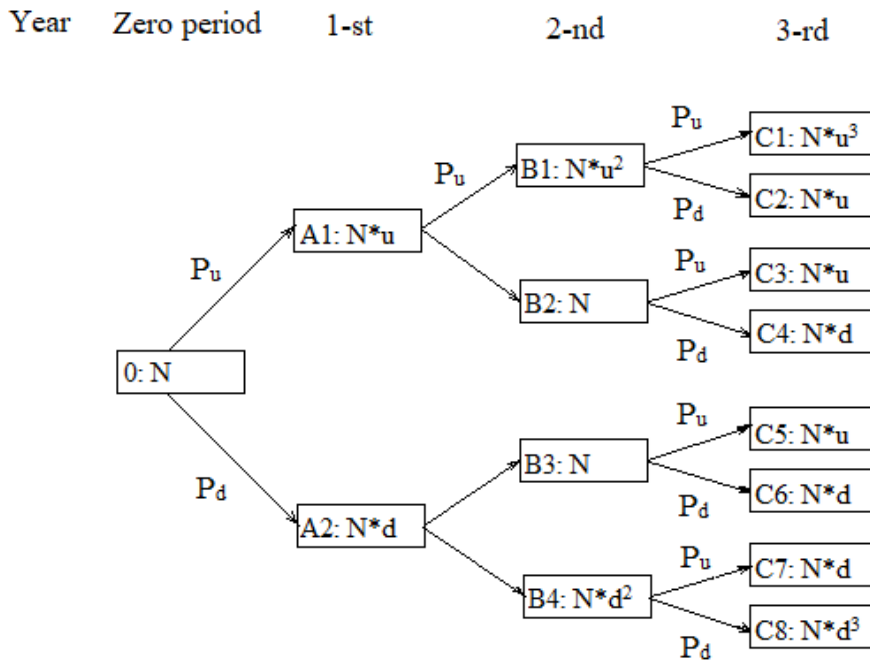
Figure 1. Binary decision tree on issue of stocks
Source: author's calculations

Let us now consider all cases for bondholder to exercise the right of conversion, and what benefit he will receive in each scenario.

If the amount of benefit in at least one scenario is greater than zero, it is advisable for the investor to convert the bonds, if the difference is less than zero - it is worth abandoning the conversion and obtain the principal amount of the bond and the coupon payment. Sometimes, even with a slight negative or zero scenario, investor may convert if his strategic purpose is to participate in the authorized capital of the corporation, which issues the convertible bonds.

If several scenarios have the potential benefit, then the investor will choose the scenario with the maximum amount (Table 1).

**Calculation of investor benefits when converting
under different types of scenarios**

Scenario number	Risk-neutral probability	Principal amount and coupon payment for the 3-rd period	Price of the parity number of shares under conversion	Conversion benefit
1	P_u^3	$M(1+k)$	Nu^3t	$Nu^3t-M(1+k)$
2	$3P_u^2P_d$	$M(1+k)$	Nut	$Nut-M(1+k)$
3	$3P_uP_d^2$	$M(1+k)$	Ndt	$Ndt-M(1+k)$
4	P_d^3	$M(1+k)$	Nd^3t	$Nd^3t-M(1+k)$

Source: author's calculations

The cost of the conversion right (option price) for one bond under the first scenario, according to the Cox-Ross-Rubinstein formula [Cox J.C., Ross R.A., Rubinstein M., 1976: 239], will be:

$$W_1 = \frac{(Nu^3t - M(1+k))P_u^3}{(1+R_f)^3} \tag{3}$$

If the second scenario brings a positive benefit for the investor, then similarly to the previous formula it will held:

$$W_2 = \frac{3(Nut - M(1+k))P_u^2P_d}{(1+R_f)^3} \tag{4}$$

Depending on the size of the parameters $W=max\ (W_1;W_2)$.

If the duration of the project is more than three years, the decision tree is branching even more, and the number of scenarios will be one at a time, according to the binomial distribution.

The additions of the revealed mathematical expression $(P_u+P_d)^n$ express the risk-neutral probability distribution, and the price scenarios will have the following sequence: $N*u^n$; $N*u^{(n-2)}$; $N*u^{(n-4)}$; ... $N*d^{(n-4)}$; $N*d^{(n-2)}$; $N*d^n$. The essence of the conversion cost formula does not change, only discount period changes.

Here is an example. The energy sector company issues convertible Eurobonds worth €100 million, the denomination of each bond is €1,000, and the maturity is 3 years. The coupon rate is 10% if paid once a year. Under the terms of the contract, one bond can be exchanged for 15 ordinary shares with par value of €25, although at present the quotation rate is 20 euros per share. The risk-free rate is 8%.

The standard deviation can also be determined using the table (see Table 2) if the business or investment project is known. In this case, the yield increase will be 76%, that is growth – 1.76 times, and the fall, respectively, - 0.57 times.

The risk of neutral probabilities according to formulas (1) and (2) will be: Pu = 0.42 and Pd = 0.58. Then the conversion benefit will be €535.53.

Therefore, it is advisable for an investor to exercise the right to exchange bonds for shares. The cost of the conversion right according to formula (3) will be €31,5.

Table 2

**Standard deviations of assets and equity for various branches
of economic sector**

Economic sector	Standard deviation of assets in % per annum	Standard deviation of equity in % per annum
Airlines	53,24	81,01
Cars: production	46,72	90,53
Cars: Trade	40,21	54,23
Aerospace, defence industry	55,85	66,36
Biotechnology	92,99	104,46
Banks	23,47	49,04
Hotel and game business	64,59	104,09
Woodworking	49,65	80,18
Mining of metals	103,86	116,66
Railways	34,61	43,76
Housing	47,24	80,36
Internet	109,03	111,16
Engineering	50,25	68,56
Furniture industry	62,46	81,55
Oil and gas industry	37,77	55,25
Shoe industry	54,7	56,36
Real estate operations	33,41	38,69
Manufacture of food products	45,52	56,31
Building materials industry	53,39	85,39
Advertising	79,12	121,35
Telecommunications: equipment production	73,3	80,02
Telecommunications: public services	60,4	82,51
Computer Sales	77,37	81,44
Food Trade	36,25	43,97
Clothing stores	56,73	69,17
Coal industry	52,15	62,27
Packaging	43,67	63,84
Pharmaceutical industry	96,09	106,23
Chemical Industry	45,91	53,62
Metallurgy	70,36	81,3
Energy	56,52	96,52

Source: [Limitovskiy, 2019: 383]

In investment risk management of a project, its present value tends to increase due to the flexibility of the investor's investment capabilities - the right to convert.

Shareholders' decision to issue convertible bonds is accompanied by a temporary dilemma: on the one hand, in the absence or complexity of other financing alternatives, this is a better substitute for traditional lending or expensive mezzanine financing; on the other hand, increasing the success rate of the project leads to an increase in the market value of the shares, thus stimulating unwanted

conversion. If the project succeeds in which the rate of return on the shares reaches the conversion level, there is a high probability that the investor will exercise the right the option.

Thus, the risks of the investment project and the risks of the investor are redistributed and optimized through flexibility through elementary hybridization of a simple and derivative instrument (bonds and stock options) [Посохов, 2011].

There are some methods in modern concept of convertible bonds valuation.

Solvency II and the Swiss Solvency Test recommends, for instance, using consequent blocks for pricing convertible bonds for portfolio optimization for investor.

The first block is stock price process. On this stage we build the derivation binomial tree model based on Cox and Hull [Hull, J. C., 2000]. The stock price can be build using deterministic interest rate term structure and non-zero dividend yield.

The second block is building convertible bond valuation tree. It includes for steps and describes the algorithm for convertible bonds pricing. The first step is to compute the value of an American option at maturity using the payoff function. The second step is to move backwards in the tree by one-time step and calculate the continuation value of the nodes, which is the discounted value of the expected payoff under the risk-neutral measure. The third step is to take the maximum of the continuation value and the exercise value of each nodes. Finally, the iterative process continues by moving back one-time step and repeating the procedure until the first node of the tree is reached [Convertible Bond Pricing, 2015].

The third block considers some extensions of the model, which we need to apply according to the type of convertible bond. There are models with exotic features, credit adjusted discount rate, reduced form of credit model.

The overall global market capitalization of the asset class is estimated for $450 bn. This includes roughly $50bn in equity-like instruments such as mandatory convertibles, and roughly $50bn in onshore Chinese convertible bonds that are accessible only to domestic or qualified foreign buyers. That leaves approximately $350bn in global convertible bonds accessible to any investor [UBS Convertibles Marketing, 2019] (Fig. 2).
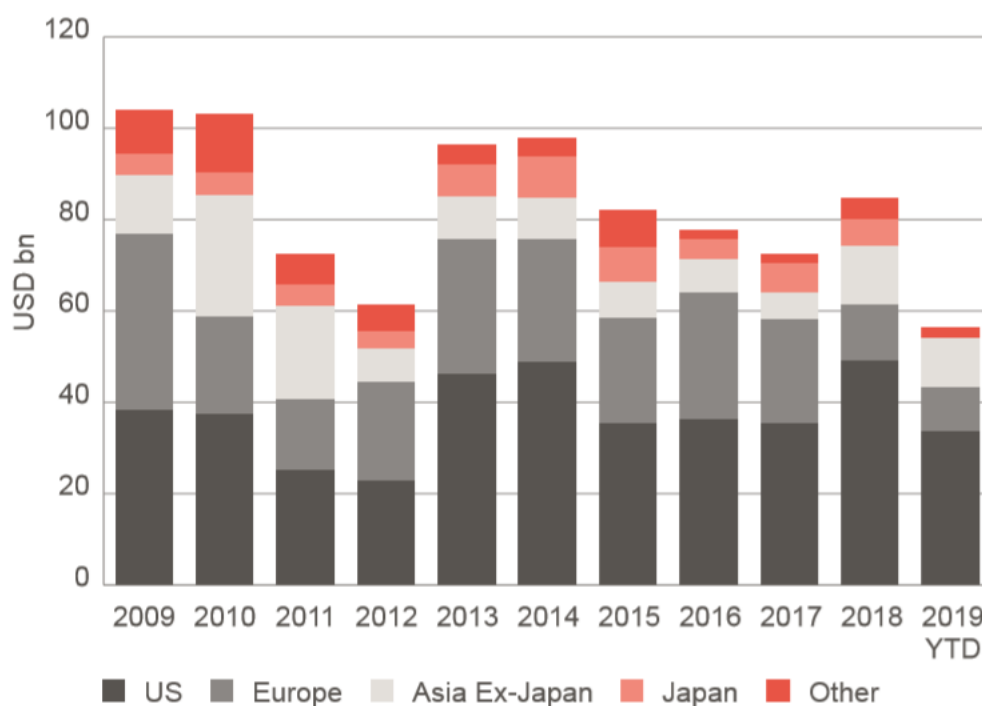

Figure 2. Annual convertible bonds issuance

Source: [RWC, 2019]

On average, the typical convertible issuer's equity base is large cap in size but at the smaller end; i.e. there is more representation from mid-cap issuers, with fewer mega caps. Also, growth focused sectors tend to have higher representation than they would in the corporate bond markets, but there is less issuance from ex-growth sectors such as banks [***Clor- Proell, 2016;*** Bundgaard, 2016: 765].

According to the statistics data of Putnam Convertible Securities Fund Annual Report as for year 2019, there are 3 leading sector allocations, where convertible bonds are widespread: technology (34,7%), health care (16,1%), consumer cyclicals (11,5%), finance (9,8%). Now we can forecast the strengthen of this sectors' development, hence – the growth of convertible bonds issuance. The third quarter of 2019 showed near-record new issuance of convertible bonds as issuers took advantage of lower interest rates and high equity valuations to raise capital [Putnam Convertible Securities Fund, 2019].

So, we expect the continuation of the positive dynamics in volume increase of convertible bonds in USA and in Asia countries except Japan. There are key factors we indicate: economic stabilization and quick restoration after possible recession; dynamics of medicine and technology sectors development; coupon rates and conditions of converse; emerge of new attractive sectors for investors.

Conclusion. Nowadays we have a wide range of valuation methods of convertible bonds. Each of them is linked to the factors, which are taken into consideration by implementing the mechanism of converse as well as circumstances, under which investor has right to change the definite number of bonds into the definite number of shares.

We have represented the method of benefit calculation for investor, who buys convertible bond with the aim to have right of participation in managing the project. Formulas (3) and (4) represent the probable benefit, which investor can get by converting bonds into common shares of the given par value. Besides we have another markable methods, which allow assessing complicated parameters and conditions. One of them is Swiss Solvency Test. It shows us some consequent steps we need to apply for convertible bonds valuation.

Convertible bonds are known for more than 200 years; however, they have been used actively for the last 40 years. Technology and health care sectors implement convertible bonds at a rapid pace, using complicated models of their pricing. The future dynamics of development of these hybrid financial instruments will depend on key economic factors. The emerge of new mechanisms of implementing convertible bonds in international projects can will be able to increase its market volume, so the last could become an evidence of real economy gradually equilibrium stabilization.

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ЗМІСТ

ПОЛІТИЧНІ ПРОБЛЕМИ МІЖНАРОДНИХ ВІДНОСИН

СУЧАСНА СИСТЕМА МІЖНАРОДНОГО ПРАВА

ОСОБЛИВОСТІ РОЗВИТКУ
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