**Evaluation of the Effectiveness and Appropriateness of Korean Tax Incentive Policy on Foreign Investments and Straight Line Depreciation***

by

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Abstract

Various tax incentives and accelerated depreciation methods are often used by many countries to induce foreign investment. In Korea where only straight line depreciation is allowed, the central and local governments provide low tax rates to certain types of foreign corporate investments. To evaluate the effectiveness of the low tax incentives, it is useful to examine the impact of different levels of tax incentives on the profit and risk aspects of a typical foreign investment. Using the first two moments (The expected value and the variance) of the NPV and a typical investment project, the paper conducts a sensitivity analysis of the profit and risk aspects to evaluate the effectiveness and appropriateness of Korean tax incentive policy and the straight line depreciation method.

## I. Introduction

Foreign countries often use tax incentives and accelerated depreciations to induce corporate investments. Obviously, such incentives enhance the profitability of investment projects. When assessing profitability, the profit and risk aspects are combined. For example, under the NPV (net present value) method, the expected NPV (the profit aspect) is adjusted using a risk-adjusted discount rate, which accommodates the overall risk of the project. Once the expected cash flows are estimated, the impact of various tax incentives on the profit aspect can be easily examined based on E(NPV), the expected NPV.

Since the E(NPV) so computed does not provide any information about the risk aspect of the project such as the probability that the project will be profitable, it is possible to accept a highly risky project without proper evaluation of its risk aspect. A complete probability distribution of all possible NPVs can be derived if the E(NPV) and Var(NPV), the variance of the NPV, are available. It should be noted that once the first two moments are known, even when the underlying probability distribution of the NPVs is unknown, the probability distribution still can be derived using Tchebycheff's inequality. Kim et al.[8] provided models which can be used to derive the Var(NPV) based on cash flow components.

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The objective of this paper is to briefly review tax incentives offered by the Korean central and local governments to foreign capital invested companies and by using a typical investment project and the first two moments of the NPV to evaluate the effectiveness and appropriateness of Korean Tax incentive policy and the straight line depreciation method based on a sensitivity analysis.

The next section briefly reviews the first two moments of the NPV which were derived by Kim et al.[8]. Section III reviews briefly the tax incentives offered by Korean central and local governments to foreign investments. Section IV provides a numerical example to show how the tax incentives offered in Korea can affect the profit and risk aspects of a typical foreign investment project under both straight line and sum of year’s digits depreciation. Section V is the paper’s conclusion.

## II. Review of the Var(NPV) Model

Under the NPV method, the Expected NPV is found such that

$$E(NPV) = \sum_{t=1}^{n} \frac{E(C_t)}{(1 + r_f)^t} - C_o \qquad (1)$$

where $E(C_t)$ = the expected periodic cash flow at period t, $C_o$ = the initial investment, $r_f$ = the risk-free discount rate, n = the project's useful life. To make a separate assessment of both the profit and risk aspects of investment projects, the expected cash flows need to be discounted by the risk-free interest rate rather than a risk-adjusted discount rate because the main concern is to find the expected NPV without considering the risk aspect.

As shown by Hillier [5], the variance of the NPV can be written as

$$Var(NPV) = \sum_{p=1}^{n} \sum_{q=1}^{n} \frac{1}{(1+r_f)^{p+q}} r_{pq}\sigma_p\sigma_q \qquad (2)$$

where $r_{pq}$ = the inter-temporal correlation coefficient between cash flows of $p^{th}$ and $q^{th}$ periods, n = the project’s useful life, and $\sigma_p$ ($\sigma_q$) = the standard deviation of the periodic cash flow for period p(q). The inter-temporal correlation coefficients, $r_{pq}$, are considered the most difficult parameters to be estimated especially in the case of lengthy multi-period investment projects due to the large number of $r_{pq}$ that must be estimated.

Numerous papers [1][2][3][4][][5][9][10] have been published associated with the estimation of the inter-temporal correlation coefficients. All these methods, however, have deficiencies because the underlying assumptions are not realistic or the information required is not easily available.

According to equation (1), Var(NPV) is a function of the four variables: n, $r_f$, $\sigma_p$, and $r_{pq}$. Since $\sigma_p$, and $r_{pq}$. are affected by cash flow components, in order to measure the impact of tax and depreciation on Var(NPV), it is necessary to derive models for $\sigma_p$, and $r_{pq}$ based on cash flow components. Recently, Kim et al [8] showed how to derive the estimation model based on cash flow components.

The periodic cash flows ($C_t$) which are composed of cash flow components can be expressed as:

$$C_t = A_t \left( \sum_{i=1}^{k} C_{ti} - \sum_{i=k+1}^{m} C_{ti} \right) + D_t T_t \qquad \text{for } t=0,1,..n \tag{3}$$

where the subscript t represents $t^{th}$ period, $A_t = (1 - T_t)$ = the corporate after-tax earnings rate, $C_{ti}$ = $i^{th}$ component cash flow which represents cash inflow when $i \leq k$ and cash outflow when $i > k$, m = total number of component cash flows, k = total number of component cash inflows, and $D_t$ = depreciation. The component cash flows ($C_{ti}$) include items such as sales revenue, any cash saving, service revenue, royalties, material cost, wages, advertising costs, and so forth.

Then, it can be shown that

$$E(C_t) = A_t\left[\left( \sum_{i=1}^{k} E(C_{ti}) - \sum_{i=k+1}^{m} E(C_{ti}) \right) + D_t T_t \qquad \text{for } t= 1,..n \tag{4}$$

$$Var(C_t) = A_t^2\left( \sum_{i=1}^{m} \sigma^2_{ti} + 2 \sum_{i=1}^{k} \sum_{j=i+1}^{k} \tau_{ij}\sigma_{ti}\sigma_{tj} - 2 \sum_{i=1}^{k} \sum_{j=k+1}^{m} \tau_{ij}\sigma_{ti}\sigma_{tj} + 2 \sum_{i=k+1}^{m} \sum_{j=i+1}^{m} \tau_{ij}\sigma_{ti}\sigma_{tj} \right) \qquad \text{for } t= 1,..n \tag{5}$$

where $E(C_{ti})$ = the expected $i^{th}$ component cash flow of the $t^{th}$ period, $\tau_{ij}$ = the correlation coefficient between the $i^{th}$ and the $j^{th}$ component cash flows, $\sigma_{ti}$ ($\sigma_{tj}$) = the standard deviation of the $i^{th}$ ($j^{th}$) component cash flow for period t, and the other notations are the same as defined before.

Then, the inter-temporal correlation coefficient between pth and qth periods can be derived as:

$$rpq = \frac{1}{\sigma_p\sigma_q}\left\{ A_pA_q\left[ \sum_{i=1}^{m} \sum_{j=1}^{m} E_{ij} - 2 \sum_{i=1}^{k} \sum_{j=k+1}^{m} (E_{ij}+E_{ji}) \right] + A_pD_qT_q\left[ \sum_{i=1}^{k} E(C_{pi}) - \sum_{i=k+1}^{m} E(C_{pi})\right] + E(C_q)\left[D_pT_p - E(C_p)\right]\right\} \tag{6}$$

where $Eij = \tau_{piqj}\sigma_{pi}\sigma_{qj} + E(C_{pi})E(C_{qj})$, $\tau_{piqj}$ = the inter-temporal correlation coefficient between $i^{th}$ cash flow component of $p^{th}$ period and $j^{th}$ cash flow component of $q^{th}$ period, and the other notations are the same as defined before, except that the subscripts p and q are used for periods p and q.

According to equations (5) and (6), the variance of the cash flows and the inter-temporal correlation coefficients are a function of six of the following variables: $A_t$, $D_t$, $E(C_{ti})$, $\sigma_{ti}$, $r_{ij}$, and $\tau_{piqj}$ .

The first three variables are the information required for the expected periodic cash flows, which are essential for the E(NPV). Without these variables, project evaluation itself is not possible. Regarding the fourth and fifth variables ($\sigma_{ti}$, $r_{ij}$), Hillier [5,6] showed how to estimate these variables by extending the PERT (Program Evaluation and Review Technique), which was originally developed by Malcolm et al. [11]. Also, Kim and Elsaid [7] extended Hillier's estimation method. Since Hillier [5,6] and Kim and Elsaid [7] already showed how these two variables can be derived, the only additional variables which needs to be estimated is $\tau_{piqj}$ .

Depending on the project, the total number of $\tau_{piqj}$ can be significant. However, it should be noted that the two variables, $\tau ij$ and $\tau_{piqj}$ are closely related. The former represents the correlation coefficient between two cash flow components and the latter represents the inter-temporal correlation coefficient between two cash flow components of two different periods.

The correlation coefficients that represent the relationship between two cash flow components are expected to remain relatively the same during the project life. On the other hand, the inter-temporal correlation coefficients, $\tau_{piqj}$, decay away as the time lag (the difference between p and q ) increases. For example, consider the impact of an advertisement in a certain period on sales of later periods.

Therefore, a practically feasible approach is to estimate $\tau_{piqj}$ based on a constant annual decay rate just as a constant annual dividend growth rate is assumed for the valuation of common stock. It is practically impossible to estimate all possible future dividends without making a certain assumption regarding the dividend growth rate. Just as the constant dividend growth model is modified depending on the nature of the growth rate of different stocks, the estimation model based on a constant decay rate can also be adjusted depending on the nature of the decay rate of different projects.

Let $\delta$ = the constant annual decay rate for $\tau_{ij}$ . Then, one possible way in which the inter-temporal correlation coefficient between two components of two different periods can decay away is:

$$\tau_{piqj} = \delta^{q-p}\tau_{ij} \tag{7}$$

where $q \geq p$.

The decay rate, which can range: $0 \leq \delta \leq 1$, may not be constant and is impossible to be accurately estimated. However, it should be noted that equation (6) makes it possible to perform a sensitivity analysis to observe the impact of a possible range of the decay rate on the $r_{pq}$, Var(NPV), and probability distribution of the project's NPV.

Since the main concern of this paper is to examine the tax impact, it will be assumed that the first five variables and a reasonable decay rate are provided.

## III. Korea Tax Incentives

In Korea, foreigners are allowed, without restraint, to make various investments except for the following:

a. those that threaten the maintenance of national safety and public order,

b. those which have harmful effect on public hygiene or the environmental preservation of Korea, or are against Korean morals and customs, and

c. those, which violate the laws of Korea.

In general, the corporate income tax rate in Korea is 16% if net profit is less than or equal to 100 million won; if net profit is over 100 million won, the rate is 28% for the exceeding amount. However, in addition to the corporate income tax, there are various other taxes that affect both domestic and foreign investments such as the corporate tax, acquisition tax, registration tax, property tax, aggregate land tax, value-added tax, and special consumption tax. Of these, the corporate tax, income tax, value-added tax, and special consumption tax are national taxes, while the acquisition tax, registration tax, property tax, and aggregate land tax are local government taxes.

Foreign investment in Korea is primarily regulated by the “Foreign Investment Promotion Act” and the “Enforcement Decree of the Foreign Investment Promotion Act” However, foreign investments are also regulated by many other laws and regulations in trade, finance, intellectual property rights, tax, labor relations, etc. [14]. Tax incentives on foreign investments are provided primarily by the following acts:

a. “Foreign Investment Promotion Act” (Act No. 5559, Sep. 16, 1998),
b. “Enforcement Decree of the Foreign Investment Promotion Act” (Presidential Decree No. 16720, Feb 23, 2000),
c. Korea Trade and Investment Promotion Agency Act,
d. The Custom Duties Act,
e. Act on Designation and Management of Customs-Free Zones for Fostering International Logistics Centers (Act No. 6054, Dec. 28, 1999), and
f. Act on the Designation, ETC., of Free Trade Zone ( Act No. 6142, Jan 12, 2000).

In general, the tax incentives allowed to foreign capital invested companies are reduction of or exemption from corporate taxes or income taxes for the first seven year period and thereafter a 50% reduction for the next three year period. If the foreign investment is less than 100%, the exemption or reduction is accordingly reduced depending on the percentage of the foreign investment. In addition, if corporate taxes and income taxes are exempted and reduced, acquisition taxes, registration taxes, property taxes, and aggregate land taxes are also usually exempted or reduced, regardless of the percentage foreign ownership, by the full amount for the first five year period from the starting date of business and thereafter by 50% for the next three year period.

The foreign investments that receive tax incentives such as a reduction or exemption from corporate tax, income tax, acquisition tax, registration tax, property tax, and aggregate land tax include:

a. Industry-supporting service business vital to the improvement of international competitiveness in the domestic industry and business involving highly developed technology,
b. Business carried out by a foreign-invested enterprise that operates in a foreign investment zone and provides a certain number of newly hired full time employees with a certain amount of capital investment,
c. Business for which tax reduction and exemption is unavoidable in order to attract foreign investment, as determined by Presidential Decree, and
d. Manufacturing business or distribution business operating in a free trade zone.

In addition to tax incentives, various other incentives are provided to induce of foreign investments that will contribute to the development of the nation's economy. For example:

a. A local government, with funds fully or partially provided by the central government, may form a foreign investment zone (for example, as a site for factories) and sell lots in the zone at a price lower than the land formation fee, or rent the land in lots to foreign-capital invested companies at a reduced or exempted rental fee,
b. State owned or public properties may be leased or sold to foreign capital invested companies, and in the case of a lease, the term of the lease can be for up to fifty years,
c. When a foreign capital invested company purchases a state owned property and certain conditions are met, the purchase price may be paid in installments for up to twenty years or the time period for the payment of the purchase price may be extended for up to one year, and
d. With funds supplied by the central government, a local government may provide various subsidies such as education and training subsidies.

Furthermore, reduction of or exemption from various taxes is provided for both domestic and foreign investments by the Restriction of Preferential Taxation Act (Act No. l 6194, Jan 21, 2000), if the investments satisfy certain conditions.

## IV. Numerical Example and Examination of Impact of Tax Incentives.

If no tax incentives are allowed, the corporate income tax rate in Korea is 16% if net profit is less than or equal to 100 million won, and if net profit is over 100 million won, the rate is 28% for the exceeding amount. However, if a foreign investment fully qualifies for various tax incentives offered by the central and local governments, almost all taxes are exempted for the first seven year period. For the next three year period thereafter, the corporate tax rate is 8% if net profit is less than or equal to 100 million won, and if net profit is over 100 million, the rate is 14% for the exceeding amount.

Therefore, if a foreign investment is less than fully qualified, the corporate tax rate is greater than 0% but less than 28%; and for the next three year period thereafter, the tax rate is greater than 8% but less than 16% if net profit is equal to or less than 100 million won, and if net profit is over 100 million, the rate is greater than 14% but less than 28%.

In addition, there are numerous other national and local taxes that are applied not only against taxable income but also against numerous other bases. These other taxes include acquisition tax, registration tax, property tax, aggregate land tax, value-added tax, special value-added tax, temporary income value-added tax, special consumption tax, stamp duty, education tax, additional tax, and so forth.

However, all of these taxes are not paid faithfully. For example, it is a common practice in Korea not to issue a special receipt showing that the value-added tax is paid when services are provided or goods are sold. If one needs such a receipt for tax deduction purposes, an additional amount equivalent to the value-added tax should be paid.

Consequently, due to the numerous taxes, without various investment incentives offered to foreign investments, it does not appear that foreign companies make investments in Korea with marginally profitable businesses. It is worthwhile to note that in China, which is enjoying very rapid development due to the successful inducement of foreign investment, all foreign investments are subject to a national tax at a flat rate of 30% plus a local surtax of 3% against taxable income. However, the 30% tax rate can be reduced depending on the type of foreign investment project, the economic zone the project operates in, and other variables. Also, the 3% local surtax can be reduced subject to negotiation with the local government.[13] Most noteably, however, China does not have the additional taxes that exist in Korea.

A typical numerical example was prepared to evaluate the impact of the tax incentives offered by the central and local governments of Korea on both the profit and risk aspects of a foreign investment. Suppose that a multi-national firm (Associated Automobile Company (AAC)) is considering the production of a new energy saving auto part containing computer chips developed by the company. The device can be installed in new as well as used cars. The company is considering producing the devices in Korea. To produce this device, equipment worth $4.5 million will be needed. Technological advances will limit the project's life to ten years. Since only straight line depreciation is allowed in Korea, the equipment will be depreciated on a straight-line basis over the ten year life of the project.

If the investment qualifies for the full tax incentives, AAC is entitled to a tax exemption for the first seven profit-making years followed by 50% reductions for the subsequent three-year period. This amounts to zero tax in the first seven years and only 14% (28% x 50%) in the next three years.

These tax rates, which amount to an average annual tax rate of 4.2% over the ten year project life, are the most favorable tax rates which can be offered to foreign investment in Korea. The possible impacts of an increase or decrease in the average tax rates on both the profit and risk aspects of the project will be very useful information for both the multi-national firm and the central and local governments. It is especially important information for governments agencies in re-evaluating the appropriateness of the various tax incentives offered to foreign investments in Korea.

Suppose that AAC's management has made three estimates (optimistic, most likely, and pessimistic estimates) for each cash-flow component for the next ten years, as shown in Table 1.

**Please insert Table 1 around here.**

There are three cash inflow components and six outflow components: $X_1$ ( new car market sales), $X_2$ (used car market sales ), $X_3$ (royalties from licensing agreements with foreign car manufacturers), $X_4$ (labor cost of $X_1$), $X_5$ (labor cost of $X_2$), $X_6$ (material cost of $X_1$), $X_7$ (material cost of $X_2$), $X_8$ (advertising and sales promotion), $X_9$ (other selling and delivery expenses), and $X_{10}$ (general and administrative expenses).

Given the estimates of the cash flow components, the project's $E(C_t)$, $Var(C_t)$ and $r_{pq}$ can be measured as follows:

a. For the estimation of the expected values and standard deviations for the random cash flow components ($X_1$ - $X_{10}$ ), the method suggested by Wagle [12] and Hillier [6], can be used. According to the method, the two parameters can be estimated as follows:

$$E(X) = \frac{1}{6} [X_{pes} + 4X_{most} + X_{opt}] \quad (8)$$

and

$$Var(X) = \left[\frac{1}{6}(X_{opt} - X_{pes})\right]^2 \qquad (9)$$

where $X_{pes}$ = pessimistic estimate, $X_{most}$ = most likely estimate, and $X_{opt}$ = optimistic estimate. The expected values and standard deviations of the cash flow components which are shown in Table 2 were computed using the three estimates in Table 1 and equations (8) and (9).

**Please insert Table 2 around here.**

b. The original PERT method proposed by Malcolm et al. [11] does not provide any estimation procedure for the correlation coefficients ($\tau_{ij}$). Hillier [5,6] and Kim and Elsaid [7] showed how to derive the correlation coefficients between an investment project's cash flow components for the PERT technique based on the regression slope parameter. Therefore, rather than repeating the lengthy estimation method proposed by Kim and Elsaid [7], this paper assumes that $\tau_{ij}$ are already estimated. Table 3 depicts the assigned $\tau_{ij}$.

**Please insert Table 3 around here.**

c. The expected values ($E(C_t)$) and variances ($Var(C_t)$) of each periodic cash flow were computed using the data in Tables 2 and 3, equations (4) and (5), and ten different average tax rates (0 to 45% in 5% increments) under two different depreciation methods (straight line and the sum of year's digits depreciation methods). Table 4 shows the computed values of the expected values and standard deviations of each periodic cash flow.

**Please insert Tables 4.**

d. Then the inter-temporal correlation coefficients, $r_{pq}$ were computed using equation (6) and the different tax rates. Tables showing all computed $r_{pq}$ were not prepared because of the huge number of correlation coefficients. For the computations of $r_{pq}$, a decay rate of .6 was used for $\vartheta_{piqj}$ such that: $\vartheta_{piqj} = (0.6)^{q-p}\vartheta_{ij}$ where q > p.

**The impact of changes in tax rates on the project's profit and risk:**

When the distribution of the NPV is assumed to be approximately normal, the first two moments, E(NPV) and Var(NPV), are necessary and sufficient information for the probability distribution of the NPV. The probability of any possible NPV such as P(NPV ≥ X) can be evaluated, where *X* = any possible NPV of interest. If the probability distribution of the NPV is unknown, Tchebycheff's inequality can be used to evaluate the possible range of NPV such that

$$P[E(NPV) + h\sigma_{NPV} \leq NPV \leq E(NPV) - h\sigma_{NPV}] \leq \frac{1}{h^2} \tag{10}$$

for all h regardless of the probability distribution of the NPV, where h represents any real number.

The first two moments, E(NPV) and Var(NPV) were computed based on the estimated values of $E(C_t)$, $\sigma_t$, $r_{pq}$, and equations (1) and (2). For the computation of E(NPV) and Var(NPV), 12% was used for the discount rate. Table 4 shows the computed E(NPV)s and the standard deviations of the NPV under ten different average tax rates which range from 0 to 45%. The same table shows P(NPV ≥ 0), the probability that the project's NPV is greater than zero -- the possibility that the project can be profitable. For the computation of the probability, Tchebycheff's inequality was used, assuming that the underlying probability distribution of the NPV is unknown. Figures 1 and 2 are graphical representation of the table. A careful observation of the two figures shows that as the tax rate increases, the E(NPV) decreases at a constant rate. But the probability that P(NPV>0) decreases at an increasing rate.

**Please insert Figures 1 and 2 around here.**

The analysis provides several important implications:

First, the expected profit (the net present value) alone is not enough information for making a sound investment decision. For example, under straight line depreciation, even when the average tax rate is as high as 45%, the expected profit (NPV) from the project is $1,360,000. However, at the 45% tax rate, the (PNPV>0) is only 9.2%, implying that it is highly probable that the NPV can be less than zero. Traditionally, both the profit and risk aspects are combined by using the risk-adjusted discount rate. The risk-adjusted NPV alone provides incomplete information, which can lead to the acceptance of highly risky projects. Consideration of both the profit and risk aspects separately is very important in evaluating risky investment projects.

Second, at very low tax rates, the P(NPV>0) is not sensitive to changes in the tax rate, implying that unnecessarily low tax rates are not needed to induce foreign investment. Table 4 and Figure 1 show that up to the tax rate of 25%, the P(NPV > 0) is greater than 50%. Consequently, if there are no other taxes, the policy that the corporate tax rate is, in general, around 28% does not appear to be excessive.

Third, the P(NPV ≥ 0) is very sensitive at higher tax rates. Thus, the Korea central and local governments should not raise the current 28% tax rates. Additional increases in tax rates significantly deteriorate corporate profit prospects and investments.

Fourth, as can be seen from the two figures, the accelerated depreciation method improves both the profit and risk aspects of the project. The improvement gradually increases as the average tax rate rises. It is much higher at higher tax rates than at lower tax rates. In addition, the improvement of the risk aspect is much larger than the improvement of the profit. Consequently, the extent of the benefit of accelerated depreciation depends on the average level of tax incentives. For example, under a very low average tax rate, an additional investment incentive in the form of accelerated depreciation is not a good incentive policy because of its insignificant improvement of a project's profit and risk.

## V. Conclusion

Traditionally, in evaluating a risky investment project based on the risk-adjusted NPV method, only the project's profit aspect is considered by using a risk-adjusted discount rate. The E(NPV) so computed, however, does not properly take into account the risk aspect of the project. As a result, a highly risky project may be accepted. Therefore, the separate assessment of both the profit and risk aspects is very useful in the evaluation of risky investment projects.

Various tax incentives are offered to foreign investments in Korea. Such incentives obviously affect both the profit and risk aspects of foreign investments. Therefore, to evaluate properly the effectiveness and appropriateness of the tax incentive policy, the two aspects should be examined. For the evaluation, a numerical example of a typical manufacturing investment project was used.

The analysis revealed that at very low tax rates, the P(NPV>0) is not sensitive, implying that unnecessarily low tax rates are not needed to induce investment. However, the P(NPV>0) is very sensitive at higher tax rates. Thus, a very small amount of tax increase above the current 28% maximum corporate tax rate can significantly deteriorate corporate profit and risk.

In addition, at low average tax rates, both the E(NPV) and P(NPV>0) are not sensitive to the accelerated depreciation method, implying that an accelerated depreciation (the sum of year's digit method) is not needed to induce foreign investment. An accelerated depreciation does not appear to be a good additional investment incentive to those multi-national firms which get maximum tax incentives. However, to those domestic companies that pay the maximum 28% corporate tax on their profits an accelerated depreciation method can significantly improve both the profit and risk aspects of these firms. It also implies that if accelerated depreciation is allowed, a small amount of additional tax can be assessed above the 28% rate without adversely affecting the overall companies' profit and risk.

Other variables such as the duration of a project can also affect the profit and risk aspects of an investment. Therefore, it is possible that the results derived can be somewhat different depending on the size of other variables. However, it should be noted that it is always possible to conduct a sensitivity analysis based on the mathematical models of the first two moments. Furthermore, the sensitivity analysis is very useful not only for the evaluation of the appropriateness of a change in the government's investment incentive policy, but also for the company's accept/reject decision of a project.

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**TABLE 1**

**Optimistic, Most Likely, and Pessimistic Estimates of Cash Flow Components**

**(000's)**

| Variable | Year ⇒ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Optimistic | 5,000 | 7,000 | 10,000 | 12,500 | 12,500 | 10,000 | 7,000 | 7,000 | 5,000 | 2,500 |
| $X_1$ | Most likely | 4,165 | 5,831 | 8,330 | 10,413 | 10,413 | 8,330 | 5,831 | 5,831 | 4,165 | 2,083 |
| | Pessimistic | 2,533 | 2,786 | 3,040 | 3,546 | 3,546 | 3,293 | 2,786 | 2,533 | 1,520 | 760 |
| $X_2$ | Optimistic | 1,000 | 3,000 | 5,000 | 7,500 | 10,000 | 10,000 | 7,500 | 7,500 | 5,000 | 2,500 |
| | Most likely | 835 | 2,499 | 4,165 | 6,248 | 8,330 | 8,330 | 6,248 | 6,248 | 4,165 | 2,083 |
| | Pessimistic | 507 | 507 | 760 | 1,013 | 1,267 | 1,267 | 1,013 | 507 | 507 | 253 |
| $X_3$ | Optimistic | 120 | 200 | 200 | 400 | 450 | 400 | 290 | 290 | 200 | 100 |
| | Most likely | 100 | 167 | 250 | 333 | 375 | 333 | 242 | 242 | 167 | 83 |
| | Pessimistic | 61 | 66 | 76 | 91 | 96 | 91 | 76 | 61 | 41 | 20 |
| $X_4$ | Optimistic | 1,075 | 1,582 | 2,370 | 3,025 | 3,088 | 2,420 | 1,659 | 1,659 | 1,130 | 538 |
| | Most likely | 895 | 1,318 | 1,974 | 2,572 | 2,572 | 2,016 | 1,382 | 1,382 | 942 | 448 |
| | Pessimistic | 545 | 599 | 654 | 762 | 763 | 708 | 599 | 545 | 327 | 164 |
| $X_5$ | Optimistic | 215 | 678 | 1,185 | 1,815 | 2,470 | 2,420 | 1,778 | 1,778 | 1,130 | 537 |
| | Most likely | 180 | 565 | 987 | 1,543 | 2,058 | 2,016 | 1,481 | 1,481 | 941 | 448 |
| | Pessimistic | 109 | 109 | 163 | 218 | 272 | 272 | 218 | 109 | 109 | 54 |
| $X_6$ | Optimistic | 2,150 | 3,080 | 4,500 | 5,625 | 5,750 | 4,500 | 3,150 | 3,150 | 2,200 | 1,075 |
| | Most likely | 1,791 | 2,566 | 3,749 | 4,686 | 4,790 | 3,749 | 2,624 | 2,624 | 1,833 | 896 |
| | Pessimistic | 1,089 | 1,198 | 1,307 | 1,524 | 1,525 | 1,416 | 1,198 | 1,098 | 654 | 327 |
| $X_7$ | Optimistic | 430 | 1,320 | 2,250 | 3,375 | 4,600 | 4,500 | 3,375 | 3,375 | 2,200 | 1,075 |
| | Most likely | 359 | 1,100 | 1,874 | 2,811 | 3,832 | 3,748 | 2,812 | 2,812 | 1,832 | 895 |
| | Pessimistic | 218 | 218 | 327 | 436 | 545 | 545 | 436 | 218 | 218 | 109 |
| $X_8$ | Optimistic | 288 | 480 | 500 | 500 | 500 | 480 | 500 | 500 | 240 | 120 |
| | Most likely | 240 | 400 | 450 | 500 | 450 | 400 | 500 | 500 | 200 | 100 |
| | Pessimistic | 146 | 158 | 137 | 164 | 116 | 109 | 182 | 146 | 80 | 80 |
| $X_9$ | Optimistic | 410 | 613 | 868 | 1,122 | 1,249 | 1,122 | 842 | 842 | 613 | 359 |
| | Most likely | 350 | 513 | 717 | 921 | 1,023 | 921 | 697 | 697 | 513 | 309 |
| | Pessimistic | 185 | 192 | 205 | 225 | 232 | 225 | 205 | 185 | 158 | 132 |
| $X_{10}$ | Optimistic | 780 | 1,000 | 1,275 | 1,550 | 1,688 | 1,550 | 1,247 | 1,247 | 1,000 | 725 |
| | Most likely | 750 | 950 | 1,200 | 1,450 | 1,575 | 1,450 | 1,175 | 1,175 | 950 | 700 |
| | Pessimistic | 530 | 537 | 550 | 570 | 577 | 570 | 550 | 530 | 503 | 477 |

Key: optimistic (most likely, pessimistic) = optimistic (most likely, pessimistic) estimate, $X_1$ = new car market sales, $X_2$ = used car market sales, $X_3$ = royalties, $X_4$ = labor costs of $X_1$, $X_5$ = labor cost of $X_2$, $X_6$ = material cost of $X_1$, $X_7$ material cost of $X_2$, $X_8$ = advertising and sales promotion, $X_9$ = other selling and delivery expenses, and $X_{10}$ = general and administrative expenses.

## TABLE 2
## Expected Values and Standard Deviations of Cash Flow Components
**(000's)**

| Year ⇒ Variabl | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| $E(X_1)$ | 4,032 | 5,518 | 7,727 | 9,616 | 9,616 | 7,769 | 5,518 | 5,476 | 3,863 | 1,932 |
| $\sigma_1$ | 411 | 702 | 1,160 | 1,492 | 1,492 | 1,118 | 702 | 745 | 580 | 290 |
| $E(X_2)$ | 808 | 2,251 | 3,737 | 5,584 | 7,431 | 7,431 | 5,584 | 5,500 | 3,695 | 1,848 |
| $\sigma_2$ | 82 | 416 | 707 | 1,081 | 1,456 | 1,456 | 1,081 | 1,166 | 749 | 375 |
| $E(X_3)$ | 97 | 156 | 229 | 304 | 340 | 304 | 222 | 220 | 151 | 75 |
| $\sigma_3$ | 10 | 22 | 37 | 52 | 59 | 52 | 36 | 38 | 27 | 13 |
| $E(X_4)$ | 867 | 1,242 | 1,820 | 2,346 | 2,357 | 1,865 | 1,298 | 1,289 | 871 | 416 |
| $\sigma_4$ | 88 | 164 | 286 | 377 | 388 | 285 | 177 | 186 | 134 | 62 |
| $E(X_5)$ | 174 | 508 | 883 | 1,368 | 1,829 | 1,793 | 1,320 | 1,302 | 834 | 397 |
| $\sigma_5$ | 18 | 95 | 170 | 266 | 366 | 358 | 260 | 278 | 170 | 81 |
| $E(X_6)$ | 1,734 | 2,424 | 3,467 | 4,316 | 4,406 | 3,485 | 2,474 | 2,456 | 1,698 | 831 |
| $\sigma_6$ | 177 | 314 | 532 | 684 | 704 | 514 | 325 | 344 | 258 | 125 |
| $E(X_7)$ | 347 | 990 | 1,579 | 2,509 | 3,412 | 3,340 | 2,510 | 2,474 | 1,624 | 794 |
| $\sigma_7$ | 35 | 184 | 321 | 490 | 676 | 659 | 490 | 526 | 330 | 161 |
| $E(X_8)$ | 232 | 373 | 406 | 444 | 403 | 365 | 447 | 441 | 18 | 100 |
| $\sigma_8$ | 24 | 54 | 61 | 56 | 64 | 62 | 53 | 59 | 27 | 7 |
| $E(X_9)$ | 333 | 476 | 657 | 839 | 929 | 839 | 639 | 636 | 471 | 288 |
| $\sigma_9$ | 38 | 70 | 111 | 150 | 170 | 150 | 106 | 110 | 76 | 38 |
| $E(X_{10})$ | 718 | 890 | 1,104 | 1,320 | 1,428 | 1,320 | 1,083 | 1,080 | 88 | 667 |
| $\sigma_{10}$ | 42 | 77 | 121 | 163 | 185 | 163 | 116 | 120 | 83 | 41 |

Key: $E(X_i)$ = expected value of the ith cash flow component, $X_1$ = new car market sales, $X_2$ = used car market sales, $X_3$ = royalties, $X_4$ = labor costs of $X_1$, $X_5$ = labor cost of $X_2$, $X_6$ = material cost of $X_1$, $X_7$ = material cost of $X_2$, $X_8$ = advertising and sales promotion, $X_9$ = other selling and delivery expenses, and $X_{10}$ = general and administrative expenses.

## TABLE 3
Correlation Coefficient Matrix for Component Cash Flow

| | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | $X_9$ | $X_{10}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| $X_1$ | 1.00 | | | | | | | | | |
| $X_2$ | .60 | 1.00 | | | | | | | | |
| $X_3$ | .40 | .30 | 1.00 | | | | | | | |
| $X_4$ | .94 | .20 | .10 | 1.00 | | | | | | |
| $X_5$ | .20 | .94 | .10 | .20 | 1.00 | | | | | |
| $X_6$ | .98 | .30 | .20 | .95 | .10 | 1.00 | | | | |
| $X_7$ | .30 | .98 | .20 | .10 | .95 | .20 | 1.00 | | | |
| $X_8$ | .50 | .70 | .30 | .20 | .30 | .20 | .30 | 1.00 | | |
| $X_9$ | .40 | .50 | .05 | .10 | .12 | .10 | .12 | .05 | 1.00 | |
| $X_{10}$ | .20 | .20 | .10 | .10 | .10 | .10 | .10 | .05 | .05 | 1.00 |
| | | | | | | | | | | |

$X_1$ = new car market sales, $X_2$ = used car market sales, $X_3$ = royalties, $X_4$ = labor costs of $X_1$, $X_5$ = labor cost of $X_2$, $X_6$ = material cost of $X_1$, $X_7$ = material cost of $X_2$, $X_8$ = advertising and sales promotion, $X_9$ = other selling and delivery expenses, and $X_{10}$ = general and administrative expenses.

# Table 4

## Periodic Cash Flow, Expected NPV, Standard Deviation, and P(NPV>0) Under Different Tax Rates and Depreciation Methods

## (000's)

| Tax Rates | Depreciation | | Yearly Expected Cash Flows & Standard Deviations 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | E(NPV) $\sigma_{NPV}$ | P(NPV>0) (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0% | SL | $E(C_t)$ | 532 | 1022 | 1660 | 2364 | 2626 | 2498 | 1554 | 1518 | 1142 | 362 | 4074 | 66.56% |
| | | $\sigma_t$ | 171 | 422 | 706 | 1021 | 1150 | 1009 | 681 | 735 | 550 | 290 | 2356 | |
| | SYD | $E(C_t)$ | 532 | 1022 | 1660 | 2364 | 2626 | 2498 | 1554 | 1518 | 1142 | 362 | 4074 | 66.56% |
| | | $\sigma_t$ | 171 | 422 | 706 | 1021 | 1150 | 1009 | 681 | 735 | 550 | 290 | 2356 | |
| 5% | SL | $E(C_t)$ | 528 | 994 | 1600 | 2268 | 2517 | 2395 | 1499 | 1465 | 1107 | 367 | 3772 | 64.80% |
| | | $\sigma_t$ | 162 | 401 | 671 | 970 | 1093 | 959 | 647 | 698 | 522 | 276 | 2238 | |
| | SYD | $E(C_t)$ | 546 | 1008 | 1610 | 2274 | 2519 | 2393 | 1493 | 1455 | 1093 | 3482 | 3794 | 65.19% |
| | | $\sigma_t$ | 162 | 401 | 671 | 970 | 1093 | 959 | 647 | 698 | 522 | 76 | 2238 | |
| 10% | SL | $E(C_t)$ | 524 | 965 | 1539 | 2172 | 2408 | 2293 | 1445 | 1411 | 1073 | 371 | 3471 | 62.68% |
| | | $\sigma_t$ | 154 | 380 | 636 | 919 | 1035 | 908 | 613 | 661 | 495 | 261 | 2120 | |
| | SYD | $E(C_t)$ | 560 | 994 | 1560 | 2185 | 2413 | 2889 | 1432 | 1391 | 1044 | 3342 | 3513 | 63.57% |
| | | $\sigma_t$ | 154 | 380 | 636 | 919 | 1035 | 908 | 613 | 661 | 495 | 61 | 2120 | |
| 15% | SL | $E(C_t)$ | 520 | 937 | 1479 | 2077 | 2300 | 2191 | 1389 | 1358 | 1038 | 375 | 3169 | 60.07% |
| | | $\sigma_t$ | 145 | 359 | 600 | 868 | 978 | 858 | 579 | 624 | 467 | 247 | 2003 | |
| | SYD | $E(C_t)$ | 575 | 980 | 1509 | 2095 | 2306 | 2184 | 1370 | 1327 | 995 | 320 | 3233 | 61.62% |
| | | $\sigma_t$ | 145 | 359 | 600 | 868 | 978 | 858 | 579 | 624 | 467 | 247 | 2003 | |
| 20% | SL | $E(C_t)$ | 515 | 908 | 1418 | 1981 | 2191 | 2088 | 1333 | 1305 | 1003 | 380 | 2868 | 56.80% |
| | | $\sigma_t$ | 137 | 337 | 565 | 817 | 920 | 807 | 545 | 588 | 440 | 232 | 1885 | |
| | SYD | $E(C_t)$ | 589 | 965 | 1459 | 2006 | 2199 | 2080 | 1309 | 1264 | 964 | 3062 | 2952 | 59.24% |
| | | $\sigma_t$ | 137 | 337 | 565 | 817 | 920 | 807 | 545 | 588 | 440 | 32 | 1885 | |
| 25% | SL | $E(C_t)$ | 511 | 879 | 1358 | 1885 | 2082 | 1986 | 1278 | 1251 | 969 | 384 | 2566 | 52.58% |
| | | $\sigma_t$ | 128 | 316 | 530 | 766 | 863 | 757 | 511 | 551 | 412 | 218 | 1767 | |
| | SYD | $E(C_t)$ | 603 | 951 | 1409 | 1916 | 2092 | 1976 | 1248 | 1200 | 897 | 2922 | 2672 | 56.26% |
| | | $\sigma_t$ | 128 | 316 | 530 | 766 | 863 | 757 | 511 | 551 | 412 | 18 | 1767 | |
| 30% | SL | $E(C_t)$ | 507 | 851 | 1297 | 1790 | 1973 | 1883 | 1223 | 1198 | 934 | 389 | 2265 | 46.96% |
| | | $\sigma_t$ | 120 | 295 | 494 | 715 | 805 | 707 | 477 | 514 | 385 | 203 | 1649 | |
| | SYD | $E(C_t)$ | 618 | 937 | 1358 | 1827 | 1985 | 1871 | 1186 | 1136 | 848 | 2782 | 2391 | 52.44% |
| | | $\sigma_t$ | 120 | 295 | 494 | 715 | 805 | 707 | 477 | 514 | 385 | 03 | 1649 | |
| 35% | SL | $E(C_t)$ | 503 | 822 | 1237 | 1694 | 1864 | 1781 | 1168 | 1144 | 900 | 393 | 1963 | 39.14% |
| | | $\sigma_t$ | 111 | 274 | 459 | 664 | 748 | 656 | 443 | 477 | 357 | 189 | 1531 | |
| | SYD | $E(C_t)$ | 632 | 922 | 1308 | 1737 | 1879 | 1767 | 1125 | 1073 | 799 | 264 | 2111 | 47.38% |
| | | $\sigma_t$ | 111 | 274 | 459 | 664 | 748 | 656 | 443 | 477 | 357 | 189 | 1531 | |
| 40% | SL | $E(C_t)$ | 499 | 794 | 1176 | 1598 | 1756 | 1679 | 1113 | 1091 | 865 | 397 | 1661 | 27.60% |
| | | $\sigma_t$ | 103 | 253 | 424 | 613 | 690 | 606 | 409 | 441 | 330 | 174 | 1414 | |
| | SYD | $E(C_t)$ | 646 | 908 | 1258 | 1647 | 1772 | 1662 | 1064 | 1009 | 750 | 2501 | 1831 | 40.37% |
| | | $\sigma_t$ | 103 | 253 | 424 | 613 | 690 | 606 | 409 | 441 | 330 | 74 | 1414 | |
| 45% | SL | $E(C_t)$ | 495 | 765 | 1116 | 1503 | 1647 | 1576 | 1057 | 1037 | 830 | 402 | 1360 | 9.19% |
| | | $\sigma_t$ | 94 | 232 | 388 | 562 | 633 | 555 | 375 | 404 | 302 | 160 | 1296 | |
| | SYD | $E(C_t)$ | 661 | 894 | 1208 | 1558 | 1665 | 1558 | 1002 | 945 | 702 | 2361 | 1550 | 30.13% |
| | | $\sigma_t$ | 94 | 232 | 388 | 562 | 633 | 555 | 375 | 404 | 302 | 60 | 1296 | |

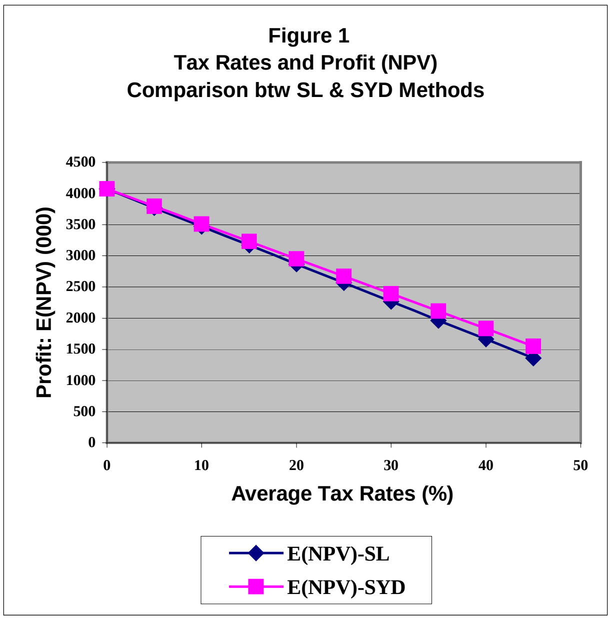
Figure 1
Tax Rates and Profit (NPV)
Comparison btw SL & SYD Methods
Profit: E(NPV) (000)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
10
20
30
40
50
Average Tax Rates (%)
E(NPV)-SL
E(NPV)-SYD

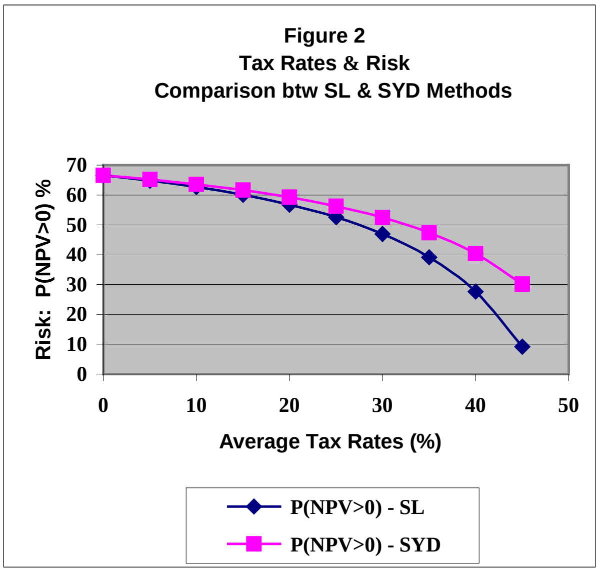
Figure 2
Tax Rates & Risk
Comparison btw SL & SYD Methods
Risk: P(NPV>0) %
70
60
50
40
30
20
10
0
0
10
20
30
40
50
Average Tax Rates (%)
P(NPV>0) - SL
P(NPV>0) - SYD