一般論文

Equipment Replacement Cost Analysis within the Construction Industry

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Abstract

Whithin the current construction industry, contractor equipment management practices lack structure and often are not addressed through an economic analysis and evaluation process. This paper explores two areas···cos of capital and inflation···with the intention of providing insight for a more structured and economic based approach to contractor equipment replacement practices rather than by the traditional "rule of thumb."

1. Introduction

Because there are so many factors that affect equipment replacement cost analysis, it is essential that the present day constructor keep abreast of these factors as they have the ability to greatly affect the final outcome of an equipment replacement cost analysis. Some of these factors that need to be taken into account are cost of capital[6], inflation[5], governmental regulations[4], the state of the economy[1], advancements in technology[2], downtime costs[8], equipment procurement [12], rate of return and the potential for an energy crisis.

Much of the literature which presents information on the current equipment management paratices of constructors indicates that a majority of the firms do not incorporate a formal economic analysis when attempting to determine how long a piece of equipment should remain in service before selling it or trading it for another item of equipment[11]. Another problem that surfaced in the literature is that in many cases constructors are not tracking and utilizing data in regard to their financial situation, items of equipment or the construction euqipment market in order to make sound replacement analysis and decision. These data include such items as a firm's cost of capital as well as records of performance, maintenance costs, large repair item costs and the amount of downtime over specific periods for all items of equipment. An area that is often overlooked by constructors is the construction equipment market. There are many facets of the market that need to be periodically explored so that the constructor will have an un-

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derstanding of where the market is going in terms of cost of equipment(new or used), current production characteristics and safety requirements of new equipment.

2. Equipment replacement analysis

The first area to be examine is found within the financial arena of the constructor's organization. A large part of making wise decisions in regrad to equipment replacement is knowing all the costs associated with the present equipment on hand and also the forecasted costs of new or used equipment that potentially will be a part of the company's pool of equipment in the near future. Often times, three costs that are associated with the ownership of construction euqipment are combined. They are interest, taxes and insurance. Taxes and insurance are, for the most part, easily determined, whereas interest is more complicated if determined through the correct procedures. Often times the interest used in cost analysis is nothing more than the interest rate that banks are charging for borrowed funds or the rate that funds might earn if invested elsewhere[3]. Using a cost analysis, interest rate that is derived solely from the current interest charged by a contractor's bank to secure financing or from the rate of return that the contractor can acquire from placing his money in the bank will not give the contractor a true picture of his cost of interest. The cost of interest must be developed by examining the costs associated with all capital fund sources.

Terbourgh[15] correctly identified the interest cost while at the Machinery and Allied Products Institute and devoted an entire chapter to its explanation in his writing of Dynamic Equipment Policy. In his explanation of the cost of interest he outlines the cost elements of each source of capital funds. They are debt, equity and retained earnings. Terbourgh concluded his writing by explaining that the circumstances which affect each of these elements varies to such a large degree that to develop a general solution for calculation of the cost of capital is impossible.

The problem of how a firm should evaluate its particular circustances to arrive at its cost of capital remained unsolved until two gentlemen, by the names of Modigliani and Miller [7], developed a technique in 1958. The technique is called the market value maximization technique and is based upon the fact that the cost of capital or interest rate that we are seeking reflects a balance point between each increment of financing cost utilized to purchase an asset and the value the asset will accrue for the firm by its application on the job. Another expression of this balance point interest rate is minimum rate of yield. In order to maintain the wealth of firm's capital contributors a minimum net gain in the company's value is required over each increment of financing cost. After a company has determined its proper cost of capital rate, it can use the figure to identify how any proposed decision will affect the wealth of its owners.

Any industry has a certain amount of risk that is associated with it due to the operation-

al characteristics of that industry. Based upon an industry's basic business risks, the investing public will perceive an expected annual rate of return on the funds that they have invested in the firms of that particular industry. That annual rate of return is actually an after-tax discount rate. The actual cost of capital is not the same for each firm in an industrial class as is the basic business risk discount rate. The reason for this lies with the presence of such things as corporate income taxes and deductibility of interest payments which cause the actual cost of capital to be influenced by the source of the capital funds. The next section will identify the basic formulas for computing the basic business risk class discount rate as well as weighted average cost of capital. The procedures used are those of Modigliani and Miller and are based upon a market value maximization criterion[7].

In assessing the cost of capital of a given construction firm, it must first be assumed that the primary goal of that construction company is to increase the net worth of its owners. That goal is defined, for our purposes, in terms of the common stock price and the projected future wealth expectations from dividends and capital gains from those common stocks. When using the market value maximization technique, it should be remembered that only those companies that have stock which is traded over commercial or over-the-counter exechanges can be directly investigated. Some of the sources of raw financial data needed to make the necessary calculations are the construction company's annual reports and stock exchange prices as published in the major journals.

3. Weighted cost of capital

The following procedure was demonstrated in the article "Interest Factor in Equipment Economics" by Schexnayder and Hancher[9]. Explanation of the formulas used in the calculations can be found in "The Cost of Capital" by Lewellen[6].

The first step of calculating the cost of capital is to determine the frim's projected growth rate. Based upon the firm's history of earnings per share or the dividends per share, an annual growth rate(g) can be determined using the following formula :

$$d_i = d_o(1+g)^y$$

where d_i = the dividend per share or earning per share in year i,

d_o = the dividend per share or earning per share in a selected base year,

y = the time period difference in years between d_i and d_0.

Because the objective is to define the company's long-term growth pattern, it is essential that the points d_i and d_o be selected with care. Keep in mind that these points need to represent the long-term growth pattern rather than those points resulting from a single bad year or event.

The next step is to calculate a discount rate K(K is referred to sometimes as the cost of equity) which represents the future returns to an investor. Because most firms do not pay out all their earning in dividends, the equation

to define K is made up of two components···one of which is dividends, with the other being capital gains. K is calculated by using the following equation :

$$K = d_1/P_o + g$$

where d_1 = the current year's expected dividend,

P_o = the current trading price of the stock,

g = the annual growth rate.

Both d_1 and P_o can be found in most newspapers listed under the daily transactions of the stock in question.

Next, the after-tax discount rate s_t(also known as the basic business risk class rate), is calculated. This rate is applied by the market to the expected income streams generated by firms of a paticular risk class. It has been previously determined that K is related to s_t in the following manner[9] :

$$K = s_t + (s_t - r)(1 - t_c)(D/V_s)$$

where r = the current market interest rate the firm would be charged on long-term debt,

t_c = the corporate income tax rate experienced by the firm in question,

D = the amount of long-term debt utilized by the firm, discounted to present dollars,

V_s = the sum of the current market value of the firm's issued common stock. (Shares purchased by the firm and held in the treasury should be subtracted from the total of issued shares.)

After discovery of the after-tax discount rate, the cost associated with the repective sources of capital funds needs to be calculated. In order to properly calculate the cost of retained earnings, it is necessary to have information about the income and tax circumstances of the shareholders. When evaluating a large firm with many shareholders it is more practical to use a "typical investor" scenario to approximate the shareholders situation in regard to income and tax circumstances. This typical investor situation is assumed to be t_p = 0.30 and t_g = 0.10[12]. However, in small and medium size firms, it may be possible to actually ascertain this information through a survey of the shareholders. Cost of retained earenings is defined by the following equation [14] :

$$R_R = s_t(1 - t_p)/(1 - t_g)$$

where t_p = the personal income tax rate for the owner of the firm's stock,

t_g = the relevant capital gains tax rate of the investor.

Cost of debt capital is defined by the following equation :

$$R_D = s_t(1 - t_c)$$

Cost of equity capital is defined by the following equation :

$$R_E = s_t/(1 - b)$$

where b = the percentage gap between the theoretical and actual proceeds realized from a new stock issue.

The percentage gap, b does include both the cost of sale and the price differential.

The next step in calcuating the cost of capital for a firm is to determine the weighted averages of how a firm derives its long-term

funds. Within the long term funds structure there are three percentages : retained earnings, X_R ; long term debt, X_D ; and common stock, X_E. Therefore, $X_R+X_D+X_E=1$. Figures for these calculations can be found in the firm's annual report.

The last step is to combine the respective costs associated with each type of capital funding after they have been properly weighted by the percentages found in the preceding step. From this combination a weighted average cost of capital(R_A) can be determined:

$$R_A=(X_R)(R_R)+(X_D)(R_D)+(X_E)(R_E)$$

where R_A = the cost of capital for a certain industry risk class and the firm's mix of capital funding.

Within the literature, six publicly held firms were examined that engage in contract construction. The calculated basic business risk-class rate for each of these firms varies from 0.124 to 0.236[13]. These numbers seem to be in contradiction to the basic assumption that all firms within the same type of industry should have the same s_t value. A closer examination of revenue generating activities within each of the six firms explains the differences. The company with the 0.236 s_t factor receives forty-five percent of its income from agribusiness which means that this particular company is actually involved in two industries. The market recognizes this situation and assigns an appropriate risk class. This type of situation needs to be considered when evaluating the basic business risk-class rate for a particular industry. In order to develop a alid risk-class rate for a particular industry the companies that are evaluated will need to have a large percentage of their revenue generated from the business of the industry that is being evaluated.

Even though firms within a particular industry have approximately the same risk-class rate, their cost of capital may be significantly different. This is primarily because of different capital funding structures within the different companies of the industry. Depending on the state of the economy, each of the primary sources of capital discussed earlier will have more or less of an effect on the cost of capital.

If a small to medium sized company's business is primarily construction, then one can examine the s_t of several public construction firms to determine the approximate s_t for the industry. It may seem that there should be some sort of adjustment to the s_t because it logically follows that there is a greater risk associated with the smaller firm because of its smaller size. If an adjustment is made and the s_t factors is increased to account for unknown cost factros, a bias will be created that will favor the "defender" in a replacement analysis. This will in turn cause old equipment to be retained beyond its economical replacement time. A small difference in the s_t factor because of the size of a firm will not significantly affect the results of a replacement analysis. Thus, the best practice may be to use the s_t factor as calculated from major public firms and not alter the factor because of unknown cost elements of a smaller firm.

Upon discovering the risk-class discount rate for the construction industry, a contractor can proceed to determine the cost of capital rate for his particular company based on the individual firm's capital funding structure. After a cost of capital rate has been established, there are two reasons why that rate does not have to be refigured each time a replacement analysis takes place within the firm. The first reason is that an industry's risk-class rate tends to shift slowly with the market's long range perception of that industry. The second reason is that the funding structure within a firm is based upon a long range financing strategy that stays relatively stable. It is advisable to update the cost of capital annually or when there is a major shift in the financing strategy of a firm. The cost of capital is a determinable figure for any firm and should be calculated so that it can be used in equipment replacement cost analysis.

4. Total replacement cost with inflation

One of the major concerns for a contractor when analyzing the time frame in which he will have to trade older equipment for newer equipment is inflation. Equipment economics cannot be separated from the broad overall business environment[10]. The business and industrial environments are dynamic, and it is not difficult to understand why the upper level management of a construction firm, with millions of dollars worth of equipment, needs to be aware of the environmental factors that affect the company's equipment replacement analysis strategy.

Over the many years since the early fifties, there has always been one external factor that seems to rise above the rest in equipment replacement studies. In the mid-fifties and early sixties, there were great advances in the technology of construction machinery. Machine productivity was increased greatly by such improvements as high-strength steels, nylon cord tires, and high speed, light weight, high-output diesel engines. These types of improvements made it very difficult for older, less productive machinery to compete with the newer machines on an economic basis. This problem could easily be compounded by older equipment that frequently required time consuming and costly repairs. As a result, obsolescence bcame most of a factor in the replacement analysis. During the late seventies and early eighties, the factor that became the number one concern was inflation. During this time, equipment managers came to understand and recognize the effects of inflation on replacement cost and salvage values. Those managers that did not recognize this aspect of the economy during this time were faced with one of two possible consequences. Either the necessary funds for the increased replacement cost were withdrawn from what were initially perceived to be "profits" or, if these "profits" were insufficient or had been expended arleady, the company was forced out of business when its current equipment inventory reached the end of its physical life. Inflation is a factor in the replacement analysis that can-

not be overlooked.

The increase in the price of construction equipment is made up of two elements. One element represents pure inflation without any offsetting increase in the performance of the machine. The other element represents the cost of technological improvement. It is assumed that the cost which is linked to technological improvements will be offset by an increased revenue stream as a result of a machine that is more productive. However, the analysis of inflation that follows does not attempt to separate these two elements of increaed machinery cost.

In order for a contractor to properly account for inflation in his equipment replacement cost analysis, he must make a prediction of increases in equipment prices. One example of a source that would help in making these predictions is the Bureau of Labor Statistics (BLS), U.S. Department of Labor. The BLS currently provides an index designated to indicate trends in the cost of equipment rather than the actual cost increases. Price index values are provided for all construction equipment lumped together and also for each of thirty-eight major classes.

Some contractors that have large enough spreads of equipment can determine a cost index for all of their equipment or for individual pieces of equipment from their past acquisition costs. One procedure used to determine a growth rate is the "two-point annual groth rate"[10] method. The growth rate(g) is determined using the following equation :

$$(\text{Base Value}) = (1+g)^X$$

$$= \text{Later period value}$$

where X = (Later period date) − (Base date), in years.

The selection and study of the base period, as well as careful consideration of any forecasts or changes in governmental restrictions or polices that could change the market environment, are very important in determining a growth rate that will be fairly accurate for the time period being analyzed.

After an annual growth rate has been determined, the contractor can calculate machine replacement costs in future time periods. The formula for such projections is as follows:

$$(\text{original purchase price})(1+g)^X = \text{replacement price in year n}$$

where g = annual growth rate for the class of machinery under consideration,

X = the difference in years between the purchase date and the assumed replacement date.

To properly account for the time value of money, each year's inflation price rice needs to be calculated separately. A particular period's allocated cost is the difference between the price in the next future period and the price in the period of consideration.

Replacement cost in year n

= (Price, year n+1) − (Price, year n)

A tax adjustment is necessary because the dollars to makeup the inflation portion of the purchase price of the replacement price will have to come from corporate profits.

Tax adjusted replacement cost, year n

$$= (\text{replacement cost, year n})/(1-t_c)$$

where t_c = the corporate tax rate.

The present value(PV) at time zero of the total replacement cost caused by inflation for a assumed service life of X years is,

PV total replacement cost for a service life of X years=(tax adjusted replacement cost, year n)(P/F, i, n)

where P/F=the single-payment present worth factor under the stated conditions of i and n,

i=the cost of capital as eariler described in this paper,

n=a particular year within a time frame of interest.

Owning and operating rates as well as consideration for replacement timing need to be examined and established after determining the inflation cost factor. If a construction company fails to do this and its internal rental rate accounts do not address inflation's effect on ownership cost, the company will not generate the necessary revenue to purchase replacement mechinery.

5. Conclusion

Many times contractors have to look to their profits to provide the needed cash to sustain or increase their bonding capacity. If a construction company is unable to retain the funds needed to secure a larger bonding capacity, and thus be able to contract for more work, the company will be unable to grow. The construction industry's market is very competitive and unless a constructors utilizes two of his most vital assets, people and equipment, in the most efficient and effective manner he will run the risk of zeor growth or losses within his company.

One area within the management of equipment that all constructors can benefit from is equipment replacement cost analysis. Constructors must remember that it is impossible to properly manage a construction firm without considering closely the business environment in which they must work. This business environment establishes the ground rules for determining the most economic time frames in which to replace equipment. By using methods that take into account this business enviroment as well as the unique financial structure of the construction firm, constructors will be able to make sound decisions in regard to equipment management. Many constructors still use a "rule of thumb" method of equipment replacement or perhaps do not replace equipment until the end of its physical life rather than at the end of its economic life. In doing so, they have ignored many aspects of equipment replacement cost analysis. Two of those aspects have been explored more fully in this paper.

Constructors must remember that cost of capital is not simply the interest rate that the local banks are paying for borrowed money. The cost of capital for a construction firm can only be rightfully calculated after considering cost associated with all capital fund sources. It is also important to realize that there is a risk factor associated with every industry which plays a part in establishing a cost of capital.

Inflation is another aspect of equipment re-

placement cost analysis that cannot be overlooked. If inflation is not regarded as an important factor, internal rental rates will not reflect it, and constructor will not have the needed funds to purchase new equipment in the future.

The construction marketplace is a difficult place to do business in this day and age. To be able to grow or just survive, the constructor must use his assets in the best possible manner. One of the tools that help him to do just that is equipment replacement cost analysis.

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저자소개

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