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22.812   Nuclear Energy Economics and Policy Analysis (S '04)

Problem Set #3

1. Nuclear power plant construction lead-times have ranged from less than 4 years (for some units in France) to 15 years or more (for the most delayed units in the United States).

   a. Compare the 'ratebase cost' (i.e., the future worth of the project at the start of commercial operation) for two identical units which started construction in 1978, one with a lead time of 4 years and the other with a lead time of 15 years. Assume that the overnight cost in 1978 dollars was the same for both plants, and that in each case the rate of expenditure in constant dollars was constant throughout the construction period. Also, assume an interest rate of 11%/year and an escalation rate for nuclear construction of 15%/yr during the period in question. In your calculation, use the approximate expression for the future worth of the project at the date of startup that was presented in class.

   b. Repeat the problem in a. using an exact expression for the future worth. What do you conclude regarding the validity of the approximation you used in part a?

   (Note: The escalation rate characteristic of specific activities (such as construction) may be substantially different from the general inflation rate in the economy. This has been true of nuclear construction, for which regulatory impacts and other factors drove nuclear escalation rates far above the general inflation rate. During the 1970s, for example, nuclear power plant capital cost escalation averaged about 18%/year, compared with a general inflation rate of about 8%/yr.)

2. Construction work on a new coal-fired power plant began on January 1, 2002. Construction is expected to take 4 years. The construction budget (specified in constant 1996 dollars) calls for an initial rate of expenditure of $80M/yr, increasing continuously and in linear fashion to $160M/yr by the end of the construction period.

Assume an escalation rate for coal plant capital costs of 4%/year, and a cost of funds of 7%/year, continuously compounded.

Calculate:

a. The overnight cost of the plant in 2002 dollars
b. The overnight cost of the plant in year 2006 dollars
c. Total direct construction expenditures in current dollars
d. The value of the plant at the start of operation
e. The 'ratebase' cost (assuming the plant is to be built under traditional economic regulatory conditions)
f.   The time-related costs of the project

3. Suppose that the actual escalation rate for the project in Question 2 turned out to be 7%/year, and that the cost of funds was 10%/year. Suppose also that the project budget consistently underestimated actual expenditures by 10%. Find new answers for parts a. through f. in Question 2 under these conditions. Also in this case, what fraction of the project cost increase relative to the original budget estimate would you attribute to changes in the macroeconomic environment for the project (i.e., in escalation and interest rates) -- changes that presumably could not have been controlled by the construction project team?

4. In class we discussed the overnight construction costs in 1982 dollars for 75 U.S. nuclear power plants estimated by the Energy Information Administration based on the mixed current dollar construction costs reported by the plant owners.   Compare this cost range with the predicted overnight construction costs in the DOE '2010 Roadmap Study' (also discussed in class.) Note : To make this comparison you will need to make sure the overnight cost estimates are all in the same year's dollars. This will require the use of capital cost escalation rates. To make your calculation easier, you can use a general inflation index such as the CPI or the PPI or the GDP-deflator.