

Measuring the value of employee stock options

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1. Introduction

In Japan, employee stock options (hereafter ESOs) were introduced in 1997. Corporations increased the amount of ESOs issues in recent years. Thereby, the measurement of ESOs has become important in order to evaluate the indebtedness of private corporate sector in Japan's Flow of Funds Accounts (hereafter JFFA). 2008 SNA also recommends that ESOs should be measured.

This paper introduces the BOJ's attempt to evaluate the value of ESOs. Available data for the outstanding amounts of stock acquisition rights are equivalent to ESOs in Japan, but they are evaluated at book value. Thus, we made an attempt to estimate market value of ESOs using the book value data.

The contents of Chapter 2 through 4 are as follows. Chapter 2 explains the basic framework for ESOs in Japan. Chapter 3 illustrates the estimation to capture the marked-to-market value of ESOs in Japan. Chapter 3-1 describes the background of the following measurement of the value of ESOs. Chapter 3-2 discusses the cases of measurement of the marked-to-market value in Japan. Section 4 concludes.

2. The basic framework for ESOs in Japan

2.1 General characteristics

In Japan, corporations are able to offer their employees tax-favored ESO plans and this tax-qualified ESO is used commonly. The framework of tax-qualified ESOs is explained as follows by "Sozei tokubetsu sochi ho" [Act on Special Measures Concerning Taxation] and Nakazato et al. (2006).

Provided a plan qualifies under the tax code, employees obtain tax benefits: employees pay no tax when they receive the option; pay no tax when they exercise the option and buy stock; and pays tax only at capital gains rates when he eventually sells that stock. To qualify for advantageous tax treatment, an option program must stay within several limits: (a) less than 12 million yen's worth of stock can be purchased in a year by exercising options; (b) options can be exercised within 2 to 10 years after receiving them; (c) options are non-negotiable; and (d) exercise price of options has to be at stock price or higher at the time of receipt.

Most non-tax-qualified ESOs in Japan, on the other hand, are called "1-yen ESOs," and their exercise price is one yen.

The ESOs are, as it were, the rights for getting the stocks with free of charge and mainly offered as retirement bonuses for executives.

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² The views expressed here are those of the authors and do not necessarily represent the views of the Bank of Japan. The authors are responsible for any errors and omissions.

2.2 Application of the 2008 SNA recommendations on ESOs

AEG paper (Eurostat (2004)) explains the idea of 2008 SNA recommendations concretely.³ The paper states that if ESOs were spread across the vesting period, one would either need to create assets/liabilities in financial derivatives, or assets/liabilities in “Other accounts receivable and payable” which would then be extinguished by the creation of a financial derivative at vesting date. The Annex 1 of the paper also suggests that “Other accounts receivable and payable” should be valued at fair value at grant date and should reflect no revaluation effect from grant date to vesting date, and that “financial derivatives” should be valued at market value and should reflect revaluation effects, or change in value. Figure 1 shows an example.

The main source data for ESOs in Japan is “Financial Statements Statistics of Corporations by Industry, Quarterly” (hereafter FSSCIQ) published by the Ministry of Finance, which compiles the accounting data of Japanese corporations as recorded in their financial statements for the quarter. The FSSCIQ identifies the outstanding amounts of stock acquisition rights which can be regarded as the outstanding amounts of ESOs in Japan. As previous studies pointed out, however, these outstanding amounts data are not sufficient for the JFFA because they are neither evaluated at market price nor represented at fair value. They are evaluated at book value.⁴ Under Japanese accounting standard ESOs are evaluated at the initial market value when they are offered and subsequent changes in their value are not reflected on financial statements. To conform to the recommendations of the 2008 SNA, the market value of ESOs and its changes have to be captured.⁵

Once market value is captured, all three accounts in the FFA, i.e. transactions, amount outstanding, and reconciliation between flow and stocks, can be compiled accordingly. Market value and the term-on-term difference on the book value of ESOs are recorded as stock and transaction flow respectively.

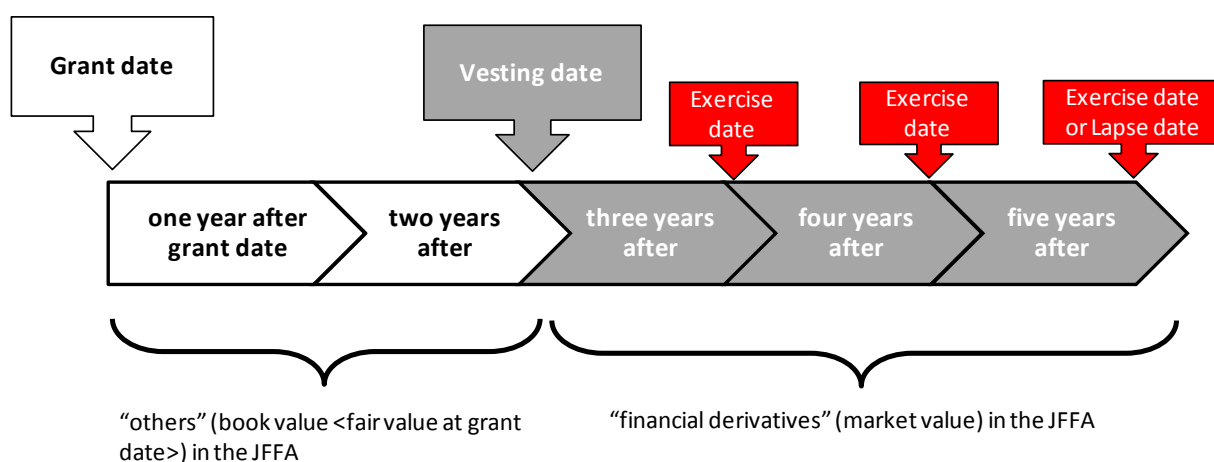
³ From a basic point of view, see Eurostat, IMF, OECD, UN and World Bank (2009).

⁴ See Hagino, Hiroki, Inadachi, Sakuraba & Sato (2011) and Sakuramoto & Hagino (2011).

⁵ In respect of other aspects of ESOs in the 2008SNA, such as compensation of employees, see Yoshino (2011).

Figure 1

A case of timing and accounting of ESOs



3. Measuring the marked-to-market value of ESOs

3.1 Tools, methodologies and assumptions

We made an attempt to estimate market value of ESOs from book value data using a market-price-to-book-value ratio.

The relevant section of 2008 SNA, paragraph 13.83, reads as follows.

Employee stock options (ESOs) should be valued by reference to the fair value of the equity instruments granted. The fair value of equity instruments should be measured at grant date using a market value of equivalent traded options (if available) or using an option pricing model (binomial or Black-Scholes) with suitable allowance for particular features of the options.

3.1.1 Tools (an approach to measure the fair value of the ESOs)

John Hull and Alan White (2002) presented an ESOs-valuation model to calculate fair value of ESOs and offered employee stock option software that accompanied the model.⁶ The software provides two approaches to measure the value.

The first approach is a simple one using the Black-Scholes-Merton formula with option's expected life. The expected life refers to the average period for which employees hold the option before it is exercised or expires. Another approach is based on Cox, Ross, and Rubinstein binomial tree model. The original model is modified to account for the vested amount of option, the probability of exercising option, and so on. Both approaches can be chosen under accounting standard in Japan.⁷

The first approach lacks theoretical background as John Hull (2012) explains: *There is no reason why the value of a European stock option with the time to maturity set equal to the*

⁶ See <http://www.rotman.utoronto.ca/~hull/ESOPS/index.htm>.

⁷ Based on the standard, financial statements show the amount outstanding of ESOs at initial market value when ESOs are offered to employees. See Accounting Standards Board in Japan (2006) for further details.

expected life should be approximately the same as the value of the American-style employee stock options. Nonetheless, it is practical and Hull also says *the results given by this approach are not totally unreasonable.* In fact, the following trial calculations using this approach proved that the approach could approximate the second approach, a more sophisticated approach based on a binomial tree model.

3.1.2 Methodologies

Based on the assumptions listed in section 3.1.3, we measured current fair values of ESOs. Input parameter as follows:⁸

Stock price = TOPIX (the Tokyo Stock Price Index, which is capitalization weighted index of all corporations listed on the First Section of the Tokyo Stock Exchange)

Exercise price = $\begin{cases} \text{TOPIX at grant date, when tax-qualified ESOs} \\ 0.1, \text{ when non-tax-qualified ESOs} \end{cases}$

Time to vest = 2 years

Expected life = 3 years at vesting date (5years at grant date)

Expected volatility = historical volatility of the TOPIX (% per year), using daily data for the period that corresponds to the remaining life of the options⁹

Risk-free rate = the yield on Japanese government bonds for the period that corresponds to the remaining life of the options (% per year)

Dividend yield = capitalization weighted average of dividend yield of all firms listed on the First Section of the Tokyo Stock Exchange (% per year)¹⁰

Employment exit rate pre-vesting = 0

On this condition, we measured both current and initial fair values for ESOs.¹¹ And then, we took the ratio of current to initial fair values. Since initial fair values at grant date are maintained on financial statements and are equal to current book values, the ratio can be regarded as a market-price-to-book-value ratio. Finally, we can arrive at the marked-to-market value of ESOs in Japan by multiplying book value of ESOs, i.e. which are available as source data, by this ratio.

3.1.3 Assumptions

Measuring the fair value of the ESOs based on John Hull and Alan White (2002) relies on the following assumptions.

⁸ A formula for pricing of a European option on a stock paying a dividend yield can be applied to evaluation of a European option for an index. In this case, stock price is set equal to the value of index, volatility is set equal to the volatility of index, and dividend yield is set equal to the average annualized dividend yield on the index during the life of the option. See Hull (2012).

⁹ As respect the period of data, we apply accounting standards in Japan. See Accounting Standards Board in Japan (2006).

¹⁰ With reference to the risk-free rate, we conform to accounting standards in Japan. See Accounting Standards Board in Japan (2006).

¹¹ The value of ESOs with expected life of 1 to 3 years, i.e. exercisable ESOs, offers current fair value. We backcast initial value when they were granted 3 to 5 years ago using parameters above.

- a. The actual amount of granted ESOs is assumed to have the same composition and weight as the TOPIX: Strictly speaking, we must calculate fair values of each ESO individually and sum up these values. However, it is not practical.¹² We calculate fair value by multiplying book value-based ESOs macro data by market-price-to-book-value ratio on the assumption that the actual amount of granted ESOs has same composition and weight as the TOPIX.
- b. The volatility of the TOPIX is assumed to be equal to that of macro ESOs: Admittedly, the volatility of the TOPIX tends to have negative bias comparing to averaged volatility of each ESOs. This assumption can be acceptable, however, when the ratio of two fair values, i.e. fair values at present and at grant date. When we calculate fair value itself, the assumption is too strong to be accepted. On the other hand, however, the numerator and the denominator of the ratio of the two fair values tend to be biased in the same direction. Hence, we consider the bias caused by undervalued volatility can be acceptable when the bias is sufficiently small compared with the level of numerator and denominator.
- c. Exercise price of tax-qualified ESOs is the TOPIX at grant date. Exercise price of non-tax-qualified ESOs is 0.1 points: Exercise price of the tax-qualified ESOs usually equals stock price at grant date in Japan. This knowledge is acquired from a major securities company saying, "On the ground that 'Act on Special Measures Concerning Taxation (Article 29-2)' requires that exercise price of tax-qualified ESOs is over or equal stock price at grant date, almost all companies set exercise price of the ESOs at lower limit, stock price at grant date." Most non-tax-qualified ESOs, on the other hand, are "1-yen ESOs" in Japan as mentioned above. In terms of index of the TOPIX, one yen is converted into 0.1 points.¹³
- d. Expected volatility is historical volatility, which is the estimate of the standard deviation of the return using closing price, for the period that corresponds to the remaining life of the ESOs.
- e. Time to vest is 2 years and expected life at vesting date is 3 years: The assumption that the period between the grant date and vesting date is 2 years is acquired from a major securities company saying "Tax-qualified ESOs are major in Japan and the time to vest of the ESOs is usually 2 years on the ground that 'Act on Special Measures Concerning Taxation (Article 29-2)' requires that time to vest of the ESOs be over or equal 2 years but less than 10 years." The assumption that expected life at vesting date is 3 years is also acquired from a major securities company saying "Although there is no evidence that the average period between the vesting date and exercise date is 3 years, it seems to be consistent with our views."
- f. ESOs one year after vesting date account for one third of the entire ESOs and those of two years after and those of three years after also account for one third respectively: Since there is not enough data to make a reasonable estimation, we assume that the options are evenly granted every year when we estimate the market-price-to-book-value ratio. In consequence, on the condition that expected life

¹² The same assumption is applied to other part of JFFA. In the case of bonds, although each sector holds each portfolio, market value-based issues and holding amounts of many sectors are calculated by multiplying face value-based macro data by one market price index on the assumption that each sector holds the same as the portfolio of entire market. See Bank of Japan (2006b).

¹³ The Nikkei 225 Stock Average is a widely quoted average of Japanese equities and this unit is yen. Broadly speaking, the NT ratio, the ratio of the Nikkei 225 Stock Average to the TOPIX, is about 10. Thus, we convert one yen into 0.1 points of the TOPIX.

at vesting date is 3 years as mentioned above, ESOs one to three year after vesting date account for one third of the entire ESOs respectively.

- g. Tax-qualified ESOs account for about three fourth of the entire ESOs and “1-yen ESOs” account for about one fourth: Although it is based not on amount outstanding but on the number of ESOs, Tax-qualified ESOs account for 72.6% of the entire ESOs in Japan and “1-yen ESOs” account for 27.4%, according to the information from a major security company.
- h. Employee exit rate pre-vesting is assumed to be zero: There is no information about employee exit rate pre-vesting and it seemed reasonable to suppose that few Employees exit after the grant of ESOs in Japan.

3.2 Cases of measurement of the marked-to-market value in Japan

See chart 1. On the ground that the Japanese stock prices decline, the market valuations of ESOs are much lower than book valuations. The ratio of current to initial fair values tends to be less than 1.

As mentioned above, the exercise price of tax-qualified ESO is over or equals stock price at grant date. When stock price is on a downtrend trend and is much lower than exercise price, market value of tax-qualified ESOs is almost zero. Generally speaking, the value of call option is almost zero when stock price is much lower than exercise price. It means that the probability that stock price will become higher than exercise price approaches to zero when stock price is much lower than exercise price.

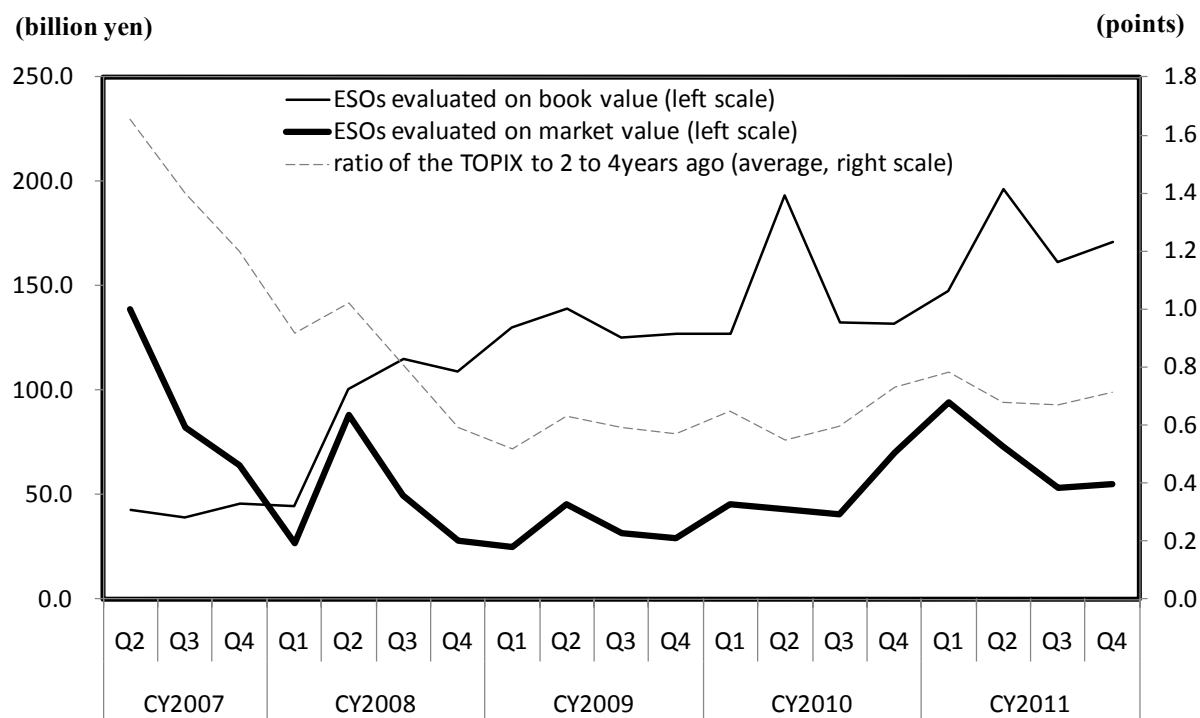
The book valuation of tax-qualified ESO, on the other hand, is rarely equal to zero. Stock price is a positive value and equals exercise price when booking. It means that the probability that stock price will become higher than exercise price is not zero.

Consequently, the ratio of the two values above, i.e. market-price-to-book-value ratio, is much lower than 1 and the estimations of market valuations of ESO in Japan are much lower than book valuations.

Market value of “1-yen ESOs” stays above zero and almost equals stock price itself regardless of the level of stock price. However, it accounts only for 27.4% of the entire ESOs.

Altogether, the market valuations of the entire ESOs are estimated much lower than book valuations.

Chart 1
Book value VS Market value of ESOs in Japan



Sources: Bloomberg; Ministry of Finance; Tokyo Stock Exchange.

4. Concluding remarks

In this paper we aimed at showing the way to evaluate ESOs. We presented the way to estimate market value of ESOs using book value source data. Since the Japanese stock prices has fallen, market valuation of ESOs was found much lower than book valuation. When the difference between market and book values widens, it has a significant impact on the implicit indebtedness of private corporate sector that cannot be read from their financial statements.

We relied on some assumptions in the estimation. Some of the assumptions had to be relatively strong to allow us to utilize available source data. Although we found that the method we took was practical and yields reasonable results, there may be room to improve in measuring market value of ESOs more accurately.^{14, 15} We plan to continue making effort to measure ESOs in more sophisticated ways and to balance cost and benefit.

¹⁴ Measuring more accurately means collecting large amount of micro data (stock price, exercise price, expected Life, volatility, etc. of each ESO) and pricing each ESO respectively.

¹⁵ Concerning the way to compile in the JFFA, see Bank of Japan (2006a) and (2006b).

APPENDIX:

Estimation of the marked-to-market value using data by industry

This paper presented the way to estimate market value of ESOs from book value source data using index data, the TOPIX. However, index data are not individual stock data but weighted averages of each of the stocks. To verify our estimation method we attempted to use the Stock Price Index by Industry. Conceptually, the TOPIX is a weighted average of the Stock Price Index by Industry, and Stock Price Index by Industry is a weighted average of each of the stocks. Thus, by measuring the difference between the estimations of market value using the TOPIX and those using the Stock Price Index by Industry, we can infer the difference between the estimations using the TOPIX and those using each of the stock data.¹⁶

In measuring the difference FSSCIQ can be used as source data because data are available industry by industry. Based on the data, we extracted main industries' data with respect to the ESOs. The amounts of outstanding of main industries' ESOs account for about 80% of ESOs of all industries. Then, we calculated market value of ESOs for each of the main industry by the pricing model and estimated market-price-to-book-value ratio for them. For the remaining 20%, we estimated market values using the TOPIX.

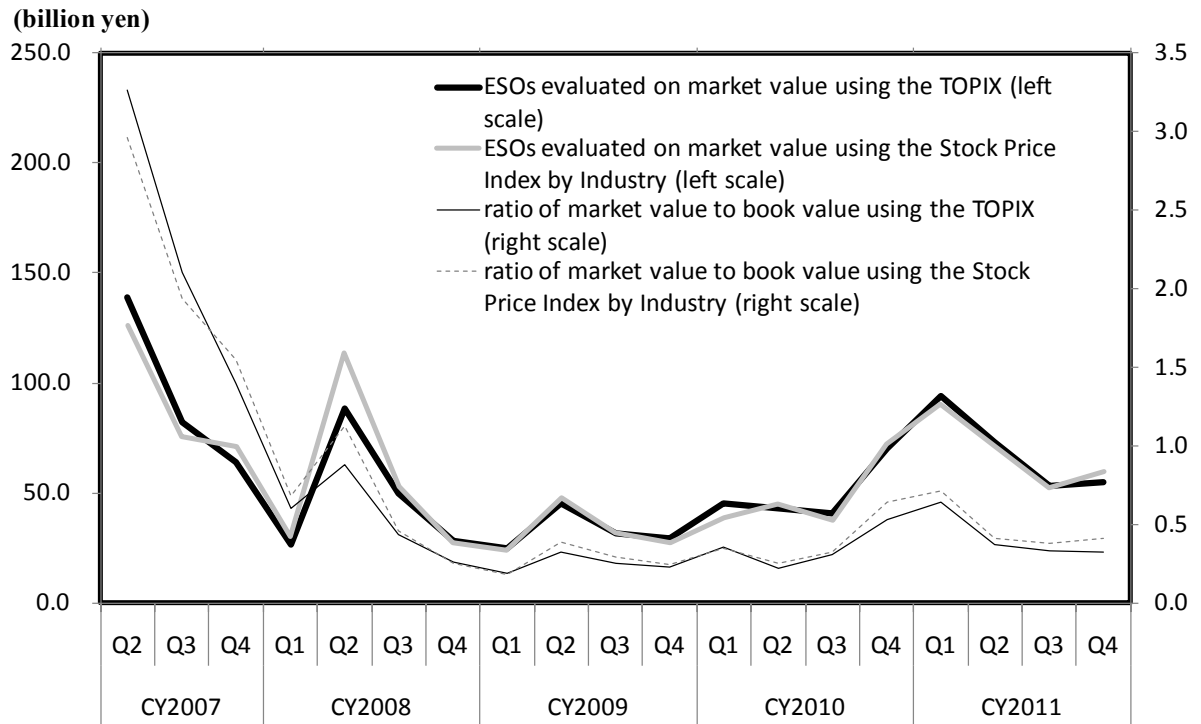
We added them together and obtained market values of ESOs. And then, we compared it to the estimation of market value using the TOPIX only.

See chart 2. Two bold lines that represent market values are almost identical and the difference is negligible. Some reasons can be pointed out. First, when stock price is at much lower level than exercise price, the value of call option approaches to zero whatever stock price is chosen as a parameter, i.e. the Stock Price Index by Industry or the TOPIX. Second, broadly speaking, the Stock Price Index by Industry had the same trend as the TOPIX has. Finally, while the level of the Stock Price Index by Industry is clearly different from that of the TOPIX, our objective value is the market-price-to-book-value ratio, the ratio of a fair value to a fair value, as mentioned above. Calculating this ratio using the Stock Price Index by Industry, the numerator usually has the difference from the estimation using the TOPIX and the denominator has the difference to the same degree. Hence, these differences are balanced at the ratio.

Note that these estimations using the Stock Price Index by Industry are one-shot estimations. Taking cost-benefit performance into consideration, we will use the TOPIX when we compile the JFFA every quarter.

¹⁶ We may also be able to calculate the market value using each of the stock data as one-shot estimation in future.

Chart 2
Using the TOPIX VS Using the Stock Price Index by Industry



Sources: Bloomberg; Ministry of Finance; Tokyo Stock Exchange.

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