Discussion of "Win-Win Concession Period Determination Methodology" by Xueqing Zhang

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There are inconsistencies in Eqs. (5), (6), and (8) in the author's original paper, and revisions are suggested to Eqs. (6) and (8) to rectify the inconsistencies.

The discount rates in Eqs. (5) and (6) in the paper are not consistent. Eq. (5) was the formula for calculation of the net present value of the total project construction cost, and it was expressed by the author as

$$\text{NPV}_c = \sum_{i=1}^{T_c} \frac{C_i}{(1+R)^{i-1}}$$

where NPV_c = net present value of the total project construction cost; C_i = project construction cost in year i; R = discount rate; and T_c = project's construction completion time. The discount factor for cash flow in year i is $1/(1+R_a)^{i-1}$, which means that the reference year for discounting is the starting year of project construction.

Eq. (6) was the formula for calculation of the net revenues in the operation period, and it was expressed by the author as

$$\text{NPV}_o = \sum_{j=T_c+1}^{T_c+T_o} \frac{\text{NCF}_j}{(1+R)^j} = \sum_{j=T_c+1}^{T_c+T_o} \frac{Q_j P_j - OM_j}{(1+R)^j}$$

where NCF_j = net cash flow (NCF) in operation year j; NPV_o = net present value of NCFs; T_o = project franchise operation period; Q_j = service/product demanded in year j during the operation period; P_j = price of a unit of service/product in year j during the operation period; and OM_j = operation and maintenance cost in year j during operation.

Because the reference year for discounting in Eq. (5) is the starting year of construction of the project, in order to be consistent with Eq. (5) on the reference year for discounting, Eq. (6) in the paper should be modified as

$$\text{NPV}_o = \sum_{j=T_c+1}^{T_c+T_o} \frac{\text{NCF}_j}{(1+R)^{j-1}} = \sum_{j=T_c+1}^{T_c+T_o} \frac{Q_j P_j - OM_j}{(1+R)^{j-1}} \qquad (1)$$

The discount rates in Eq. (8) in the paper are also inconsistent. Eq. (8) was developed on the principle that the franchise operation period should be long enough to enable the concessionaire to recoup his investment and earn a reasonable return over the period. The concession period is the sum of the project construction period plus its franchise operation period. Eq. (8) in the paper was

$$\sum_{j=T_c+1}^{T_c+T_o} \frac{Q_j P_j - OM_j}{(1+R_a)^j} = \sum_{i=1}^{T_c} \frac{C_i}{(1+R_a)^{i-1}}$$

where T_o = minimum length of the project franchise operation period acceptable by the concessionaire; P_j is less than the maximum public affordable price for protecting the public interest; and R_a = internal rate of return (IRR) on equity agreed by the host government and the concessionaire.

The discount factor for cash flow in year i is $1/(1+R_a)^{i-1}$; again, this indicates that the reference year for discounting is the starting year of construction of the project. In order to be consistent with the reference year for discounting, the discount factor for cash flow in year j during the operation period thus should be $1/(1+R_a)^{j-1}$, rather than $1/(1+R_a)^j$. Hence, Eq. (8) in the paper should be modified as

$$\sum_{j=T_c+1}^{T_c+T_o} \frac{Q_j P_j - OM_j}{(1+R_a)^{j-1}} = \sum_{i=1}^{T_c} \frac{C_i}{(1+R_a)^{i-1}} \qquad (2)$$

To summarize, in order to be consistent with the reference year for discounting, Eqs. (6) and (8) in the paper must be modified.

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The writer sincerely thanks the discussers for their comments. The discussers argue that there are inconsistencies in Eqs. (5), (6), and (8) in the paper and suggest revisions to Eqs. (6) and (8) to rectify the inconsistencies. Regarding the argument and suggestion, the writer would like to make the following clarifications.

The issue arises from the recognition of the cash flows of a concession project in terms of when revenues are actually received or expenses are paid out. There are two different accounting systems: accrual basis accounting and cash basis accounting. The former reports revenues when earned and expenses when incurred in contrast to the latter, which reports revenues when received and expenses when paid. Specifically, in accrual basis accounting, a revenue is reported in the fiscal period it is earned regardless of when it is received, and an expense is deducted in the fiscal period it is incurred whether it is paid or not. On the other hand, cash basis accounting recognizes revenues and expenses at the time physical cash is actually received or paid out.

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It is a common practice in the current account system that the balance sheet is based on accrual basis accounting, whereas the statement of cash flow is based on cash basis accounting. In the paper, cash basis accounting is applied to recognize the cash flows of a concession project. The real situation is that a number of revenues are received and expenses paid at different times in each year of the concession period. For simplicity, in this paper, revenues (or net revenues) are assumed to be received at the end of each year, whereas pure expenses are assumed to be paid out at the beginning of each year. To be specific, in Eqs. (5), (6), and (8), the project construction cost, C_i, is assumed to occur at the beginning of each year of the construction period, T_c, and the net cash flow (or net revenue), NCF_j, to occur at the end of each year of the operation period, T_o. Under this assumption, there are no inconsistencies in Eqs. (5), (6), and (8). Nonetheless, the writer would like to acknowledge that this assumption should have been clearly stated in the paper to avoid misunderstanding.

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The discussers point out an incorrect explanation for Eq. (2) in the work by Chiang et al. An inconsistency exists between Eq. (2) in the discussed paper and the logical procedure for calculation of the marginal return on invested capital (MRIC) presented in Kennedy and Plath (1994). A revision of Eq. (2) to rectify the inconsistency is suggested. The MRIC method proposed in Kennedy and Plath (1994) is more reliable than the method proposed by Chiang et al. when compared side-by-side with a revised equation.

Incorrect Explanation

The formula for calculation of the internal rate of return (IRR) was expressed by Chiang et al. as

$$\text{NPV}(X) = \sum_i a_i(1+k)^{-i} = 0 \qquad \text{where } i = 0, 1, 2, \ldots, n$$

and a_i = the net cash flow expected at time t_i; k = IRR; and $(1+k)^{-i}$ = discount factor. a_i can be either positive or negative. When more than one sign change exists in a profile of cash flows, multiple IRRs may emerge. The authors thus introduced the MRIC method presented in Kennedy and Plath (1994) to address this problem.

The MRIC method is simplified in two steps. The first step is to calculate MRIC. The final step is to compare MRIC and the marginal cost of capital (MCC). According to Kennedy and Plath (1994), the calculating procedure for MRIC is logically broken down into its components as follows:

- Separating the periodic cash flow of the project into negative and positive cash flows;
- Identifying the project's horizon period;
- Converting the negative cash flows to capital funds required by the project and discounting all capital funds to the origin at $t = 0$;
- Compounding all positive cash flows to the terminus at $t = n$; and
- Determining the rate of return (MRIC) that equates the discounted and totaled capital flows at the origin with the compounded and totaled positive cash flows at the terminus.

The equation for calculating MRIC proposed by the discussed paper is

$$(1+m)^n \sum_t - a_t(1+k)^{-t} = \sum_t b_t(1+r)^{n-t}$$
$$\text{where } t = 0, \ldots, n$$

where m = MRIC. The authors treated negative net cash flow of a project in period t as a_t and positive net cash flow in period t as b_t; r = compounded rate that compounds all positive cash flows to the terminus at horizon period n; and k = discounted rate to discount all negative cash flows a_t to the origin at $t = 0$. Chiang et al. stated that k and r are identical because they are the interest rate to the investor and borrower, or the cost of capital.

Chiang et al. stated that capital funds required by the project in period t is equal to a_t. In fact, the capital fund required by the project in period t in their MRIC method should be $-a_t$ instead of a_t because a_t in Eq. (2) of the original paper is negative.

Modifying the Equation

Eq. (2) in the discussed paper is not in conformity with the logical procedure for calculating MRIC because the negative cash flows should first be converted to capital funds required by the project before the capital funds can be discounted to the origin at $t = 0$. According to the previous logical procedure for calculation of MRIC presented in Kennedy and Plath (1994), Eq. (2) of the discussed paper should be revised to the following:

$$(1+m)^n \sum_t |a_t|(1+k)^{-t} = (1+m)^n \sum_t (-a_t)(1+k)^{-t}$$
$$= \sum_t b_t(1+r)^{n-t} \qquad (1)$$

The value of m derived from this revised Eq. (1) is the same as that derived from the authors' Eq. (2). Eq. (1) follows the logical procedure for calculating MRIC proposed by Kennedy and Plath (1994), but Eq. (2) of the discussed paper did not.

To make this discussion more useful, the discussers add more details and explanations on the calculation of MRIC as postulated by Kennedy and Plath (1994), explicitly compare side-by-side revised Eq. (1) with that of Kennedy and Plath, and show that the MRIC derived from the method of Kennedy and Plath might be lower than MRIC derived from the revised Eq. (1).

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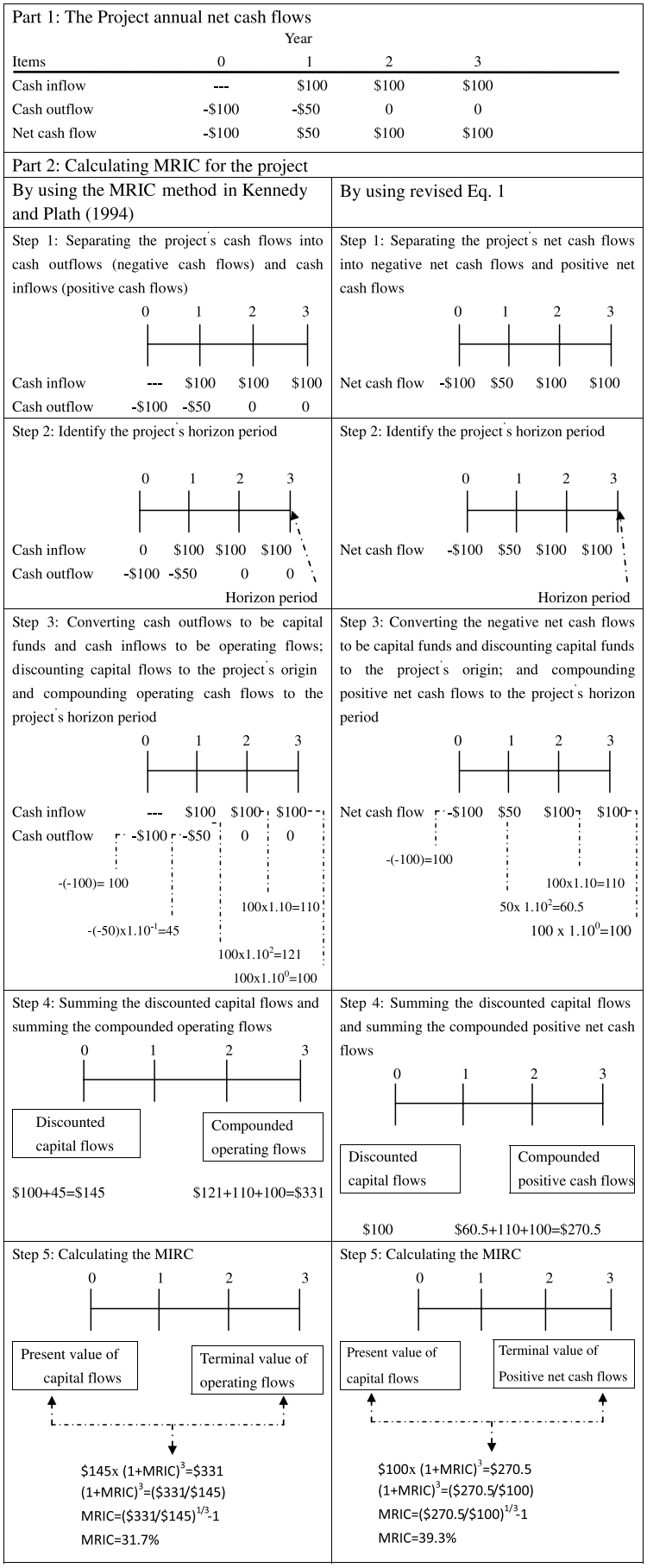

Fig. 1. Calculating and comparing the MRIC for a project (adapted from Kennedy and Plath 1994)

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MRIC Method in Kennedy and Plath

The MRIC method postulated by Kennedy and Plath (1994) is

$$(1 + \text{MRIC})^n \sum_{t=0}^{n} \text{CCF}_t (1 + k)^{-t} = \sum_{t=0}^{n} \text{OCF}_t (1 + k)^{n-t}$$

where CCF_t = capital cash flow required by the project in period t. Capital funds represent the amount of new capital external to the project that the organizational sponsor must contribute to finance the project. OCF_t is the operating cash flow generated by the project in period t. Operating funds represent excess cash flow generated by the project that is available for investment in other projects maintained by the sponsor. CCF_t is governed by the cash outflow in period t, and OCF_t is governed by the cash inflow in period t when cash inflow and outflow data are available (Kennedy and Plath 1994). k is the cost of capital used to (1) discount capital funds to the project's initial period (i.e., $t = 0$); and (2) compound operating cash flows forward to the horizon date specified by the analyst (i.e., $t = n$). Again, n is the analyst's horizon period.

Comparing the Revised Equation with the MRIC Method

The MRIC in the revised Eq. (1) is derived from net cash flow data, whereas the MRIC in Kennedy and Plath might be derived from cash inflows and cash outflows data (Kennedy and Plath 1994). The example projects in Chiang et al. are short of cash inflow and cash outflow data. Therefore, the example project presented in Kennedy and Plath (1994) is adopted in this paper (see Part 1 in Fig.) to show the different MRIC that might be derived from revised Eq. (1) and Kennedy and Plath's equation.

By using data in Part 1 in Fig. , Part 2 in Fig. shows that the MRIC of 31.7% derived from the method of Kennedy and Plath (1994) is lower than the MRIC of 39.3% derived from the method of revised Eq. (1). This is because revised Eq. (1) treats only the negative net cash flow as capital funds, but the method in Kennedy and Plath (1994) treats all cash outflows as capital funds. Hence, the capital funds required in the method of Kennedy and Plath (1994) are greater than that required in the method of revised Eq. (1), although the project remains the same. A greater amount of capital funds usually entails more capital costs, resulting in a lower rate of return, and thus a lower MRIC in the method of Kennedy and Plath (1994). Cash outflow can hardly be avoided, so the additional capital cost has to be paid. Therefore, the MRIC derived from cash inflow and cash outflow data is more reliable than the MRIC derived purely from net cash flow data.

As mentioned previously, the value of m derived from the revised Eq. (1) is the same as that derived from Eq. (2) of Chiang et al. Therefore, the MRIC method proposed in Kennedy and Plath (1994) is more reliable than that in Chiang et al.

To summarize, Eq. (2) from the discussed paper and one of its explanation notes have to be modified. Most importantly, the MRIC method proposed in Kennedy and Plath (1994) is shown to be more reliable than the method of Chiang et al.

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The writers would like to thank the discussers, Professors Wu, Chau, and Shen, for their interest in commenting on their paper. They have the following two critiques pertaining to the writers' paper:

1. Eq. (2) in the original paper is incorrect because of the use of positive values of a_t. The discussers stated, "In fact, the capital fund required by the project in period t in their MRIC method should be $-a_t$ instead of a_t, because a_t in Eq. (2) of the original paper is negative."
2. The writers' equation used "net" cash flow data (i.e., net cash inflows or outflows at each period before compounding and discounting them, respectively), thus violating the logical procedure from Kennedy and Plath (1994). The discussers made two additional statements: (1) "The authors treated negative net cash flow of a project in period t as a_t and positive net cash flow in period t as b_t"; (2) "Eq. (2) in the discussed paper is not in conformity with the logical procedure for calculating MRIC, because the negative cash flows should first be converted to capital funds required by the project before the capital funds can be discounted to the origin at $t = 0$."

The writers are afraid that both critiques are incorrect. The writers offer their responses in the following.

First, the writers actually used the negative value of a_t. Putting a negative sign for a_t in their equation would cancel out the effect of the negative value of a_t. Referring to the cash flow pattern $\{-1, 6, -11, 6\}$ of their example for their equation (see Hazen 2003, p. 40), the "−1" and "−11" were cash outflows. In this example, the cash outflow of "−11" was discounted to the origin at $t = 2$ and $r = 10\%$. When substituting them in their Eq. (2), $\sum_t - a_t(1 + k)^{-t} = -[-1 - 11(1.1)^{-2}] = 1 + 11(1.1)^{-2}$. Therefore, the use of $-a_t$ is correct in their equation, conforming to the equation proposed by Kennedy and Plath (1994). However, the use of an absolute value of a_t can also get the same result: $\sum_t |a_t|(1 + k)^{-t} = 1 + 11(1.1)^{-2}$.

Second, the writers did not use "net" cash flow data in their equation before compounding and discounting cash inflows and outflows respectively. Their equation indicates that "$a_t =$ the capital funds required by the project in period t; $b_t =$

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the operating cash flows generated by the project in period t" (p. 812). The writers also mentioned that "the second steps are to discount all negative cash flows (i.e., capital funding) to the origin at $t = 0$ and to compound all positive cash flows (i.e., operating cash flows) to the terminus at $t = n$" (p. 812). The writers have not incorporated the "net" concept in their equation. Therefore, their equation is neither similar nor identical to Eq. (2) (revised) and does not violate the equation proposed by Kennedy and Plath (1994). As the writers used a simple example without cash inflow and outflow at the same period, the discussers have made an incorrect interpretation of the explanation note for the writers' equation. In the discussers' Fig. 1, the steps in the left-hand column are consistent with the writers' equation.

With these points, the following conclusions can be drawn:

1. In the writers' equation, the value of a_t (i.e., cash outflow) is negative. The use of "$-a_t$" in their equation would cancel out the effect of the negative value of a_t. Moreover, both $|a_t|$ and $-a_t$ are appropriate for use in their equation.
2. The writers did not use "net" cash flow data (i.e., combined cash inflows and outflows for each period) before the step for compounding and discounting.

The preceding rejoinders indicate that the writers have conformed to the equation proposed by Kennedy and Plath (1994). Despite the discussers' misinterpretation of the writers' equation, the writers do thank them for providing an opportunity to clarify the equation. Also, the writers thank the discussers for their use of a more complicated example to demonstrate the MRIC method, especially for those who may have the same misinterpretation of this equation.

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