Discussion of "Optimal Capital Structure Model for BOT Power Projects in Turkey" by Sandalkhan Bakatjan, Metin Arikan, and Robert L. K. Tiong

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In their paper, the authors introduced a simplified model using the combination of a financial model and linear programming (LP) to find the target ratio in capital structure that maximizes the return of the equity holder's investment. Previous authors like Kim (1978), Dias and Ioannou (1995), and Pollio (1999) have also dealt with the optimal capital structure using probabilistic approach. The subject is of the greatest interest to the discusser as the discusser is currently working on the issue of private sector participation in infrastructure for a PhD thesis at the Technical University of Berlin. This paper provides valuable information for the discusser's work.

Need of Linear Programming Model

Let's begin with the LP model developed by the authors. Provided that underlying assumptions are valid, the discusser is of the view that LP is not necessary at all to solve the problem. If the model involved only one variable in both objective and constraint functions—namely, equity level—it is trivial to find the optimal solution by just transforming the model into a simpler one as follows:

Min E

Subject to

$E \geqslant 20$ (minimum equity constraint),

$E \leqslant 199.77$ (positive net present value [NPV] constraint),

$E \geqslant 31.69$ (debt service coverage ratio [DSCR] constraint).

However this is simply a calculation matter. There are more important issues the discusser would like to raise.

Cost of Debt

There must be a strong argument from the authors to explain why they set a constant borrowing rate at all leverage ratios. As the project borrows more, the risk of default increases, and the project is required to pay higher rates of interest (Brealey and Myers 2000). In other words, cost of debt increases as the leverage ratio increases. It is particularly true for the presented case study, as the project finance approach with nonrecourse basis is applied.

Cost of Equity

The authors use the opportunity cost of capital as the discount rate for the equityholders' cash flow at all leverage ratios, as shown in Eq. (14) in the paper. This assumption leads to the NPV constraint in Eq. (18) that the internal rate of return (IRR) must be equal to or exceed the opportunity cost of capital to result in positive NPV. It is true if the project is 100% equity financed. The fact is that the project is financed with a mixture of debt and equity and the model aims at finding the optimal capital structure. With leverage, more of the financial risk of the investment is reserved for the equityholders, who will thus require greater compensation in the form of a higher required return for having to bear it (Pollio 1999). The higher required return here is reflected by the higher cost of equity. If IRR is lower than the cost of equity for a given leverage ratio, the equityholders will be better off to invest their money elsewhere, where higher returns with a similar risk level are offered. Thus, the IRR constraint should be defined as "IRR must be equal to or exceed the cost of equity, but not the opportunity cost of capital." To value the required return for risky assets, one can use the Capital Asset Pricing Model (CAPM) or Arbitrage Pricing Theory (APT).

Financial Distress Costs

Financial distress costs must be taken into account as the side effect of leverage. Pollio (1999) stated that the present value of expected bankruptcy and agency costs are increasing functions of leverage, such that the higher the debt to equity ratio, the higher would be such costs. The reason is that the higher probability of default and the value of the lawyers' claim results from the higher promised returns to the debt holders as the project borrows more (Brealey and Myers 2000). If such costs are significant, there will be the project debt capacity that does not allow 100% debt financing as shown by Kim (1978) and Dias and Ionnaou (1995). In this paper DSCR requirements determine the project debt capacity. No information is presented about the financial distress costs. It could raise another interesting question: Is there any relationship between the high DSCR requirement and the costs in Turkey, or does this requirement merely depend on the country credit rating?

Conclusion

Based on these previous arguments, the authors seem to oversimplify the problem. Several additional assumptions and sound reasons are required to make the model more reliable.

References

Brealey, R. A., and Myers, S. C. (2000). *Principles of corporate finance*, 6th Ed, McGraw-Hill, New York.

Dias, A., Jr., and Ionnaou, P. G. (1995). "Debt capacity and optimal capital structure for privately financed infrastructure projects."*J. Constr. Eng. Manage.*, 121(4), 404–414.

Kim, E. H. (1978). "A mean variance theory of optimal capital structure and capital budgeting analysis." *J. Financ.*, 33(1), 45–63.
Pollio, G. (1999). *International project analysis and financing*, 1st Ed., University of Michigan Press, Ann Arbor, Mich.

Closure to "Optimal Capital Structure Model for BOT Power Projects in Turkey" by Sandalkhan Bakatjan, Metin Arikan, and Robert L. K. Tiong

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It is worthy to refocus on the objective of the paper in order that discussion could be carried out on common ground. The objective of this paper is to present a simplified model to determine the optimum equity level for decision makers at the evaluation stage of a build/operate/transfer (BOT) hydroelectric power plant (HEPP) project in Turkey, which takes place immediately after the completion of the feasibility study.

First of all, the financial decision of a company can be divided into two aspects:

1. the investment, or capital budgeting; and
2. the financing decision (Brealey and Myers 2003).

The paper exclusively deals with the capital budgeting decision—that is, whether the project is worthwhile to invest in (positive net present value [NPV])—and extends it into the determination of preliminary optimal equity level in order to assist decision makers to know whether the equity level is affordable. The discusser's arguments are based in a different level from our model, at the stage of financing decision—that is, structuring the capital budget. Of course, in the project finance capital structuring stage, the model should be refined and take into account more complicated financial matters. Yet, the purpose of this paper is not to deal with capital structuring but to find a simplified optimal level of equity. The points raised by the discusser are thus appropriate in a different stage of the project, which is not covered in our paper and model.

The point-by-point closure for the discussion follows.

Need of Linear Programming Model

The model was developed for general purpose. The case study included in the paper was chosen because of the completeness of the data, not because of the fit into the model. The linear programming (LP) model for this case is

Objective function: Maximize $IRR = -0.065E + 16.992$
Subject to:
$E \geq 20$
$-46.93E + 9{,}375.87 \geq 0$
$0.035E + 0.404 \geq 1.50$

Accordingly, as the discusser pointed out *in that particular case* there is not a need for LP. However, the writers believe that in other cases there will be need for the LP model to find optimal equity level.

Cost of Debt

The discusser pointed out that cost of debt increases as the leverage of the project increases, which is relevant in the financing decision stage. Moreover, it will also depend on the risk appetite of banks or financial institutions that provide loans. Yet, the model deals with the capital budgeting stage, that is, whether the project has positive NPV based on historical and average data. The companies involved in BOT projects have experiences in dealing with multimillion-dollar projects and histories of multimillion-dollar borrowings. The interviews with the financial managers of private contractors in Turkey revealed that on average, historical cost of debt provides a good predictor in capital budgeting. Moreover, this stage of a BOT project will involve a determination of the appropriate participants in project ownership. An initial question will be the degree to which state ownership is appropriate or required (Bakatjan 2000). Accordingly, exacting the cost of debt for each leverage level is impossible because the debt providers as well as equity sponsors are not yet known at this stage. In the later project finance structuring stage, the variance of cost of debt according to leverage level needs to be taken into account, but not in the capital budgeting stage.

Cost of Equity

The firm's cost of capital is not affected by its capital structure. Even if debt is cheaper than equity, increasing the proportion of debt increases the risk and the cost of equity so that the overall cost of capital remains unchanged. Tham (1999) has shown that the weighted average cost of capital (WACC) is equal to the nominal return on equity in all-equity investment. From the perceptive of appropriate return to equity, the major implication is that the debt-to-equity ratio increases the risk and, therefore, appropriate return to equity also increases. In fact, as debt is repaid, financial structure changes over the life of a project, and risk and required return to equity may be expected to decrease.

The discusser mentioned using Capital Asset Pricing Model (CAPM) as a valuation method for risky assets. In CAPM, the required rate of return is equal to the risk-free rate plus a risk premium. In the model, the calculation for a single-period project is provided, and the authors believe that the model works for multiperiod projects with the same result. "Unfortunately, the elegance of the CAPM hides two serious problems: first, the CAPM is a model and we still have to come up with the numbers, and second, the CAPM is based on some assumptions that may or may not be realistic" (Booth 1998). In addition, the existing finance theories of the developed world are not working well for developing countries due to the complicated capital market structure with lack of efficiency. Hence, there is little use of CAPM for the firms in developing countries (Glen and Pinto 1994).

Financial Distress

Koh et al. (1999) stated that debt service coverage ratio (DSCR) in the range of 1.10 to 1.25 is bankable, 1.30 to 1.50 is satisfac-

tory and comfortable, and above 1.50 is preferable. Interviews with the managers of some private power companies in Turkey show that the preferred minimum average DSCR by International Financial Authorities is 1.50, due mainly to the current Country Credit Rating of the Turkey. (At the end of 1999, Turkey's foreign currency long-term sovereign credit rating was affirmed by Standard and Poors as "B" and outlook on the long-term rating has been revised to positive to stable that reflects the possibility of an upgrade.) The DSCR covers all financial distress costs. In fact, DSCR defines the cost of international borrowing in a particular country (Bakatjan 2000).

Conclusion

The model developed by the writers exclusively deals with the capital budgeting stage of the BOT project. In that early stage, the ownership structure is not yet defined. The paramount question is to determine preliminary optimal equity level, and thereby preliminary ownership structure of the project. Thus, the objective of this paper is to present a simplified model to determine the optimum equity level for decision makers at the evaluation stage of a BOT hydroelectric power plant HEPP project in Turkey, which takes place immediately after the completion of the feasibility study. The points raised by the discusser are not relevant to the capital budgeting stage of a BOT project. They are related to the project finance structuring stage. Hence, they are of most interest to financial institutions, but not contractors, who are main focus of the paper.

References

Bakatjan, S. (2000). "Financial engineering for BOT power projects: A simplified model for optimal capital structure,"MS thesis, Dept. of Civil Engineering, Middle East Technical Univ., Ankara, Turkey.

Brealey, R. A., and Myers, S. C. (2003). *Principles of corporate finance*, McGraw-Hill, New York.

Booth, L. (1998). "The capital asset pricing model: Equity risk premiums and the privately held business," Rotman School of Management, University of Toronto, Canada. ⟨http://www.mgmt.utoronto.ca/~booth/capm.pdf⟩ (Feb. 20, 2000).

Glen, J., and Pinto, B. (1994). "Debt or equity? How firms in developing countries choose." Discussion Paper Number 22, *International Finance Corporation*, Washington, D.C.

Koh, B. S., Wang, ShouQing, and Tiong, L. K. R. (1999). "Qualitative development of debt/equity model for BOT infrastructure projects." *Proc., Int. Conf. on Construction Process Re-engineering* (CPR-99), 501–512.

Tham, J. (1999). "Multiperiod financial discount rates in project appraisal," *Development Discussion Paper No. 712*, Harvard Institute for International Development, Cambridge, Mass.