Do Farm Businesses and Big Businesses Apply Different Capital Budgeting Procedures?

Daniel A. Arthurton, L. Joe Moffitt, P. Geoffrey Allen, and Douglas A. Cox

Recent studies of capital budgeting procedures used by business executives suggest increasing use of present value methods. This study compares Massachusetts greenhouse business managers use of capital budgeting procedures to those of Fortune 1000 firms. Results indicate that different capital budgeting procedures are used and that the payback criterion remains the most popular for the farm firms studied. Some implications for Extension finance educators are drawn.

According to economic theory, firms in a deterministic environment should maximize the present value of a stream of profits. This criterion is often modified when uncertainty exists. A common practice of economists is then to adopt the von Neumann-Morgenstern paradigm and use the present value of expected utility in place of the present value of profit. However, other decision criteria have apparently played an important part in guiding the actual investment behavior of business firms. For example, the payback criterion is often referred to in the economics literature as the criterion real world managers use to evaluate investments (see e.g., Hirshleifer).

Since 1960 many studies of investment behavior have attempted by survey or other methods to identify the capital budgeting procedures that corporate business managers most often use to evaluate investments. Interest in this question currently remains high since an understanding of business investment behavior is thought to have important implications for managing the macroeconomy. Concern about the competitiveness of domestic firms in the world economy also motivates studies of investment behavior.

Previous studies of business investment behavior have found several capital budgeting procedures important in practice. However, net present value methods are apparently being used more frequently to make investment decisions than they have been in the past. For example, a recent study of Fortune 1000 companies by Kim *et al.* suggests convergence of economic theory and practice for these large firms. Their results indicate an increasing use of net present value-based methods for measuring the desirability of capital budgeting decisions. Because the discounting model is generally regarded among economic theorists as the most efficient investment decision criterion, the sophisticated investment analyses increasingly performed by these large firms may bode well for the success of their future capital budgeting decisions.

Considerable research has been done on the investment behavior of farm business managers (see e.g., LaDue *et al.*; Gustafson *et al.*). Factors affecting investment timing and decision criteria utilized by farm operators have been identified and considered vis-à-vis risk management and analysis of farm policy issues. However, very little attention has apparently been given to the relationship between farm investment criteria and the investment criteria used by large business firms. We found no study that compares and contrasts the dynamic decision rules employed by big business managers and farm operators. The question addressed in the present study is whether big business firms and farm business firms apply different capital budgeting procedures when evaluating potential investments.

This article reports the results of a study of the capital budgeting procedures used by managers in the greenhouse industry in Massachusetts and compares their behavior to Fortune 1000 firm managers. The first section describes important capital

Daniel A. Arthurton is a former research assistant, L. Joe Moffitt and P. Geoffrey Allen are Professors in the Department of Resource Economics; Douglas A. Cox is an Associate Professor in the Department of Plant and Soil Sciences, all at the University of Massachusetts, Amherst.

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budgeting procedures and some previous studies of business managers' use of these procedures. The second section presents the statistical model and hypothesis tests used in this study. Following this, the data and results are described. Conclusions are given in the final section.

Use of Different Capital Budgeting Procedures in Business

Many procedures for evaluating investment opportunities are possible. According to the net present value (NPV) method, a manager should select among mutually exclusive investments to solve

$$\underset{(i)}{\text{Maximize}} \sum_{t=0}^{T} V_{it}\,(1 + r)^{-t}$$

$$\text{subject to } i \in \{1, 2, \ldots, I\}$$

where i is an investment alternative, t is a time period, V is net value, r is a discount rate, and T is the number of periods in the planning horizon. According to the payback (PBK) method, a manager should select among the investment alternatives to solve

$$\underset{(i)}{\text{Minimize}}\ n_i$$

$$\text{subject to} \sum_{t=0}^{n_i} V_{it} > 0$$

$$i \in \{1, 2, \ldots, I\}$$

$$n_i \in \{1, 2, \ldots, N\}$$

where n_i is the number of time periods required to recover the initial investment, and N is the longest payback period still acceptable to the decision maker.

The advantages and disadvantages of these and other popular methods are well-known and will not be discussed at length (see e.g., Barry *et al.* for further discussion). In brief, non-discounting methods such as payback period (PBK) and the average rate of return method, while easy to compute, both suffer from the disadvantage of ignoring the time value of money. In addition, PBK ignores any cash flows after the breakeven date. By specifying a short payback period as criterion, the method selects projects with quick returns, a form of protection against risk and a means of rationing capital.

The discounting methods of internal rate of return (IRR) and net present value (NPV) both consider the time value of money and so conform with financial theory of wealth maximization. IRR also gives results easily compared with other interest rates. It can give multiple (i.e., ambiguous) results and assumes that reinvestment at the same rate of return is possible. Both IRR and NPV require the firm to establish a cost of capital; in the case of NPV this is explicitly required to compute the answers. Both also fail to distinguish between projects with different lives or of different sizes. An additional method, the profitability index (PI), does correctly rank projects of different sizes. It is defined variously as either the present value of the returns stream divided by project cost or NPV divided by project cost.

Tables 1 and 2 show the pattern of use of the various capital budgeting procedures in large and small U.S. firms, respectively, in selected surveys over the last 30 years. To give consistency to the table, surveys of large businesses were included provided they reported all capital budgeting methods used by respondents rather than only the primary method. Current practices in small businesses are essentially unknown. Relatively few surveys of small businesses were found and the most recent study found is approximately twenty years old.

For large firms the number of capital budgeting procedures in use has approximately doubled in 20 years to somewhat over 2.5 methods per firm. Although the percentage that a method is used might appear to have changed little, actual use has changed dramatically. For example, on the first row of Table 1, PBK is used 26.8% of the time. But 100 firms use, on average, 279 methods, of which PBK accounts for 75 (or 26.8%). Therefore, 75% of firms use PBK. Its use has grown, though not as rapidly as discounting methods.

The dominance of non-discounting methods, principally payback period, was eclipsed in the mid to late 1970s. The pattern has remained relatively stable since. Of the discounting methods, internal rate of return has always been more popular than net present value. The shift from non-discounting methods to discounting methods lasted about twenty years. In addition, there appears to be little difference in pattern of use between the largest 500 and the largest 1,000 firms.

For small businesses (Table 2), the relative scarcity of information makes discerning the use and trends in use of discounting methods more difficult. However, restricting attention to the surveys of all types of small businesses suggests that use of discounting methods increased substantially during

Table 1. Capital Budgeting Surveys, Percentage of Respondents Using Each Method, Sample Size, Total Number of Methods Used by the Sample and Per Respondent, Large U.S. Businesses[a,b]

Author	Survey Date	Population	Capital Budgeting Procedures								Respondents	Total Methods Used	Methods per Respondent[c]
			ROR	PBK	NPV	IRR	Other Disc	Total Disc	Other	None			
Cook & Rizzuto	1985	Major R&D	12.3	26.8	21.2	26.2		47.4	13.5		117	327	2.79
Kim, Crick & Kim	1985	Fort 1000	12.9	26.1	22.3	33.9	0.0	56.2	4.8	0.0	367	1056	2.88
Farragher	1984	Fort S500	0.0	28.5	34.4	37.1	0.0	71.5	0.0	0.0	149	326	2.19
Hendricks	1981	Fort 500	13.9	29.7	19.9	32.3	2.8	55.0	1.4	0.0	193	496	2.57
Kim & Farragher	1979	Fort 1000	7.0	32.3	17.1	36.1	0.0	53.2	0.0	7.6	200	316	1.58
Schall et al.	NS	Large bus	22.7	29.0	22.0	25.5		47.5		0.8	189	253	1.34
Gitman & Forrester	1976	Fast grow	20.0	24.8	17.1	35.6	2.5	55.2	0.0	0.0	103	205	1.99
Petry	1974	Fort 500+	27.2	25.7	14.8	27.0		41.8	5.3		284	637	2.24
Davey	NS	Large bus	12.5	36.4	11.4	32.4	5.1	48.9	2.2		136	272	2.00
Fremgen	1971	D&B corp	22.0	30.0	9.0	31.8	2.7	43.5	4.5	0.0	177	223	1.26
Klammer	1970	Large mfr	26.0	32.2	18.6	18.6	0.0	37.3	4.5	0.0	184	354	1.92
Christy	1964	Mfr	35.1	42.0				11.5	2.3	9.1	108	131	1.21

[a]Abbreviations; bus, business firms, either not specified as to sector or including non-manufacturing sectors; D&B corp, Dun and Bradstreet reference book of corporate managements, 1969; Fort 500, Fort 1000, leading 500 or 1000 firms listed in the Fortune magazine rankings, usually in the year of the survey; Fort S500, leading 500 firms in service sectors as listed by Fortune magazine; IRR, internal rate of return method; mfr, manufacturers; NPV, net present value method; sls, annual sales in million dollars ($M); NS, not stated in article; Other disc, other discounting method, usually profitability index; Other, non-discounting method not ROR or PBK; PBK, payback method; Response, total number of responses by respondents; surveys reported here asked for primary and all secondary methods or asked for all methods in use; ROR, simple arithmetic rate of return method; Sample, number of respondents to the survey.

[b]A blank entry under a method indicates that the report of the survey did not provide a value for that particular method. For the method "none," a zero in the table means that either a table in the original report contained a specific entry or that the discussion in the text accounted for all respondents.

[c]Methods per respondent is the number of responses divided by the sample size, including the response of "none" if the survey reported it.

the period 1966 to 1976. Even so, the rate of use of discounting methods by small businesses appears to be only approximately half that of large businesses. A disturbingly large proportion of small businesses appears to use no evaluation method at all.

We took the results of the most recent study we could find, that by Kim *et al.*, as a baseline against which to measure the practices of a sample of greenhouse managers. Our survey method is different from those reported in Table 1 in that the method used was inferred from the hypothetical investment choice made by the farmer, rather than by direct questioning of the respondent. Significantly greater resources would be required to undertake a more ideal series of tests. First, a comparison of the evaluation practices of small and large businesses at a common point in time would be undertaken, then a comparison of farm and nonfarm businesses of similar size would be undertaken. Such a sequence would indicate whether differences in practices occur between firms of different sizes or between firms of different sectors. Even this more ideal procedure would not avoid the fact that real investment choices were not observed. It seems likely that managers will not put as much effort into hypothetical investment decisions as into decisions involving money. With these limitations in mind, the survey method may nevertheless provide better insight into actual capital budgeting procedures than direct questioning of respondents without involvement of either actual or hypothetical investment choices.

The Model

An overview of the statistical model and hypothesis testing procedures is as follows. A sample of J farm business managers each receives a paper showing a set of cash flow streams. These can be thought of as the net returns streams from I different investments. Each manager ranks the I streams in order of preference. There are $K = I!$ possible

Table 2. Capital Budgeting Surveys, Percentage of Respondents Using Each Method, Sample Size, Total Number of Methods Used by the Sample and Per Respondent, Small U.S. Businesses[a,b]

Author	Survey Date	Population	Capital Budgeting Procedures								Respond-ents	Total Methods Used	Methods per Resond-ent[c]
			ROR	PBK	NPV	IRR	Other Disc	Total Disc	Other	None			
Grablowsky & Burns	1976	Small bus, VA	14.5	7.2	8.7	14.5	0.0	23.2	1.5	53.6	65	69	1.13
Williams	1969	Small mfr, US	14.3	25.0	10.7	35.7	0.0	46.4	14.3		18	28	1.56
Luoma	1966?	<5$M sls, US	20.0	42.5				15.0	22.5		35	40	1.14
Soldofsky	1961	Small bus, IA		38.5			0.0			61.5	78	78	0.38

[a]Abbreviations; bus, business firms, either not specified as to sector or including non-manufacturing sectors; D&B corp, Dun and Bradstreet reference book of corporate managements, 1969; Fort 500, Fort 1000, leading 500 or 1000 firms listed in the Fortune magazine rankings, usually in the year of the survey; Fort S500, leading 500 firms in service sectors as listed by Fortune magazine; IRR, internal rate of return method; mfr, manufacturers; NPV, net present value method; sls, annual sales in million dollars ($M); NS, not stated in article; Other disc, other discounting method, usually profitability index; Other, non-discounting method not ROR or PBK; PBK, payback method; Response, total number of responses by respondents; surveys reported here asked for primary and all secondary methods or asked for all methods in use; ROR, simple arithmetic rate of return method; Sample, number of respondents to the survey.

[b]A blank entry under a method indicates that the report of the survey did not provide a value for that particular method. For the method "none," a zero in the table means that either a table in the original report contained a specific entry or that the discussion in the text accounted for all respondents.

[c]Methods per respondent is the number of responses divided by the sample size, including the response of "none" if the survey reported it.

preference orderings. One of the orderings corresponds to use of the net present value criterion while another corresponds to the payback criterion. Other orderings may reflect application of no known investment criterion and some may indeed be irrational.

Let R_j be the ranking of the jth farm manager of the cash flow streams; that is

$$R_j = (r_1, r_2, \ldots, r_I)$$

where

$$r_i \in \{1, 2, \ldots, I\}$$

$$r_i \neq r_{i'}, \text{ for } i \neq i'$$

$$j = 1, 2, \ldots, J$$

Let x_{jk} indicate the ranking provided by manager j where

$$x_{jk} = \begin{cases} 1; \text{ if } R_j = \text{ ranking } k \\ 0; \text{ otherwise} \end{cases}$$

Let P_k be the probability that the ranking indicator, x_{jk}, is one ($P_k = Pr[x_{jk} = 1]$; $k = 1, 2, \ldots, K$). Beforehand, manager j's survey response is unknown and must be regarded as a random variable characterized by a probability density function. The probability density function of the x_{jk} is

$$f(x_{j1}, x_{j2}, \ldots, x_{jK}; P_1, P_2, \ldots, P_K) = \prod_{k=1}^{K} P_k^{x_{jk}}$$

Assuming independence, the joint density of the sample of J managers is the product of the individual densities and is referred to as the likelihood function

$$L(P_1, P_2, \ldots, P_K) = \prod_{j=1}^{J} \prod_{k=1}^{K} P_k^{x_{jk}}$$

Maximum likelihood estimation may be used to obtain estimates, P_k^{MLE}, as the solution to

$$\underset{(P_1, P_2, \ldots, P_K)}{\text{Maximize}} \; L(P_1, P_2, \ldots, P_K)$$

$$\text{subject to } P_k \geq 0 \sum_{k=1}^{K} P_k = 1$$

with implied likelihood function

$$L^* = \prod_{j=1}^{J} \prod_{k=1}^{K} P_k^{MLE\, x_{jk}}.$$

The investment behavior of farm business man-

agers is compared to that of other business groups by specifying the formal null hypothesis in terms of the probabilities of alternative rankings H_o: $P_k^{Farm} = P_k^{Nonfarm}$, $k = 1, 2, \ldots, K$ where "Farm" and "Nonfarm" refer to the P_k^{MLE} estimated earlier and estimates from previous studies of other business groups. A likelihood ratio statistic to test the null hypothesis is

$$\lambda = \frac{\prod_{j=1}^{J} \prod_{k=1}^{K} P_k^{Nonfarm}}{L^*}$$

where $-2 \ln \lambda$ has a chi-square distribution with $K - 1$ degrees of freedom (see e.g., Mood *et al.*). The likelihood ratio permits a statistical comparison of farm business versus big business use of different investment criteria.

A statistical model may also be used in conjunction with the model selection criterion developed by Akaike (*AIC*) to identify the single investment criterion which might be used to best describe the investment behavior of the sample managers (Akaike, 1974). The criterion is to select the model which minimizes *AIC* where

$AIC(\theta) = (-2)$ ln (maximized likelihood function) + 2 number of independently adjusted parameters in θ.

Results of the hypothesis test and implementation of the *AIC* with sample data reveal the relative investment behavior of farm versus big business managers and the best explanatory hypothesis when describing farm business investment behavior.

Survey Instrument

A questionnaire was developed to elicit the investment preferences of greenhouse managers. The questionnaire provided a brief description of the investment situation. The description along with other cultural, equipment, and yield assumptions (Arthurton) were used to synthesize the cost and return streams associated with four different greenhouse irrigation methods. To avoid introducing non-economic aspects into the decision maker preferences, the methods were identified solely by number. The only information presented was of the net cash flows in each of seven years (the assumed lifetime of the investment), the initial and annual expenses and required down payment to make the investment. The rest of the questionnaire asked about the type of greenhouse cover and irrigation system in use, the size of the greenhouse operation and the age and experience of the respondent.

Results

The questionnaire described above was mailed to greenhouse managers on the University of Massachusetts Cooperative Extension System Agroecology Program mailing list. Approximately 500 questionnaires were mailed and 111 usable responses were received, a return rate of about 22 percent. No follow-up requests were sent. Table 3 summarizes the information gathered about the greenhouse operation and the respondent. The large difference between the mean size of operation and the median shows that the sample distribution is highly positively skewed. Operator age and experience display this tendency only slightly. Using asymptotic properties of the distributions of the mean and variance for samples from non-normal populations, we performed *z*-tests using the 1987 Census of Agriculture information on average size of greenhouse operation and operator age for Massachusetts as population means. At the 5 percent level of significance the sample is not representative of the population. Respondents were younger and their operations were larger than was expected from the Census data. It is possible that the respondents might be regarded as more pro-

Table 3. Summary Statistics from a Sample of 111 Massachusetts Greenhouse Operators

	Number of Respondents	Percentage
Irrigation system in use		
Hand watering	94	84.7
Drip irrigation	10	9.0
Overhead	3	2.7
Other (includes ebb and flow, capillary, hydroponic)	4	3.6
Type of greenhouse cover		
Polyethylene	75	67.6
Glass	30	27.0
Fiberglass	3	2.7
Acrylic or unspecified	3	2.7

	Mean	Median	Standard Deviation
Greenhouse space (sq. ft)	18,648	9,600	32,395
Operator age (years)	48	45	13
Operator experience (years)	18	15	11.5

gressive than the population of greenhouse operators in general.

Table 3 also shows that hand watering was by far the dominant irrigation method, reported as the main technique by roughly 85 percent of greenhouse managers. Most operations (68 percent of the sample) presently use polyethylene as the primary greenhouse cover, with most of the remainder reporting glass as the primary form of cover.

Of primary interest here, however, the survey data were analyzed using the maximum likelihood estimation technique described earlier. The findings reported by Kim *et al.*, for their survey of Fortune 1000 business managers were regarded as the maintained hypothesis against which various subsets of the sample data were compared.

A test of the hypothesis H_o: $P_k^{Farm} = P_k^{Nonfarm}$, $k = 1, 2, \ldots, 14$ where P_k^{Farm} and $P_k^{Nonfarm}$ are the probabilities of greenhouse business manager rankings and Fortune 1000 manager rankings, respectively, was conducted. A series of hypothesis tests of this type were conducted comparing various subsets of the greenhouse sample data. Table 4 specifies the tests conducted, associated likelihood ratio statistics, and decision rules based on the tests. The maintained hypothesis that Massachusetts greenhouse business managers and Fortune 1000 managers apply the same investment criteria was tested by comparing the likelihood ratio test statistic to the critical chi-square value $\chi^2_{.05}(13) = 22.36$. The maintained hypothesis was rejected both for the entire sample of respondents and the various subsets of sample respondents indicated in Table 4. The conclusion of these statistical tests is that the criteria applied to investment decisions by Massachusetts greenhouse business managers and Fortune 1000 business managers differ.

Table 4. Statistical Comparison of Investment Criteria Applied by Massachusetts Greenhouse Business Managers and Fortune 1000 Managers

Subset of Greenhouse Business Manager Respondents	Likelihood Ratio Statistic[a]
All Respondents	77.40
Early Respondents	94.77
Late Respondents	62.32
Smaller Operations	49.40
Larger Operations	27.05
Younger Respondents	65.00
Older Respondents	30.90

[a]Under the null hypothesis that Massachusetts greenhouse managers and Fortune 1000 managers apply the same investment criteria, the likelihood ratio statistic has a chi-square distribution with 13 degrees of freedom. The critical region at the 5 percent level of significance is $\chi^2 = 22.36$.

The survey responses were also used to identify the single investment method which might be used to best explain the investment behavior of Massachusetts greenhouse growers. The *AIC* model selection procedure described earlier was implemented to compare the net present value and payback methods using the survey rankings. The *AIC* values were computed ascribing a 95 percent probability to the payback and net present value rankings and uniformly distributing remaining probability to other possible rankings. Sample rankings were then used in conjunction with these alternative probability specifications to evaluate the likelihood function. The *AIC* statistic was 865.82 for the payback method and 898.74 for the net present value method. The statistic selects the payback model. This is not to say that greenhouse growers did use the payback method to make investment choices, but that the choices they made are the same as would be expected if they had used the payback method. Use of the payback method selects a benefits stream whose net present value is over $500 less than the benefits stream selected using the net present value method with an eight percent nomimal rate. The difference may be regarded as the opportunity cost of using the payback method rather than the net present value method when evaluating investment opportunities. The difference in present values in this case represents approximately seven percent of the amount invested and might be regarded as a nonnegligible amount by most of the managers.

Conclusions

A survey of Massachusetts greenhouse business managers asked them to rank the desirability of different cash flow streams in an irrigation investment context. We used the rankings to compare the capital budgeting procedures of greenhouse growers with those of Fortune 1000 managers. Greenhouse business managers follow different capital budgeting procedures from those of large business firms. Moreover, use of the payback method is the best single behavioral hypothesis for explaining the capital budgeting procedures applied by the greenhouse respondents.

The findings of this study suggest that the use of the net present value method for capital budgeting decisions does not currently enjoy the same popularity among the farm businesses studied as it does among the nation's leading business firms. The need for further research on farm business investment behavior and additional emphasis on Cooperative Extension educational priorities are also ev-

ident. In particular, additional emphasis on discounting techniques in Extension educational priorities may appear warranted if the gap between farm business investment criteria and economic theory identified in this study extends to other farming enterprises. The greenhouse industry is recognized as among the most technically advanced in agriculture (Sherry, 1988) and has been an early adopter of sophisticated production techniques such as use of computers for environmental control. If this propensity to modernization extends to decision making as well, then the greenhouse industry may reflect the leading edge in agricultural business financial management. If so, Extension programming to create awareness of alternative capital budgeting procedures might find an audience among other agriculturalists.

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