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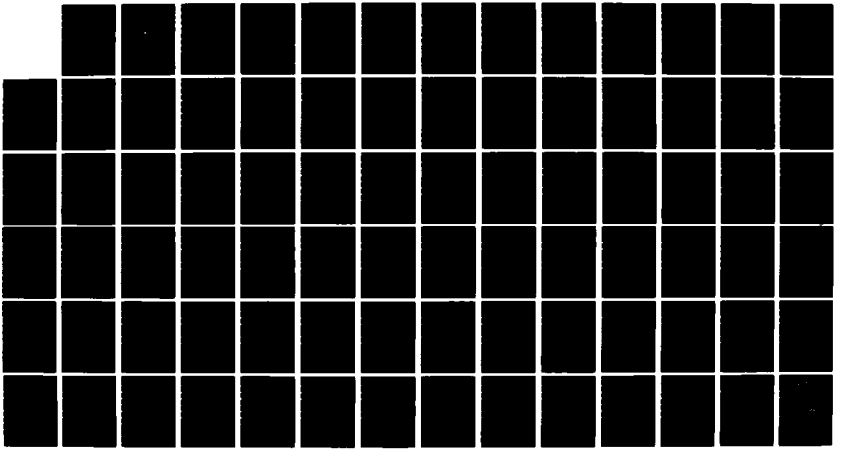

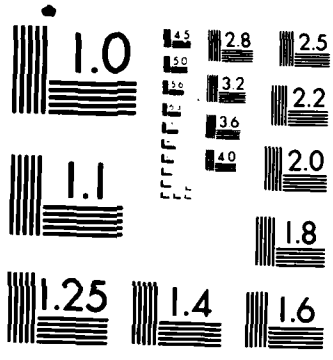

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

A MODEL OF LEASE VERSUS BUY
IN FEDERAL GOVERNMENT
CONSTRUCTION DECISIONS

by

Jerome F. Bentler

September 1985

Thesis Advisor: Dan C. Boger

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ABSTRACT

This thesis examines the interaction of cash flows in the construction and operation of child care centers. The cash flows under government operation are examined and compared with the cash flows were the center operated by a private contractor under a lease agreement. Background concerning general public and private leasing agreements is provided. For the cash flow analysis a net present value model is generated using a commercial interactive computer program. Sensitivity analysis by varying input parameters and risk analysis utilizing Monte Carlo simulation are performed.

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I. INTRODUCTION

Leasing is a standard method of acquiring needed assets and services in both the private and public sectors. This thesis examines three aspects of the lease-or-buy decision: 1) reasons leasing is used in the public and private sectors, 2) mathematical models currently used, 3) analysis of a practical example using a recommended model.

Traditionally, leasing has been used by private industry as an alternative to large capital investments. Background research in this area indicates that a new motivation has emerged as the primary reason to lease. As a result of recent changes in the federal tax code, leasing provides a means by which private industry can sell tax credits. This sale of tax credits has allowed industry to pay for needed assets at an effectively lower interest rate than they could normally receive from traditional lenders.

The reason for leasing in the public sector is explored at the local municipality and Federal government levels. The justification for leasing at the local level is quite different from that at the Federal level. At the local level, governments act much like private corporations. By selling their assets to private companies, local governments gain the benefit of tax write offs. In effect, the local government is subsidized by the Federal Government. At the Federal level, leasing is justified as a cost-effective method of doing business. However a detailed analysis of the standard cost effectiveness methodology reveals some inconsistencies that change the outcome of the analysis.

In both the private and public sectors the lease-buy option is an economic choice involving two or more alternatives. To evaluate various alternatives in a uniform and

consistent manner, capital investment models are used. Models currently used in private industry and at the Federal level are presented. The strengths and weaknesses of each are explored and critiqued.

As a practical example a lease agreement for a child care facility is reviewed. Based on the requirements of the contract, an estimated cash flow is calculated for operation using government "in-house" assets and using private contractors. The estimated cash flow is used as an input parameter and evaluated using the model currently recommended at the federal level.

Sensitivity analysis is conducted to measure the responsiveness of the output to changes in each parameter. This is accomplished by varying each parameter individually while holding all other parameters constant. Risk analysis using Monte-Carlo techniques is conducted to determine the effect on the outcome based on probability distributions for the individual parameters. To perform Monte-Carlo simulation, each parameter is given a estimated probability distribution. From each distribution, a random variable is selected and used to calculate the output. All outputs are plotted and from this a distribution function for the output is estimated.

II. LEASING IN THE PRIVATE AND PUBLIC SECTOR

A. CURRENT SITUATION

The Federal Government deficit is growing at a alarming rate. In 1970, the Federal Government spent 195.7 billion dollars and incurred a 2.8 billion dollar deficit. By 1984, the Federal Budget had increased to 853.8 billion dollars and the deficit had climbed to 183.7 billion dollars. The Federal 1985 Budget is 910.5 billion dollars while the latest deficit estimate is 185.1 billion dollars. Tabular presentation of these figures further illustrates the impact of the deficit (see Table I). As a percentage of the annual budget, the deficit has ballooned from 1.4 percent in 1970 to 20 percent in 1984. [Ref. 1: p. 304]

TABLE I
HISTORICAL BUDGET TRENDS (IN BILLIONS OF DOLLARS)

FISCAL YEAR	TOTAL BUDGET	PERCENT OF GNP	TOTAL DEFICIT	DEFICIT AS A PERCENT OF BUDGET
1970	195.7	20.0	2.8	1.4
1984	910.5	24.0	185.1	20.4

Furthermore the Government's share of the Gross National Product (GNP) is increasing. In 1970, total outlays by the Federal Government represented 20.2 percent of the GNP. The 1984 Government total outlays represented 24.0 percent, an

increase of 15 percent [Ref. 1: p. 304]. The increasing deficits are putting Congress and the Administration in a situation where one of two courses of action may be taken: Either taxes must be increased or spending decreased. The current Administration has publically stated that it will not increase taxes [Ref. 2: p. m-7]. Thus the only alternative appears to be to reduce spending.

Ramifications of the large deficits are as yet unknown, but the concern over the current situation has resulted in intense attention and scrutiny of all government spending with particular emphasis on the increase of productivity in government operations.

Although the military portion of the budget is most often cited as a causative factor, other programs also contribute to the deficit. The human resources portion of the budget, which includes such areas as education, training, employment benefits, social security, welfare, and medicaid represents a major portion of the budget.

Efforts to reduce the nonmilitary portion of the budget are subject to very strong political considerations. Elimination or reduction of benefits have a direct and immediate impact on constituents in congressional districts. It is very unlikely that a representative will vote on a bill that eliminates benefits for voters in his district until a "fair and equitable" political solution can be reached.

The defense budget doesn't have quite the same impact on voters. Probably the biggest direct impact on constituents occurs when a military base is closed in a particular congressional district. Base closure have apparently been used by Casper Weinberger, Secretary of Defense, as a political leverage tool in speeding up the approval of the defense portion of the budget [Ref. 3: p. 25]. However, other portions of the budget, such as Military Construction (MILCON), do not have a direct impact on most voters and can

be challenged with less likelihood of a negative backlash by constituents. The military construction program is itself only a very small portion of the total Defense Budget, constituting only 1.5 percent of DOD spending in 1984 [Ref. 1: p. 331]. Nonetheless, this is a portion of the budget where Congress has shown interest in reducing costs.

Currently the Navy uses MILCON funds to acquire new real property assets. In an effort to reduce costs associated with MILCON, Congress is carefully examining and testing the idea of leasing such assets rather than buying them. On a test basis, Congress has ordered that all three services examine the option of leasing at least one child care center in Fiscal Year (FY) 1985 [Ref. 4: p. 46].

B. LEASE DEFINED

Given the many general uses of the term 'Lease', two definitions, the accounting definition and the legal definition, are helpful in ensuring a full understanding of the term as used in this paper.

A lease in the accounting context is defined as

> An agreement conveying the right to use property, plant or equipment (land and/or depreciable assets) usually for a stated period of time. It includes agreements that, although not normally identified as leases, meet the above definition, such as "heat supply contract" for nuclear fuel. [Ref. 5: p. 47]

In the legal sense, a lease is

> Any agreement which gives rise to relationship of landlord and tenant (real property) or lessor and lessee (real or personal property). When used with reference to tangible personal property, word "lease" means a contract by which one owning such property grants to another the right to possess, use and enjoy it for a specified period of time in exchange for periodic payment of a stipulated price, referred to as rent. The person who conveys is termed the "lessor" and the person whom conveyed "lessee" and when the lessor conveys land or tenements to a lessor he is said to lease, demise, or let them. The word when used as a verb, means to

> transfer for term specified from lessor to lessee property therein demised, also to let, to farm out, to rent. [Ref. 6: p. 800]

Although these definitions seem clear, confusion has often arisen when using leases to acquire services and assets. As will be examined in Chapter III , one of the key variables private industry accounts for in the lease-buy decision is the taxation cost or benefit incurred. How these costs or benefits are acccunted for is important for tax purposes. Consequently accountants and the Federal Government began defining and classifying different categories for every type cf lease. Accountants first tried to establish a standard in 1949 when the Committee on Accounting Procedure issued Accounting Research Bulletin (ARB) No. 38, Disclosure of Long Term Leases in Financial Statements of Lessees. This document was followed by four separate opinions issued during the 1960's and 1970's by the successor to the Committee on Accounting Procedure, the Accounting Principles Board (APB). At the same time the Securities and Exchange Commission (SEC) adopted Accounting Series Release No. 147 as the official standard for public companies. [Ref. 7: pp. 107-117]

The most current set of accounting guidelines is the Statement of Financial Accounting Standards (SFAS) No. 13: Accounting for Leases [Ref. 5:]. The statement was first issued in 1976 and has incorporated seven additional statements and six interpretations since then. The general provisicns of the statement are underscored by paragraph 60.

> A lease that transfers substantially all of the benefits and risks incident to the ownership of property should be accounted for as the acquisition of an asset and the incurance of an obligation by the lessee and as a sale or financing by the lessor. [Ref. 5]

In many articles concerning leasing, various terms such as "third party financing", "sale leaseback", or "lease purchase" are used. Statement 13 recognizes only five types of leases: 1) operating, 2) sales type, 3) direct financing, 4) capital, and 5) leveraged leases. In an effort to eliminate the confusion Statement 13 has some simple flow charts allowing quick and easy classification of the type of lease.

It should be noted that a given lease is looked at in a different light by each party. Just because it is a capital lease to a lessee does not automatically mean that it is considered a capital lease by a lessor. What one party may view as a capital lease, the other may consider an operating, sales or leveraged lease. Thus many assets can be operating and yet not show up in either the operator's or manufacturer's balance sheet as a taxable asset. Aircraft leases are typical of this type of arrangement. [Ref. 7: p. 110]

C. PRIVATE INDUSTRY

Probably the most widely discussed article about private leasing was authored by Peter Vanaderwick, "The Powerful Logic of the Leasing Boom" [Ref. 8]. The article concerns the ownership of an aluminum-reduction mill located near Sebree, Kentucky. While Anaconda Co. was constructing the mill, two events occurred that had an immediate and long-term impact on Anaconda's cash flow. One event was the expropriation of the company's copper mines in Chile. The result was a 356.3 million dollar write-off that could be taken over a ten year period. The second was the reinstatement by Congress of the 7 percent investment tax credit in 1971. The company was then in the situation of having more tax write-offs than it could use. The article dealt with the economic benefits the company could reap by

transferring, through use of a lease, the excess tax credits to others in private industry.

Vanderwicken also noted several benefits in addition to tax incentives that result from leasing:

1. fixed monthly payments that permit accurate prediction of cash needs;
2. no down payment by the company and no compensating balance resulting in conservation of cash;
3. no legal means to restrict other financing by the company;
4. greater flexability for lower level managers in acquiring assets by using leases as an operating expenses rather than a capital expenses.

This last item is a major advantage to large organizations, such as the Federal Government, because it can greatly speed up the process of acquiring needed assets. [Ref. 8: p. 190]

D. LOCAL MUNICIPALITIES AND STATE GOVERNMENTS

In response to voter imposed spending restrictions, state and local municipalities have been taking advantage of leasing as a method to acquire needed services.

Probably the most widely known restriction on spending in local government resulted from passage of California's Proposition 13, approved by voters on June 6, 1978. Proposition 13 required that local government reduce and limit property taxes. Its basic feature was a reduction of property taxes from an average of three percent to one percent of the assessed value of a property. This had a large impact on local government which had averaged about 27 percent of their receipts from property taxes. [Ref. 9]

Faced with a reduction in tax receipts and the restrictions imposed on generation of new receipts, local governments rapidly curtailed services, limited new construction and reexamined their current methods of acquiring services.

The use of leases to acquire services rapidly became popular. The sale leaseback method was the first tc be considered and used. The city or local government would sell existing assets such as a courthouse, library or town hall to private investors. The private investor in turn would lease the building back to the local government. The local government would then get use of the assets at a reduced cost because the investors would be able to use the tax deductions generated through depreciation and capital investment. In a round-about way, the Federal Government provided a subsidy to the local government.

Two other methods were alsc used in the construction of new assets. These were use of 1) lease purchase agreements, and 2) operating leases. The latter method was adopted as a plan by Camden County in New Jersey. Faced with complying with the Clean Water Act, Camden County required funds to build two additional sewage treatment facilities. The cost of the facilities was estimated at 200 million dollars plus 110 million dollars required to complete a plant already under construction. The Environmental Protection Agency had granted the entire State of New Jersey 485 million dollars. Camden County could have absorbed 65 percent of the entire grant itself. Instead, Camden issued tax-exempt industrial develcpment bonds to generate low-interest capital for construction of the plants. After completion, a lease was signed with a private owner to operate the plant. Using this method estimated savings will be equivalent to receiving a grant from the Federal Government for 30 percent of the plants' cost. [Ref. 10: p. 36]

An added political benefit of leases is the flexibility that a lease gives local gcvernments. For example in Lakewcod, Colo., voters did not approve a bond measure for a new city hall. The Lakewood government in response arranged a lease-purchase contract and thus acquired the "needed"

hall. The lease also provided an opportunity for cities and local government to rebalance the books. Jefferson County, Colorado, for example, showed no long term debt on its books but had a lease-purchase contract for a 30 million dollar jail. The lease payments are paid every year in the same manner as any other capital expenditure. [Ref. 11]

State and local governments have used leasing for two reasons. First, leasing is a method of gaining a subsidy from the Federal Government by selling depreciation of assets to private industry. Second, leases are a way to acquire assets without having to show a long term debit as a liability on the balance sheet.

E. FEDERAL GOVERNMENT

The Federal government is extensively involved in the leasing of facilities for government use. Although twenty two agencies have a limited leasing authority, five agencies (General Services Agency (GSA), Postal Service, Department of Defense (DOD), Department of Transportation and Department of Agriculture) account for about 95 percent of the dollar value spent on leases. The largest user of leases is GSA, with an estimated one billion dollars spent in 1984 on leased property. The next largest user is the Department of Defense followed by the Postal Service. [Ref. 12]

The General Services Administration was established on July 1, 1949. The organization was created to centralize acquisition of common requirements for the Executive Branch. The organization is broken into numerous departments that handle procurement of supplies, information, and computer services. The Public Building Services (PBS) is the branch responsible for the construction, operations, and maintenance of all buildings. This branch is also responsible for

the administration and award of lease contracts. [Ref. 13: pp. 529-547]

The PBS has approximatly 14,500 employees and is the largest of the GSA branches. The PBS has control of about 228 million square feet of office space in 7800 Federally owned or leased buildings.

GSA has had both negative and positive experiences with leasing. It has received frequent complaints and has been the subject of of several Congressional inquiries concerning leasing policy. On the other hand it has also claimed some substantial successes from its policies.

An example of the former concerns GSA's dealing with the Social Security Administration. The Social Security Administration has 1,321 branch and local offices located throughout the United States. Of these 1,321 offices, 1,101 are leased spaces administered by GSA. A General Accounting Office audit showed numerous administrative problems. These include:

1. Improperly maintained offices due to overcrowding and inadequate services provided by lessores:
2. Lengthy delays in acquiring lease spaces. 12 months or more were required in some cases;
3. Problems in forecasting of future space requirements due to fluctuations in the Social Security budget.

The same example, however, also illustrates positive aspects of leasing. Although no economic analysis was performed, the GAO did note some benefits from leasing.

1. At no time was better space found for equivalent cost.
2. GSA had implemented a new program where spaces under 2500 square feet could be leased in 60 days. The improvement in timeliness increased the Social Security Administration ability to respond quickly to changing requirements.

3. Many of the offices required by the Social Security Administration are small, one floor offices located in downtown areas. Government construction would not be feasible due to small size requirements and high property costs. The lease is an excellent method of obtaining assets in this environment. [Ref. 14]

The Post Office uses leasing as a method of acquiring needed assets and services for short duration periods. It also uses leases as a method of acquiring assets when future needs and load requirements are unknown. [Ref. 15]

Currently the Post Office uses leasing for acquiring space in large commercial buildings, such as shopping malls, sporting complexes, universities and other areas requiring extensive postal services. The main purpose of leasing is to allow the Post Office flexibility in providing a wide variety of services without subjecting itself to high capital investment for areas where the length of service required and the amount of resources are unknown.

In examining the full potential of leases the Postal Service has contracted for a study of the practice and what benefits the Post Office could obtain from leasing. Using commercial programs and data bases, the following conclusions in regard to leasing were reached.

1. Construction costs for Postal buildings are considerably higher than construction costs for similar buildings by private industry;
2. On the average, cost-to-own exceeded the cost-to-lease by 20 percent;
3. An examination of current projects show that they will cost significantly more to own that to lease.

Although this analysis tends to show that leasing is cheaper than purchasing, two important items were not considered. First, the analysis did not take into account the lost revenue to the Treasury from tax benefits.

Secondly, no sensitivity or risk analysis was performed on the calculations. [Ref. 16]

Another investigation of the acquisition of capital assets by lease agreements, in this case involving Navy auxiliary ships, was conducted by Michael K. Block. The results of his effort were published in a paper entitled, "Who Should Own the Fleet?" [Ref. 17].

Mr. Block's initial curiosity about leasing was raised while reviewing background studies for the AO-75, an auxiliary oiler the Navy was interested in procuring. The study result was that leasing was a more cost-effective way for the Navy to acquire oilers than purchase. The question raised was, given the results of the cost study were true, why was the entire Navy not leased? His final conclusion was that the method used in evaluating the alternatives was faulty and the lease proposal was not cost effective.

His result was based on an examination of three areas: 1) the mechanics of leasing in the private sector, 2) prior Navy experience with the build and charter program conducted by the Military Sealift Command, and 3) the cost effectiveness of leasing in the private sector.

Block's main point is contained in the first section, an examination of the mechanics of leasing. Using Vanderwicken's article, "The Powerful Logic of the Leasing Boom" [Ref. 8] Block summarizes the use of leasing as a method of lowering the cost of capital.

> The lease payment is, in fact, an interest and amortization payment on the capital value of the asset. The critical differences from the lessee's point of view is that the effective interest rate on the lease is less than the effective interest rate on his next best commercial alternative. [Ref. 17: p. 4]

Government bonds are the cheapest way in our economic system to generate capital. The cost of capital is based on the

interrelationship between the interest and security of the investment. The more secure an investment is the lower return (i.e. interest) an investor is willing to accept. As government bonds are considered the most secure investment currently in our economic system, investor demand is satisfied at a lower interest rate than is the case for private investments. Consequently the cheapest way to currently raise capital is through the issuance of government bonds. Any proposal by industry claiming to provide a cheaper rate is false. The cheaper rate comes from hidden tax breaks the private company can use but the Federal government does not use.

In summary, leasing has been beneficial to the Federal Government in two types of cases. In the first case, if a government agency is faced with a situation where it must provide a service for a short time, leasing is a logical method. In the second, if an agency has a small requirement for space, such as a one person postal branch office or a two person Social Security office, then leasing is a way to utilize already constructed assets using minimal capital investment. Leasing, as a method of reducing cost of capital, is not beneficial for two simple reasons: 1) government bonds provide the cost of capital, 2) overall the government does not gain any advantage by transferring tax credits between agencies.

III. CURRENT MODELS USED

A. BACKGROUND

The investment models discussed in this chapter are widely used in business for making economic choices. The basic premise of all models is that they are simplified versions of reality. A "good" model incorporates the major components of a problem and their interactions and interrelationships in the environment. To relate the components to one another and to provide a reference for the user of the model, a measuring unit must be established. It is widely accepted, both in government and private industry, that the common unit is money. One key aspect of economic models is that they are not developed to calculate a specific dollar value but rather are used to rank and compare alternatives in a objective and logical manner.

Although both private industry and the public sector use the same measuring units, each has a different goal. In the business world, the goal is to achieve the highest payback from a given investment, based on production at the lowest cost and utilization of government tax incentives. In the public sector the objective, excluding some political considerations, is to achieve the minimum required service at the lowest possible cost. Both require an analysis of various alternatives based on cash flows to attain their respective goals.

Much has been written concerning the use of models, but if the user keeps the following points in mind, he/she should gain a better understanding of a model.

1. It is a simplified version of a more complex reality.

2. Its purpose is to illuminate a real-life phenomenon, using some simplification for ease and clarity of understanding;
3. The model has to include those parameters and their interrelationships that are essential;
4. The model is not all knowing, each is developed for a particular purpose and audience;
5. Many models do not directly provide a "correct" solution, but rather are used to assist the thought process.

Models are therefore simple yet contain the essential elements to assist the thought process in analyzing a particular problem. [Ref. 18: p. 55]

B. FOUR COMMON ECONOMIC MODELS

In the business world, cash flow models abound. Each model has many inputs and variables but usually falls into one or a combination of four basic models. In most cases management wants to be presented with the simplest possible format. Presentation of statistical deviations, standard error and various other statistical measurements is not been considered important to the manager. One major reason for this is that historically these calculations were exceedingly difficult to compute. However, even though the use of modern computers has greatly simplified such complex calculations, the simplicity requirement is still paramount. To meet the requirements of simplicity all four models provide only one output value. This output can be used to arrange the investment alternatives in order of desirability. [Ref. 19]

For demonstartion purposes, all four models will be used to evaluate two different cash flows. Case one has an initial investment of one thousand dollars and a one hundred

dollar return per period. Case two has an initial investment of one thousand dollars and a two hundred dollar return per period. In both cases total number of periods is ten and discount rate is ten percent.

1. Average Rate of Return Model

The average rate of return model will provide the rate at which an investment yields revenues based on the initial amount invested.

Algebraically:

$$AAR = \frac{\sum_{i=1}^{n} a_i}{n\, a_c} \qquad \text{(eqn 3.1)}$$

where:

AAR = average rate of return

a_c = initial investment outlay

a_i = return in period i

n = total number of periods

i = period

The initial outlay is positive in all situations. It is however possible for ai to be negative. This is equivalent to cash outlay exceeding cash inflow in that period. The decision rule is to choose the alternative that has the highest value of ARR. For our example, case one has a ARR equal to .10, while case two has a ARR equal to .20. Thus case two is selected as the better alternative. The

major flaw here is that the model provides no clue as to total return or return over time.

2. Payback Period Model

The pay-back period model is another simple model. In many commercial decisions, short term gain is of paramount importance. The payback period is the number of periods required for the investment to recover the initial cost.

Algebraically:

payback period is minimum k for which

$$\sum_{i=1}^{k} a_i \geq a_c \qquad \text{(eqn 3.2)}$$

where

k = pay back period

a_i = return in period i

a_c = initial investment

i = period

As in the above model, ao is always positive while ai can be either positive or negative. The decision rule is to choose the alternative that has the smallest value of k. In this model case one has a value of 10 for k while case

two has a value of 5 for k. Thus case two is selected as the better alternative. Like the previous model of average rate of return, this model does not consider total return or time difference.[1]

3. Present Worth Model

The present worth model makes use of the idea that a future sum is worth less than a current sum. To accomplish this, the model takes into consideration what a current sum could possibly earn if it was invested with a guaranteed return.

Algebraically:

$$PV = -a_0 + \sum_{i=1}^{n} \frac{a_i}{(1+r)^i} \qquad \text{(eqn 3.3)}$$

where

PV = present value

a_0 = initial investment

a_i = return in period i

i = period

n = total number of periods

r = interest rate or discount rate, $r \geq 0$

---

[1] Further discussion of this model appears in Chapter 5.

As in the previous models, ao is always positive while ai can either be positve or negative. Note that negative values of r are not defined. The decision rule is to select the alternative with the highest NPV. Case one has a PV of -385.3 dollars while case two has a PV of 229.4 dollars. Thus case two is selected as the better alternative. The present worth model does take into account the variable worth of money over time. However, the determination of r is quite difficult and can have an adverse effect on the PV if chosen incorrectly. The main problem occurs when a comparison is made between alternatives having different cash flows at different periods. If r is high, a penalty is placed on any alternative with large cash returns in later periods.

4. Internal Rate of Return Model

The last model is based on the internal rate of return required by the company to show a profit. Although very similar to the present value model, the internal rate of return model is looking for a rate r that would pay back exactly the initial investment ao over the life of the investment.

Algebraically:

$$a_c = \sum_{i=1}^{n} \frac{a_i}{(1+r)^i} \qquad \text{(eqn 3.4)}$$

where

r = rate of return

a_c = initial investment

a_i = return in period i

n = total number of periods

i = period

As with the above models ao is always positive. The value of ai can either be positive or negative. The decision rule is to select the alternative with the highest rate of return. Case one has a r equal to zero, while case two has a r equal to .16 . Thus case two is selected as the better alternative. One major shortcoming of this model occurs if there is a negative cash flow in any period of the model. In that situation a sign reversal occurs which causes multiple solutions for r which creates confusion when selecting the proper alternative.

C. CURRENT LEASING MODELS USED IN THE PRIVATE SECTOR

Currently private companies use four basic models in making the lease-or-buy decision. In a survey conducted by Paul F. Anderson and John D. Martin, companies used the internal rate of return (IRR), the Net Present Value (NPV), and two modifications to the net present value model, a variation of the Weston and Brigham model (1972) and a variation of the Bower, Herringer and Williamson model were also used. [Ref. 20: pp. 31-40]

1. Discussion of the Survey

The elements of each model are summarized in Figure 3.1. All four models share three similar characteristics:

a) the time value of money;

b) cash flow in and out;

c) tax benefits;

Each model recognizes that there is a time value associated with money. This time delay is taken into consideration by assigning a discount factor or interest rate to all cash flows in the models. The parameters representing cash flows in all four models are very similar in nature. Table 3.1 illustrates the common parameters used. Included are initial investment, operating cost, and salvage value. These models also demonstrate the importance that tax rates play in the lease-buy decision. Included in cash flows are investment tax credits, marginal and average tax rates, and tax rates on interest payments cn loans.

ELEMENT	NPVM	IRRM	LSLM	AIM
A_0		X	X	
L_i	X			X
R_i	X	X	X	X
tD_i	X	X	X	X
tR_i	X	X	X	X
tI_i	X		X	X
$C_i(1-t)$	X	X	X	X
V_n	X	X	X	X
$t_c A_c$	X	X	X	X

Figure 3.1 Comparison of the Leasing Models in Private Industry.

Also significant is the lack of sensitivity and risk analysis for each model. As noted by the authors, response

to the survey indicated that very little if any sensitivity or risk analysis is performed on the models prior to the selection of the alternatives available.

Each model is examined in detail below. The following notation is used.

A_o = purchase price

D_i = Taxable depreciation charge in year i

I_i = interest charged in year i

I_i'' = Bower, Herringer and Williamson model for computing an equivalent loan in year i

K_t = after tax weighted average cost of capital for the firm.

IRR = internal rate of return required by a company

L_i = loan payment in period i

n = useful life in periods

NAL = net advantage of lease

O_i = operating cost if firm purchases the asset

P_i = after-tax cost of leasing

R_i = lease (rent) payment in year i

r = pre-tax interest rate on intermediate debit

r_t = $r(1-t)$ after tax interest rate on intermediate debit

P_t = after-tax cost of leasing

t = corporate average and marginal tax rate on ordinary income

t_c = investment tax credits

V_n = expected after tax salvage value of asset in year n.

2. NPV Model (NPVM)

This is a basic NPV model.

$$NAL = \sum_{t=1}^{n}\left[\frac{L_t - R_t - tD_t + tR_t - tI_t + O_t(1-t)}{(1+K_t)^t}\right] - \frac{V_n}{(1+K_t)^n} - \frac{t_c A_o}{1+K_t} \quad \text{(eqn 3.5)}$$

The model makes the assumption that perfect information about all factors exist. The present values are calculated using a discount rate that equals the rate of interest. The decision rule is then to lease if NAL is greater that zero and buy if NAL is less than zero.

3. IRR Model (IRRM)

This is a basic IRR model

$$0 = A_o - \sum_{t=1}^{n}\left[\frac{R_t - tD_t + tR_t + O_t(1-t)}{(1-\rho_t)^t}\right] - \frac{V_n}{(1+\rho_t)^n} - \frac{t_c A_o}{1+\rho_t} \quad \text{(eqn 3.6)}$$

The problem is to solve for Pt. The decision rule is buy if ρ_t is less than IRR and lease if ρ_t is greater than IRR.

4. Lump Sum Loan Model (LSLM)

The only two differences in this model when compared to the NPVM is the inclusion of A_o, cash purchase price of the asset, and a different interest rate.

$$NAL = A_o - \sum_{t=1}^{n} \left[\frac{R_t - tD_t + tR_t - tI_t'' + O_t(1-t)}{(1+k_t)^t} \right] - \frac{V_n}{(1+k_t)^n} - \frac{t_c A_o}{1+k_t} \quad \text{(eqn 3.7)}$$

The decision is lease if NAL is positive and buy if NAL is negative.

5. Annual Installment Model (AIM)

The last model noted in the survey was the AIM model

$$NAL = \sum_{t=1}^{n} \left[\frac{L_t - R_t - tD_t + tR_t - tI_t + O_t(1-t)}{(1+r_t)^t} \right] - \frac{V_n}{(1+k_t)^n} - \frac{t_c A_o}{(1+r_t)} \quad \text{(eqn 3.8)}$$

In this case a positive NAL entails a lease decision while a negative NAL leads to a buy decision.

D. CURRENT LEASING MODELS USED IN THE DEPARTMENT OF DEFENSE

The Department of Defense, as a part of the Executive Branch of the Federal Government, relies on the Office of Management and Budget for guidance in capital investment decisions. DOD Instruction No. 7041.3, Economic Analysis

and Program Evaluation for Resource Management [Ref. 21] is the directive to be followed by all Program Managers in carrying out OMB and DOD policy. The Naval Facilities Engineering Command has further elaborated by publisning NAVFAC P-442, Economic Analysis Handbook [Ref. 22].

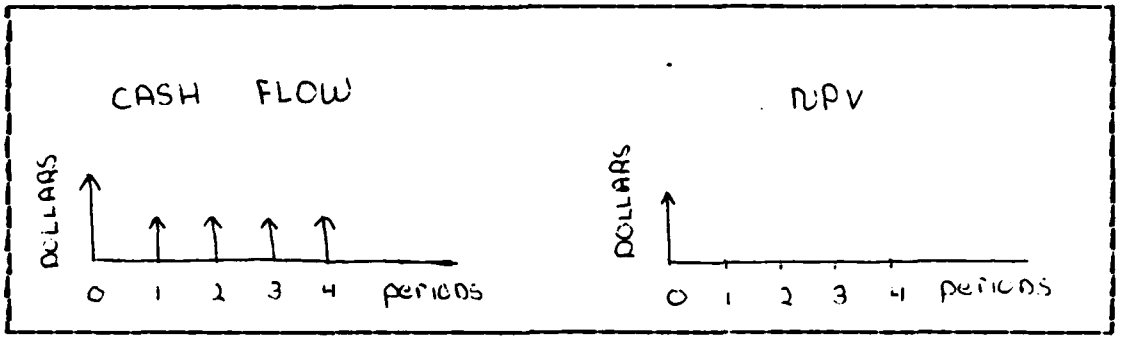

Figure 3.2 Cash Flow Diagram.

The model used exclusively for capital investment decisions and lease-buy alternatives is a NPV model based on a discrete cash flow. Utilizing the NPV concept, all cash flows are brought back to the initial point (see Fig. 3.2). The decision rule is to accept the lowest NPV as the best alternative.

To examine the limitations of the NPV model and inconsistencies in OMB and DOD directives a comprehensive review of leasing situation has been performed by the Navy Facilities Engineering Command. The study was tasked with the following objectives:

1. Review the comparison methodology used in Navy economic analysis, with emphasis on identification of indirect costs such as taxation rates and insurance cost to ensure that they are adequately accounted for by present policies;

2. Analyze the results of possible changes to the Davis-Bacon Wage Act for Military Construction costs;
3. Examine the GSA automated life-cycle costing model;
4. Do a typical case study of lease vs. construction economic analysis.

The study came to the following conclusions and recommendations.

1. Both the 10 percent discount rate established by DODINST 7041.3 and the 7 percent rate established by CMB Circular No. A-104 should be reviewed to insure they accurately reflect the current economic situation;
2. Insurance premiums have a negligible effect when comparing alternatives. However, Local and Federal taxes have a significant impact on the ranking of the comparisons. No guidance is recommended at the present time fcr these reasons:
   a) OMB Circular No. 104 States that 7 percent discount rate used fcr lease alternatives already has taken taxes into account:
   b) the total local taxes will have minimal impact on lifecycle cost;
3. The repeal or reform cf the Davis-Bacon Act would only reduce MILCON costs by a few percent and would have minimal impact on the total lifecycle cost;
4. GSA life cycle planning and budgeting model is not suitable for application by NAVFAC;
5. More sensitivity analysis on the input variables and more risk analysis would be useful in any economic decision.

Given these results, NAVFAC has therefore not changed the recommended methodology described in NAVFAC P-442, Economic Analysis Handbook when analyzing the lease or buy decision. [Ref. 23]

IV. ANALYSIS OF A LEASE-BUY DECISION

A. BACKGROUND

As noted in Chapter II, there is considerable Congressional pressure to exploit any method that decreases Federal spending. Leasing is one method currently proposed as a cost-effective way for the government to acquire assets and services. When the decision is made whether to lease-or-buy some sort of economic analysis must be conducted to rank the alternatives. The purpose of this chapter is to analyze an example and rank the alternatives using the economic model recommended by NAVFAC. In Chapter Six the model will be subjected to sensitivity analysis and to risk analysis.

The analytical process used follows six steps:

1. Define Objective
2. Generate Alternatives
3. Formulate Assumptions
4. Determine Costs and Benefits
5. Compare Cost and Benefits and Rank Alternatives
6. Perform Sensitivity Analysis and Risk Analysis

B. OBJECTIVE

As noted in Military Construction Authorization Act, Report 98-962, [Ref. 4], all three military services are to conduct lease agreements for child care centers (see Chapter II). The objective is to determine whether private industry can provide child care more economically than the current method of in-house acquisition and operation.

C. ALTERNATIVES

In carrying out the Congressional directive, NAVFAC has develcped a draft Request for Proposal (RFP). This RFP is to be issued and returned bids evaluated. Due to the structure of the contract only two alternatives are available to the gcvernment. These are:

1. The government acquires and operates a child care facility for a 25 year time period.
2. The government leases land at a minimal cost, $1.00 per year, and the construction and operation are performed by a private contractor.

Although the structure of the contract only allows for the evaluation of the two above options there are numerous options available. Four other alternatives are listed below:

1. Do nothing. Many bases are located in heavily populated areas where child care is readily available from private industry. Arguments concerning the merits of having a facility right where personnel work, problems associated with child care facilities which do not understand the unique nature of military life, and possible higher cost to individual military members should be examined when considering this option;
2. Build the structure and lease the services. This is very similar tc Executive Order A-76, a concept that has been adopted and used quite frequently in recent years to reduce costs and increase efficiency in current government operations. What A-76 does is organize a method where government employees bid in competition with the private sector for government work. The lowest bidder is then awarded the work. This is believed to result in greater efficiency in government operations;

3. Lease an existing structure from private industry. This could be cost effective in an area where over-speculation on building requirements has resulted in excess vacancy rates. In this situation, the government could reap benefits by having private industry possibly 'subsidize' the government by leasing space at a loss just to maintain some cash flow. The final profit by private industry would be made up when demand has caught up with supply. At that point the government would reexamine the possible options available;
4. Some other combination of leasing and buying. By taking advantage of private industry's ability to specialize and operate as efficiently as possible, some portions of child care could remain in-house, while other portions such as food operations and janitoral services could be subcontracted.

As a final point the cost of drafting, awarding, and inspecting and administering a contract, along with the loss of flexibility when using a contract could easily outweigh the small incremental benefits gained. In any analysis, these items should be included in the cost analysis for any given alternative.

D. ASSUMPTIONS

To reduce the model to the simplest terms, the following assumptions are made:

1. For the base case the same discount rate of 10 percent will apply to both alternatives;
2. All cash flows throughout the year are accumulated at the end of the year;
3. Due to size of the contract, inspection and administration costs of the contract will be fully offset by

overhead costs needed for in-house operation of the child care center;

4. All cash flows in the contract model are examined before taxation;
5. Interest rate for capital in the private sector is 12 percent;

E. COSTS AND BENEFITS

1. Background

The proposed child care center is still not completely designed. Therefore, construction costs, operating costs, and operating receipts will be estimated using historical data, engineering estimates and estimates by knowledgeable and experience individuals in the child care field. It is emphasized by the author that these estimates are solely generated for use in exploration of a current model that evaluates cash flow alternatives and are not official government cost estimates. Although reasonable now, changes in the draft contract proposal would most likely have a significant impact on the cash flows.

2. Cost Elements

Five cost elements are considered critical in child care operations:[2] 1) receipts, 2) operating cost, 3) initial investment, 4) one-time maintenance cost and 5) salvage value.

Total receipts in both the government cash flow and the contract cash flow are fixed. Receipts are fixed due to two constraints: 1) maximum day-care center child capacity and 2) maximum charge per child. The child care center will be approximately 6,000 square feet, based on contract

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[2]These are very similar to the critical elements used in the private leasing models found in Chapter 3.

guidelines, thus the maximum number of children the center can handle is one hundred. Due to the number of military families in the area, it is assumed that a waiting list will be maintained and that the center will always have maximum utilization. It is also assumed that users will not pay a higher price than other available private centers would charge. Current charges in the evaluation area for child care are two hundred and sixty dollars per month. Total receipts are calculated by multiplying the number of children, here one hundred, times cost per month. Then this total is multiplied by 12 for total yearly receipts of 312,000 dollars.

For analysis purposes, the fixing of receipts will have a minor impact. Any change in the cash flow of receipts merely has a negative effect on operating costs. Thus the overall behavior of the model with increasing receipts is equivalent to decreasing operating costs.

Operating cost is based on the following calculations.

14 employees working 2080 hours per year at $4.50 per hour = $131,040.00.

1 maintenance person working 2080 hours at $5.00 per hour = $10,400.00

1 supervisor working 2080 hours per year at $7.00 per hour $14,560.00

Total Labor = $156,00.00 dollars per year

Consumables, such as cleaners, mops, brooms, etc., used in the year = $1,800 dollars.

The utility cost had to be estimated since no meters are used for individual building on Navy bases. Using 68,650 cubic feet and Navy Planning Guide [Ref. 24: p.

115]. Total cost for heating is estimated to be 2,906 dollars per year.

For electrical cost, based on 2 watts per square foot [Ref. 25] at .41 dollars per kilowatt used and 60 hours operating per week, total cost per year is estimated to be 17,563.00.

Total yearly operating cost is 178,000 dollars.

The cost of initial investment is based on the current engineering estimate of 880,000 dollars. For the government cash flow this is considered one lump sum at time zero. The contract cash flow assumes the contractor will obtain a loan of the entire amount. Consequently, the contract cash flow has uniform payments over the life of the project.

The disposal of the structure at the end of the lease or economic life of 25 years is not specifically addressed in the draft proposal. It is assumed that the contractor will recover his total investment prior to the end of the lease period. At the end of the lease period the contractor, at no additional cost to the government, will turn over the structure. If the government owns the structure, full cost recovery will be accomplished prior to the end of the 25 year economic life.[3] It is therefore implied that the salvage value for both alternatives will be zero. [Ref. 26]

All of the above costs are summarized in Table II .

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[3]The insignificance of using a longer life for the structure is examined later in this chapter.

TABLE II

ESTIMATED CASH FLOW

Receipts	
Number of Children (Maximum)	100
Charges per Child per Month	260.00
Total Yearly Receipts	312,000.00
Operating Cost	
Labor	
Hourly Labor Rate for Child Care	4.50
Hourly Labor Rate for Daily Maintenance	5.00
Hourly Labor Rate for Supervision	7.00
Yearly Cost for Total Labor	156,000.00
Yearly Cost of Materials needed for Day to Day Operations	1,800.00
Utility Cost	
Heating Cost	2,906.00
Lighting Cost	17,563.00
Total Yearly Operating Costs	178,000.00
One Time Maintenance	
Painting (every five years)	2,500.00
Reroofing (every fifteen years)	10,000.00
Initial Investment	880,000.00
Salvage Value	0.00

F. RANKING OF ALTERNATIVE CASH FLOWS

1. Model

The model used for the analysis of alternative cash flows in this example is a net present value model (see Chapter III). The model discounts the cash flows over the life of the project to time zero. The alternatives are ranked and the decision rule for this model is to select the alternative with the largest NPV. Additional background can be found in Economic Analysis Handbook P-442 [Ref. 22].

2. Use of Computer Program

The computer program used to analyze the cash flows is a commercial program, "Interactive Financial Planning System (IFPS)". The program was developed by EXECUCOM Corporation as a mechanism that allows financial managers a comprehensive means of modeling and simulating financial scenarios. The program loads a modeling language into any IBM PC or IBM compatible computer. The short examples shown below will introduce the reader to the basic semantics of the language. For a more complete explanation of the system's capabilities, IFPS Tutorial [Ref. 27] and IFPS User's Manual [Ref. 28] are excellent reference sources.

The program allows the user to set up separate files for cash flows and data. For this example a file was created to model the cash flows of each alternative. The government file is listed in Table III . The contract file is listed in Table IV . The file name assigned the government cash flow is "gov" and the file name for the contract cash flow is "con". As can be seen, the language is very user friendly and contains internal functions for calculation of NPV and amortization of a loan. To allow greater flexibility, all input parameters for both models are initially set to zero. Data files are set up separately and

TABLE III

GOVERNMENT CASH FLOW

```
10 ************ESTABLISH COLUMNS (YEARS)**************
20 COLUMNS 1-25
30 ************INPUT PARAMETERS**********************
40 INITIAL INVESTMENT = 0
50 NUMBER OF CHILDREN = 0
60 COST PER CHILD = 0
75 COST TO OPERATE = 0
80 COST OF ONE TIME MAINT = 0
80 SALVAGE VALUE = 0
90 DISCOUNT RATE = 0
100 ************CALCULATE RECEIPTS********************
110 RECEIPTS = (NUMBER OF CHILDREN * COST PER CHILD
     * 12 ) + SALVAGE VALUE
120 ************CALCULATE EXPENSES*******************
130 EXP = INITIAL INVESTMENT + COST TO OPERATE
140 ************CALCULATE NET PRESENT VALUE***********
150 NPV = NPVC(RECEIPTS, DISCOUNT RATE, EXP)
```

called when the model is run for a specific cash flow (Table V and Table VI are sample data files).

To run the government program, the following command is entered:

```
Model gov using g1
solve
all options
```

TABLE IV

CONTRACT CASH FLOW

```
10 ****************SETUP FOR 25 YEARS****************
20 COLUMNS 1-25
30 ****************INPUT PARAMETERS******************
40 LOAN = 0
50 NONLOAN = 0
60 LINTEREST = 0
70 LIFE OF LOAN = 0
80 INITIAL INVESTMENT = 0
90 NUMBER OF CHILDREN = 0
100 COST PER CHILD = 0
110 COST TO OPERATE = 0
130 COST OF ONE TIME MAINT = 0
150 DISCOUNT RATE = 0
160 SALVAGE VALUE = 0
170 ********TOTAL YEARLY RECEIPTS**********************
180 RECEIPTS = (NUMBER OF CHILDREN * COST PER CHILD
185              * 12) + SALVAGE VALUE
190 ********AMORTIZED LOAN PAYMENT*********************
200 AMORT(LOAN,NON LOAN,LINTEREST,LIFE OF LOAN,1,
205       12,PAYM,INTR,PRIN,BAL)
230 *************TOTAL EXPENSES************************
240 EXP = COST TO OPERATE + COST OF ONE TIME MAINT
250       + PAYM
260 **************NPV OF PROJECT***********************
270 NPV = NPVC(RECEIPTS,DISCOUNT RATE, EXP)
```

TABLE V

GOVERNMENT ESTIMATED COST

```
INITIAL INVESTMENT = 880000, 0
NUMBER OF CHILDREN = 100
COST PER CHILD = 260
SALVAGE VALUE = 0
DISCOUNT RATE = .10
COST TO OPERATE = 178000
COST OF ONE TIME MAINT = 0 FOR 4,2500,0 FOR 4,2500,
      0 FOR 4,12500, 0 FOR 4, 2500, 0 FOR 4, 2500
```

TABLE VI

CONTRACT ESTIMATED COST

```
LOAN = 880000,0
NONLOAN = 0
LINTEREST = .12
LIFE OF LOAN = 25
INITIAL INVESTMENT = 880000,0
NUMBER OF CHILDREN = 100
COST PER CHILD = 260
COST TO OPERATE = 178000
COST OF ONE TIME MAINT = 0 FOR 4,2500,0 FOR 4,2500,
      0 FOR 4, 12500, 0 FOR 4, 2500, 0 FOR 4,2500
DISCOUNT RATE = .10
SALVAGE VALUE = 0
```

Appendix A shows the output for two sample runs over the first five years of the project.

3. Model Output

Figure 4.1, is a graphical representation of the government cash flow as a function of years and NPV. Coincidently, with a discount rate of ten percent and the estimated costs and receipts, the model output results in almost zero net present value at the end of the economical life. This should not be considered as a true estimate of the total lifetime cost. As explained earlier in this chapter, the estimates for this project are subject to change if the draft RFP changes. Further investigation will also show that NPV is subject to a great degree of uncertainty.

The curve itself is typical of a project with a large initial investment and a slow return on investment over time. The slope starts with a sharp rise and the tapers off until it is almost level. In this example the difference in NPV between 15 and 25 years is 171,000 dollars while the difference between 5 and 15 years is 440,000 dollars. Thus a significant reduction in slope is noted after the 15 year point. In this cash flow situation it is self-evident that after 25 years the initial cost has little impact on this project. This is one reason that NAVFAC's use of 25 year life expectancy is suitable even though many structures in the Navy may last fifty or more years.

Figure 4.2, is a graphic representation of the contract cash flow as a function of years and NPV. The effect of spacing the cash pay out for the initial investment is quite noticeable. Instead of the rapid increase in NPV over time seen in Figure 4.1, Figure 4.2 is quite flat with a slight negative slope.

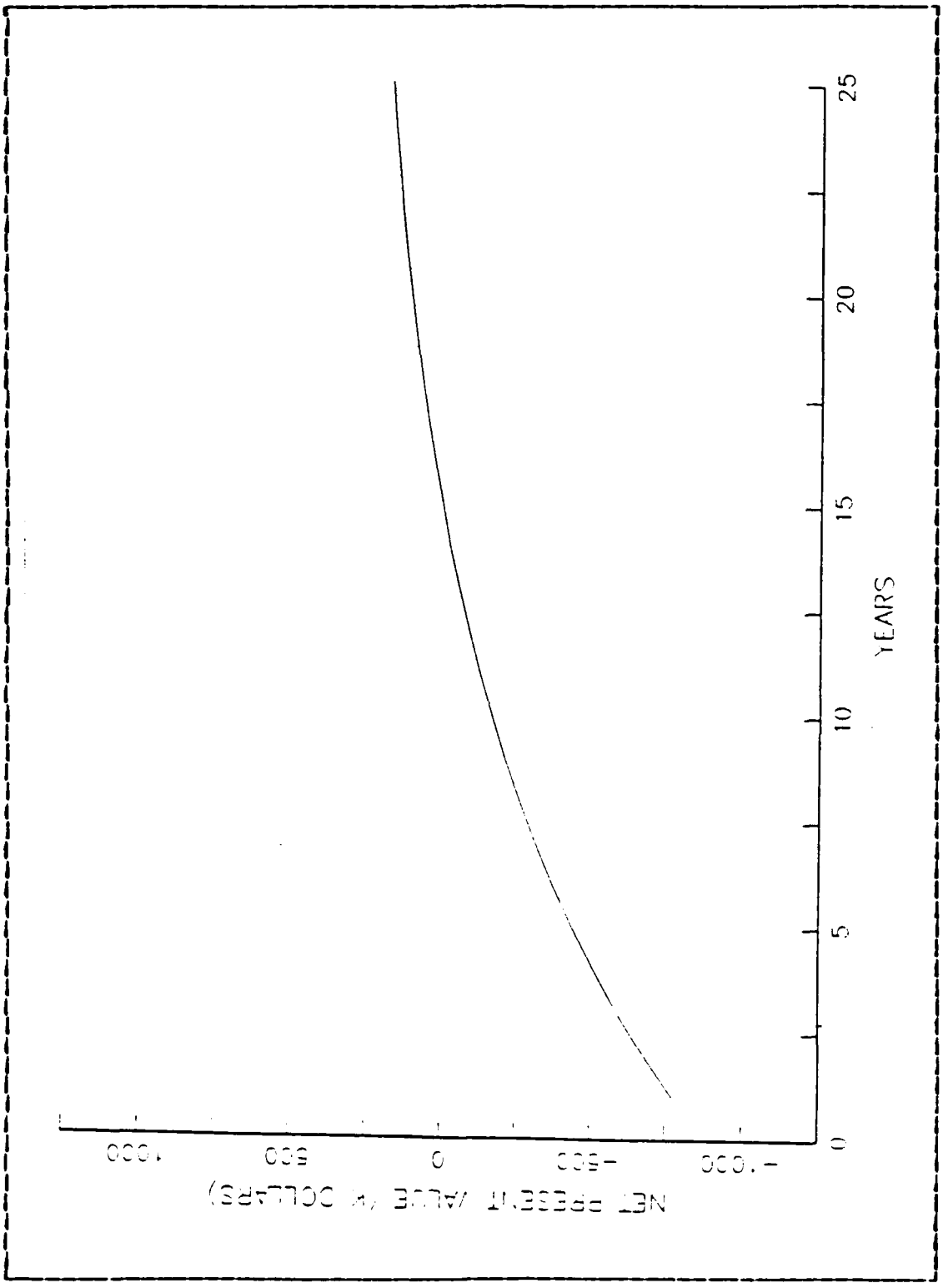

Figure 4.1 NPV, Base Run, Government Cash Flow.

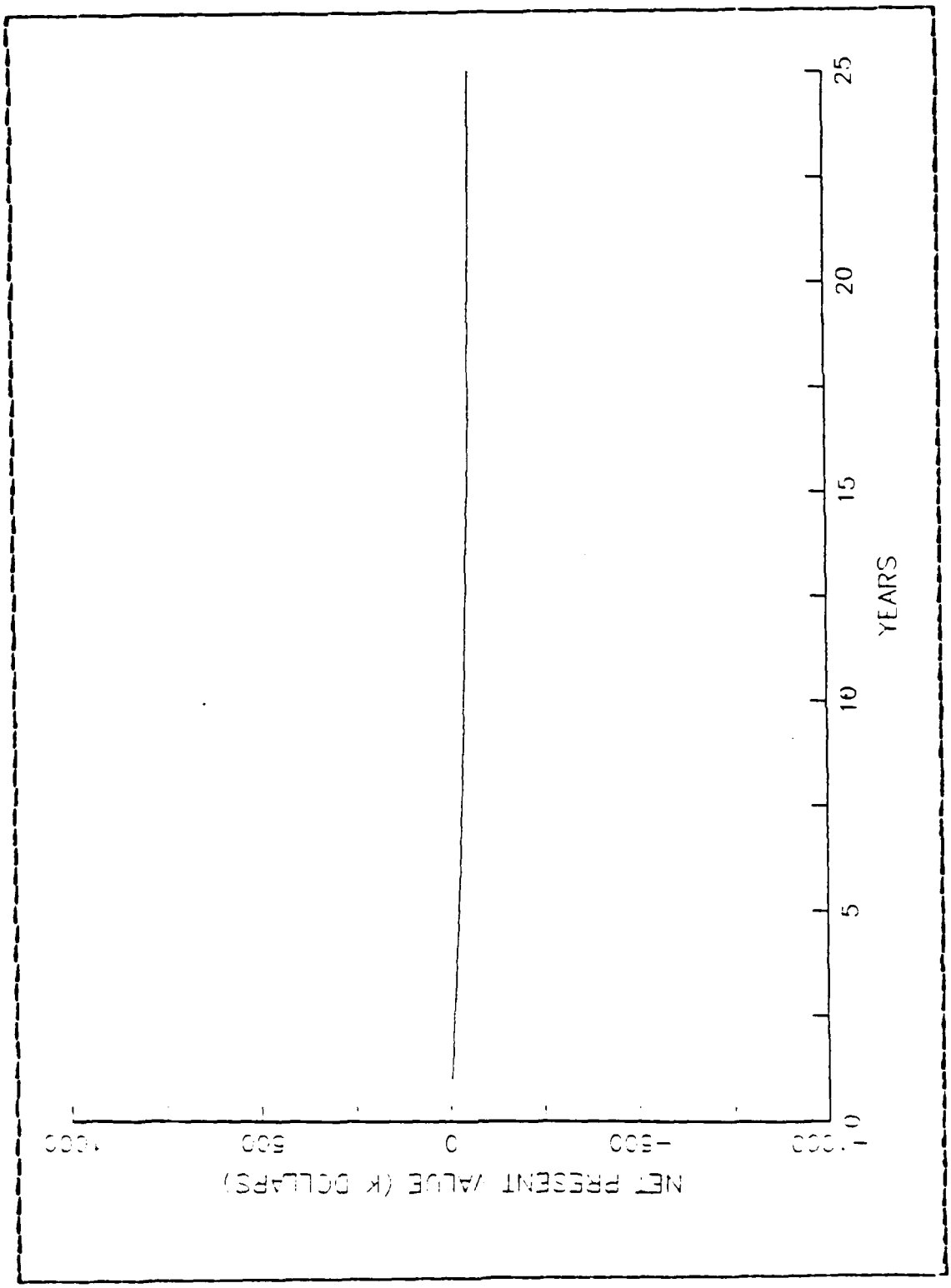

Figure 4.2 NPV, Base Run, Contract Cash Flow.

4. Results

Utilizing the decision rule of selecting the alternative with the highest NPV, the in-house operation of child care centers with a NPV of 174,000 dollars is preferred over contract operations which has a NPV of -62,000 dollars. The next chapter performs extensive sensitivity analysis on the base runs.

V. SENSITIVITY AND RISK ANALYSIS

A. BACKGROUND

In any consideration of future events, some uncertainty is involved. National interests can change, production demands can increase or decrease, unforeseen technological advances can cause radical changes in productivity and labor needs, economic pressures can change interest rates and government tax structure, strikes and labor disputes can greatly increase costs. These uncertainties will affect the input variables for any economic model.

Although the total elimination of uncertainty is impossible, methods have been developed to analyze the uncertainty in a given situation. Historical data analysis combined with future forecasting is the major technique used to analyze uncertainty for a particular variable. Through the use of regression analysis, smoothing functions or simulation, a future forecast based on historical data can be made. Although many times a single point value is given, the forecast should also include an estimate of error for that value. This allows the user of the information a method of estimating the worth of the data prior to its use.

In taking uncertainty into account, and thereby measuring the risk involved, various methods have been developed. The payback period model discussed in Chapter III is used by managers as quick risk test. The payback period model calculates the time required to payback the initial investment. The decision rule is that the alternative that pays the project back in the shortest time has the lowest risk of all the projects.

In addition to the payback period model, six other methods are frequently used to determine risk of the project.

1. Break-Even Analysis: When the choice of alternative is dependent on one parameter, "break-even" analysis is commonly used. The method involves three steps. First, the most likely value of the dependent parameter is determined. Second, the point where every alternative is economically equal is calculated. Third, the value of the dependent parameter for each economically equal alternative is compared to the most likely value. The decision rule is to select the alternative which has the least amount of difference between the calculated and estimated value of the parameter.
2. Optimistic-Pessimistic Estimation: This method is commonly used to determine if the amount of uncertainty changes the risk. The alternatives are subjected to three variations, 1) a pessimistic value for the parameter, 2) a optimistic value for the parameter, and 3) the most likely value for the parameter. The alternative that is optimal using all three values is is selected. Even if no alternative is optimal using all three values, this method allows the decision maker an opportunity to examine the best and worst case for all alternatives;
3. Risk Adjusted Minimum Attractive Rates of Return: This method is based on using a higher discount rate for those elements that are subjected to the most amount of uncertainty;
4. Reduction of Useful Life: The lifetime of each alternative is reduced by a fixed percentage, say 50 percent. All alternatives are then evaluated to determine their ranking given an earlier obsolescence time;

5. Sensitivity Analysis: Sensitivity analysis is used when one or more parameters are uncertain. This method answers two major questions. First, how does the output behave as parameters are varied? Second, what does changing the parameters do to the selection of the alternatives? This method is explained in more detail in the next section;
6. Probability Functions: In this method, a probablity function is estimated for each element and these are combined to make a probablity function that represents the total outcome of the event. [Ref. 29]

The last two methods will used to analyze the cash flows for the child care center.

B. SENSITIVITY ANALYSIS

Sensitivity analysis is a method that compares a base output with outputs resulting from various values of each parameter used in the model. The method used in this analysis is to fix all input parameters but one. The one element not fixed is subjected to a 50 percent increase and decrease in value. The value of 50 percent is based on discussions with NAVFAC project managers and engineers. A graphical comparison is then made of the outputs. If no significant changes are noted, the model is considered robust and insensitive to changes in that element. If, however, the output varies considerably from the base case, the model is considered to be sensitive to that input parameter. The sensitive elements can thus be noted and subjected to more detailed investigation.

1. Sensitivity Analysis, Government Cash Flow

Figure 5.1 demonstrates the different degrees of sensitivity each parameter has with respect to time and to magnitude of change.

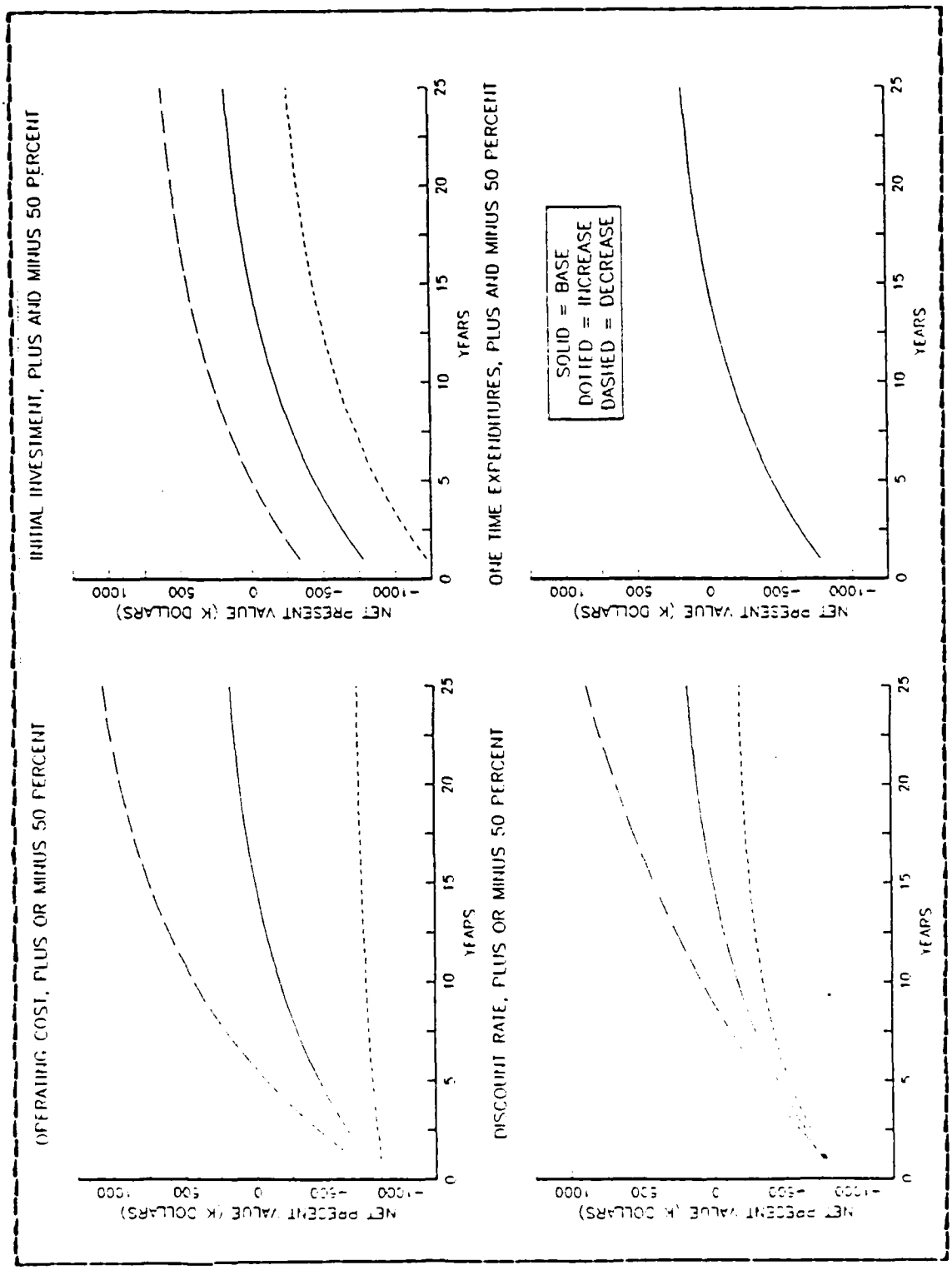

Figure 5.1 Sensitivity over Economic Life Government Cash Flow.

Changes in the operating cost are illustrated in the upper left hand graph of Figure 5.1 The operating cost has the basic characteristics of a uniform cash flow over time. The graphical representation gives the appearance that the difference between increase and decrease of operating cost is not symmetric throughout the economic life. The difference seems most apparent at the seven year point. At the seven year mark, an increase of 50 percent of operating cost results in a decrease in NPV by 440,000 dollars while a decrease of 50 percent yields an increase in NPV of 439,000 dollars.

The upper right hand graph shows the result of a 50 percent increase and decrease respectively in initial investment. The change in initial investment causes a uniform increase or decrease in the NPV.

In contrast to changes in operating cost and initial investment, increases and decreases in the discount rate result in a non-symmetric and time dependent change in the NPV, as shown in the lower left hand graph. At the 25 year point, a decrease by 50 percent results in an increase in NPV by 709,000 dollars while a 50 percent increase yields a NPV decrease of 360,000 dollars. At seven years, a 50 percent increase results in a decrease of 119,000 dollars and a 50 percent decrease results in a 158,000 dollars increase in NPV. The ratio of change goes from approximately 1.11 to 1 at seven years to approximately 1.97 to 1 at twenty-five years. Changes in the discount rate thus have a nonuniform and nonsymmetric impact on the NPV.

The right hand graph illustrates the impact that one-time expenditures have on NPV. The lines representing increase and decrease both coincide with the base case line. It is obvious that in this situation, onetime maintenance causes no significant change in NPV.

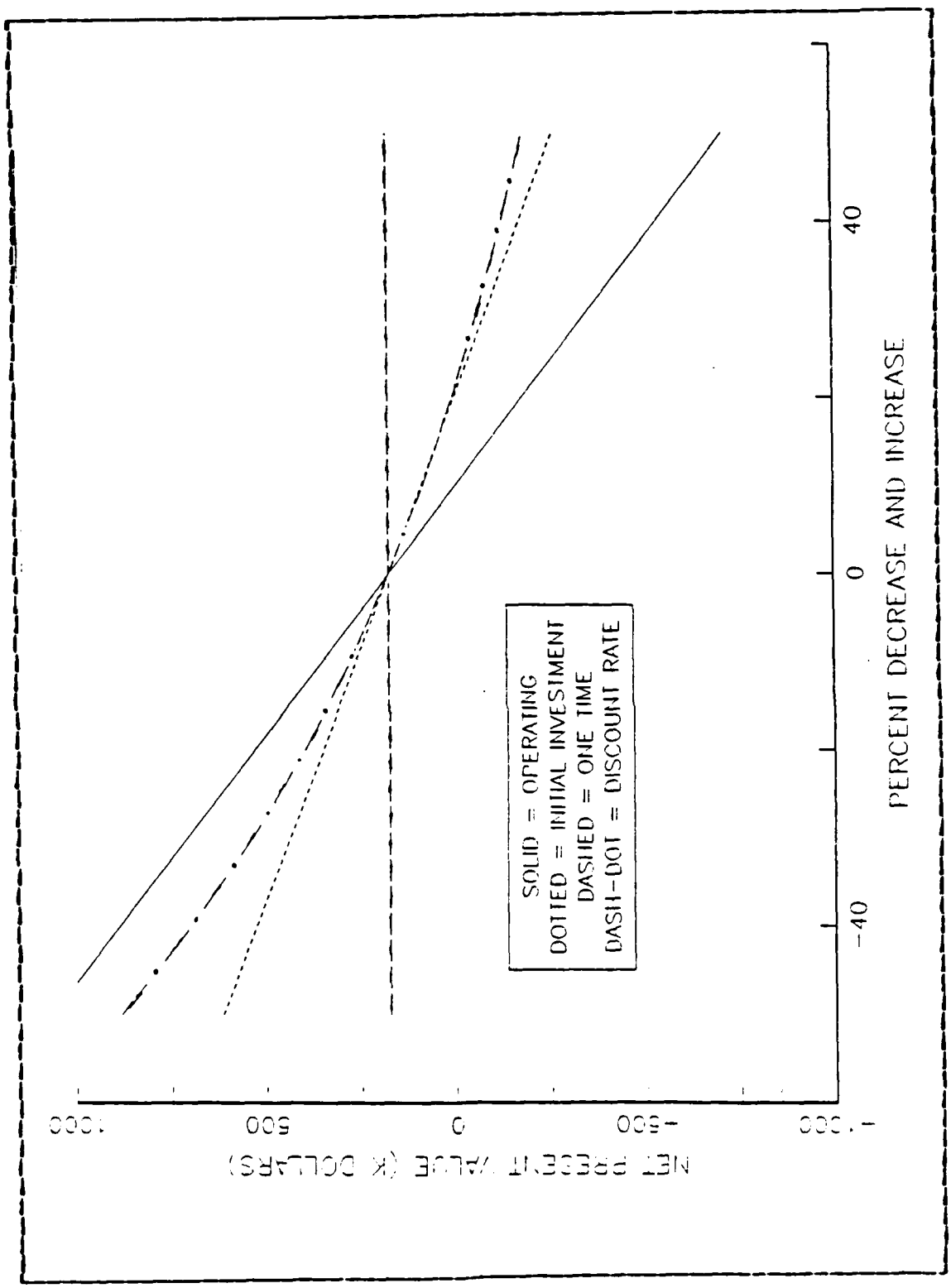

Figure 5.2 Sensitivity at Year 25, Government Cash Flow.

Figure 5.2 further emphasizes the sensitivity of the model to parameter variations at the twenty-five year point. For this graph the selected parameters were individually varied from plus 50 percent to minus 50 percent. The NPV, at the 25 year mark, was then plotted as a function of the increase and decrease for each parameter. The straight lines for operating cost, initial investment, and one time cost further illustrate that these parameters are symmetric about the base case. The curved line for the discount rate demonstrates the nonsymmetric nature of variation in this parameter.

The slope of each line is a direct indication of the relative sensitivity each parameter has on NPV. The steeper slope for operating cost demonstrates the greater sensitivity this parameter has when compared to variations in initial investment and one time cost. This graph also illustrates the impact of various combinations of changes. If operating costs were increased by 20 percent and initial investment increased by 10 percent the total change in NPV is -594,000 dollars (i.e., -420,000 dollars plus -174,000 dollars).

In summation, the government cash flow is sensitive to three factors. The most sensitive parameter, given a 25 year life expectancy, is operating cost. Closely following operating cost, and indeed more significant in the first seven years of the project, is initial investment. The sensitivity of the discount rate differs from that of initial investment and operating cost. Although not as significant in magnitude as initial investment or operating cost, the discount rate is both time dependent and nonsymmetric with respect to the base case.

2. Sensitivity Analysis, Contract Cash Flow

The upper left hand corner graph of Figure 5.3 shows that, as was the case with the government model, cost to operate has the most significant impact on NPV of all the parameters. The symmetry with respect to the base case is much more evident than for the government cash flows, as shown by the relativly uniform increase and decrease with respect to the base run.

The initial investment sensitivity was handled in a slightly different manner than in the government model. The cash flow of the contractor is subject to both the initial cost and the rate at which he/she can borrow the required capital. The upper right hand graph demonstrates the impact that increases and decreases in the initial loan would cause. The lower left hand graph shows the impact that increases and decreases in the interest rate on the loan would have. It is interesting to note that changes in interest rate on the loan do not effect the NPV in the same manner as changes in the discount rate. Changes in the interest rate are symmetric with respect to the base case. The reason behind this is that interest rates on the loan are not directly inputted into the cash flow. Loan interest rates are used to calculate an amortization payment schedule. Thus the effect of interest rate is similar to that of an increase in a periodic payment such as operating cost.

Although the variations in the discount rate are less sensitive than in the government case overall, it has the same behavior. Variations in this parameter show that it is time-dependent and also nonsymmetric with respect to the base case.

The straight lines in Figure 5.4 further demonstrate the symmetric nature of operating cost, initial loan, and

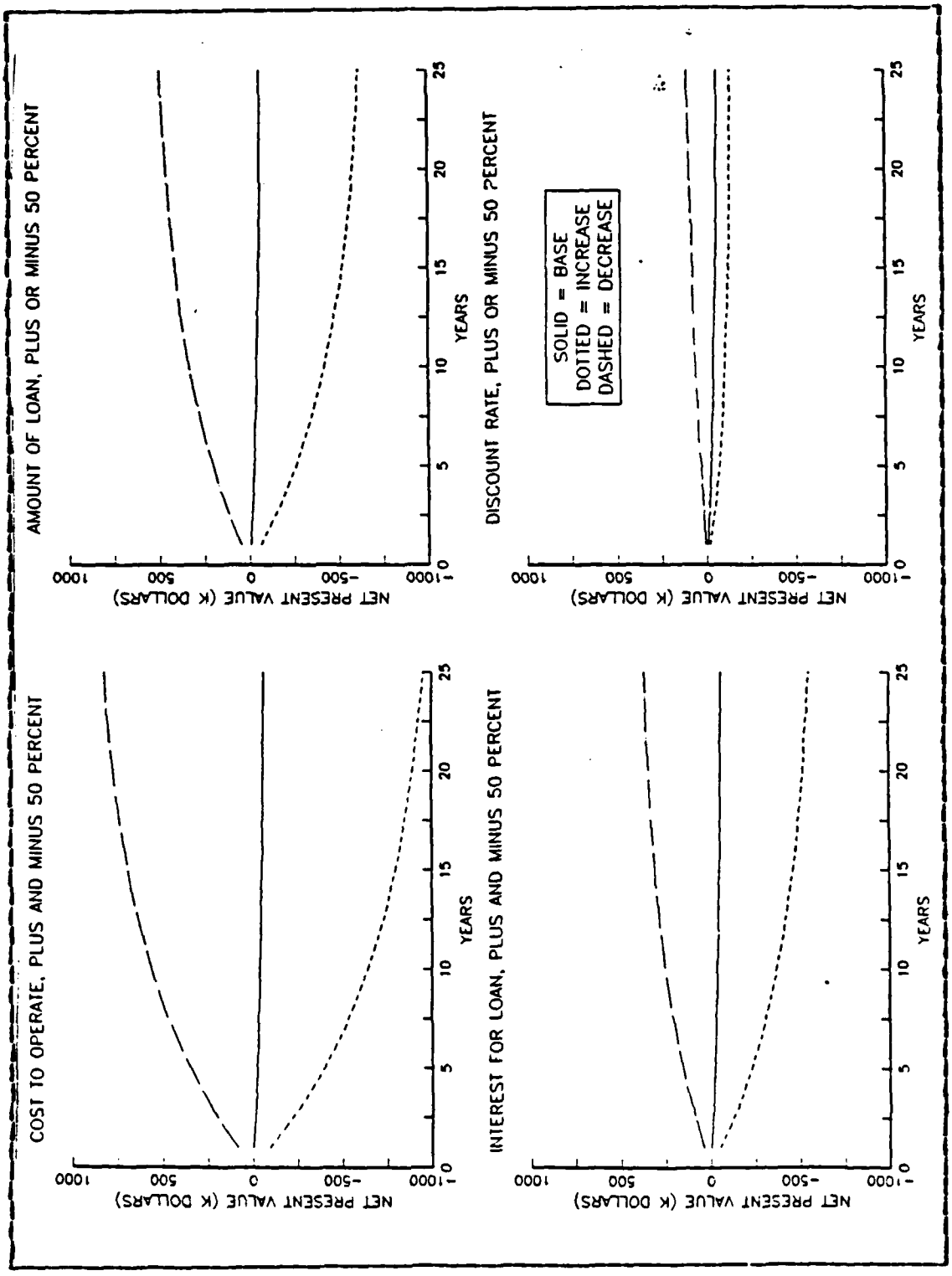

Figure 5.3 Sensitivity Over Economic Life Contract Cash Flow.

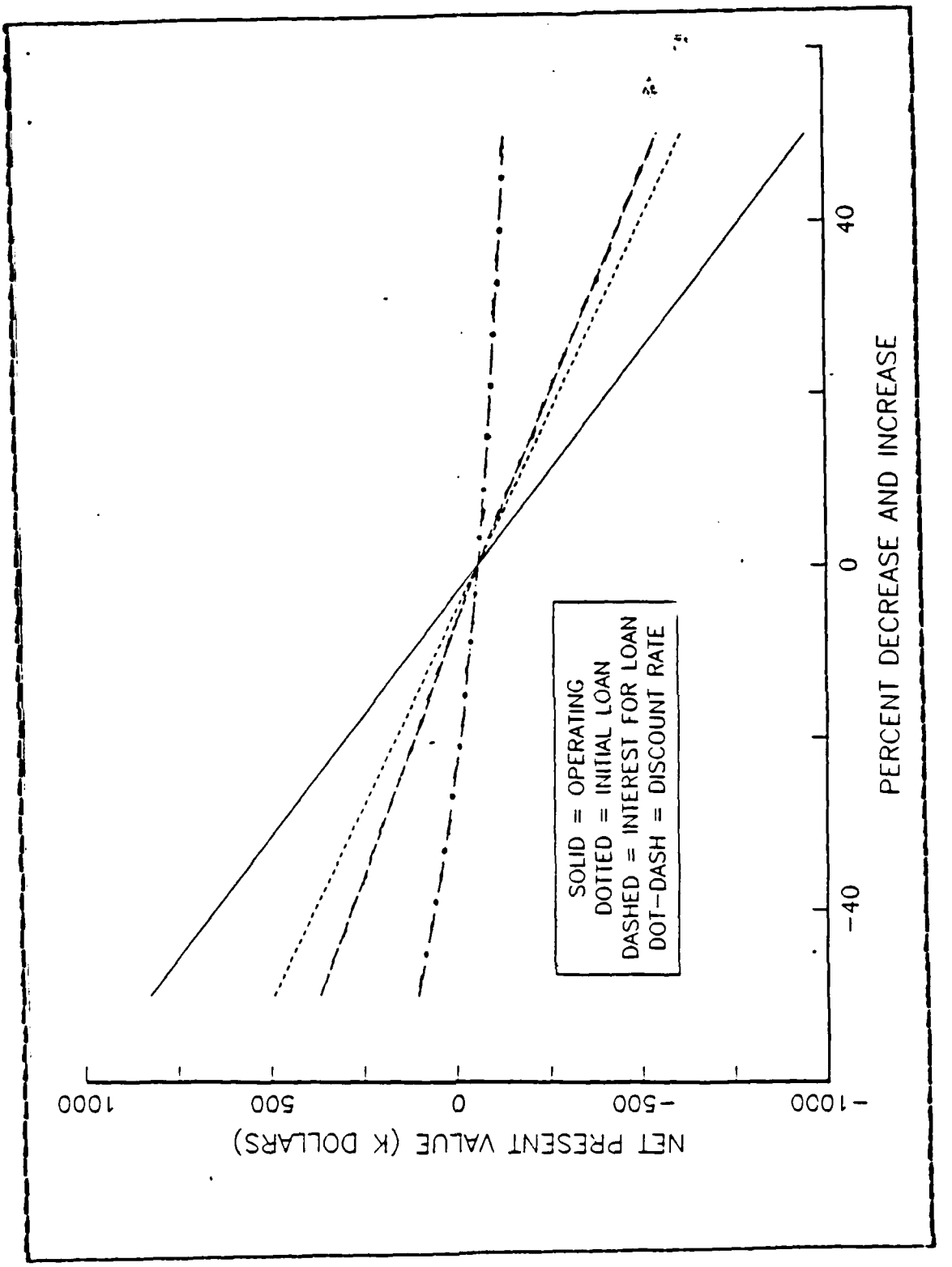

Figure 5.4 Sensitivity at Year 25, Contract Cash Flow.

loan interest rates. The curved line demonstrates the lack of symmetry in the discount rate.

3. Sensitivity Analysis, Ranking of Cash Flows

The first two sections examined the sensitivity of each cash flow to variations in input parameters. However, the decision rule is to accept the alternative with the highest NPV as the prefered choice. Therefore, how sensitive ranking is to variations in the input parameters must also be examined.

Figure 5.5 shows the impact of changing the most sensitive parameter, operating cost, for each model. The base case is pictured in the upper left hand graph and illustrates that the government model is preferred at the 25 year mark. However, the contractor model is the preferred alternative up to year thirteen of project life.* The lower graphs demonstrate the impact that increasing and decreasing the operating cost by 50 percent has on the selection. Although the operating cost is the most significant and sensitive parameter for both models individually, it is insignificant in the ranking of the models. For all three cases the crossover point is approximately thirteen years.

Figure 5.6 demonstrates the sensitivity of crossover point as a function of the initial investment. As with operating costs the crossover point is relatively stable. For both cash flows the crossover point remains approximately thirteen years.

Figure 5.7 demonstrates the sensitivity of the NPV models to discount rate. Although the discount rate is one of the less sensitive parameters for the individual cash flows, it is the most significant in ranking of the two

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*This assumption can be misleading. In the case of the contractor model, payback of the loan is calculated over a loan of 25 years. If the project is to last only thirteen years a new cash flow will have to be calculated.

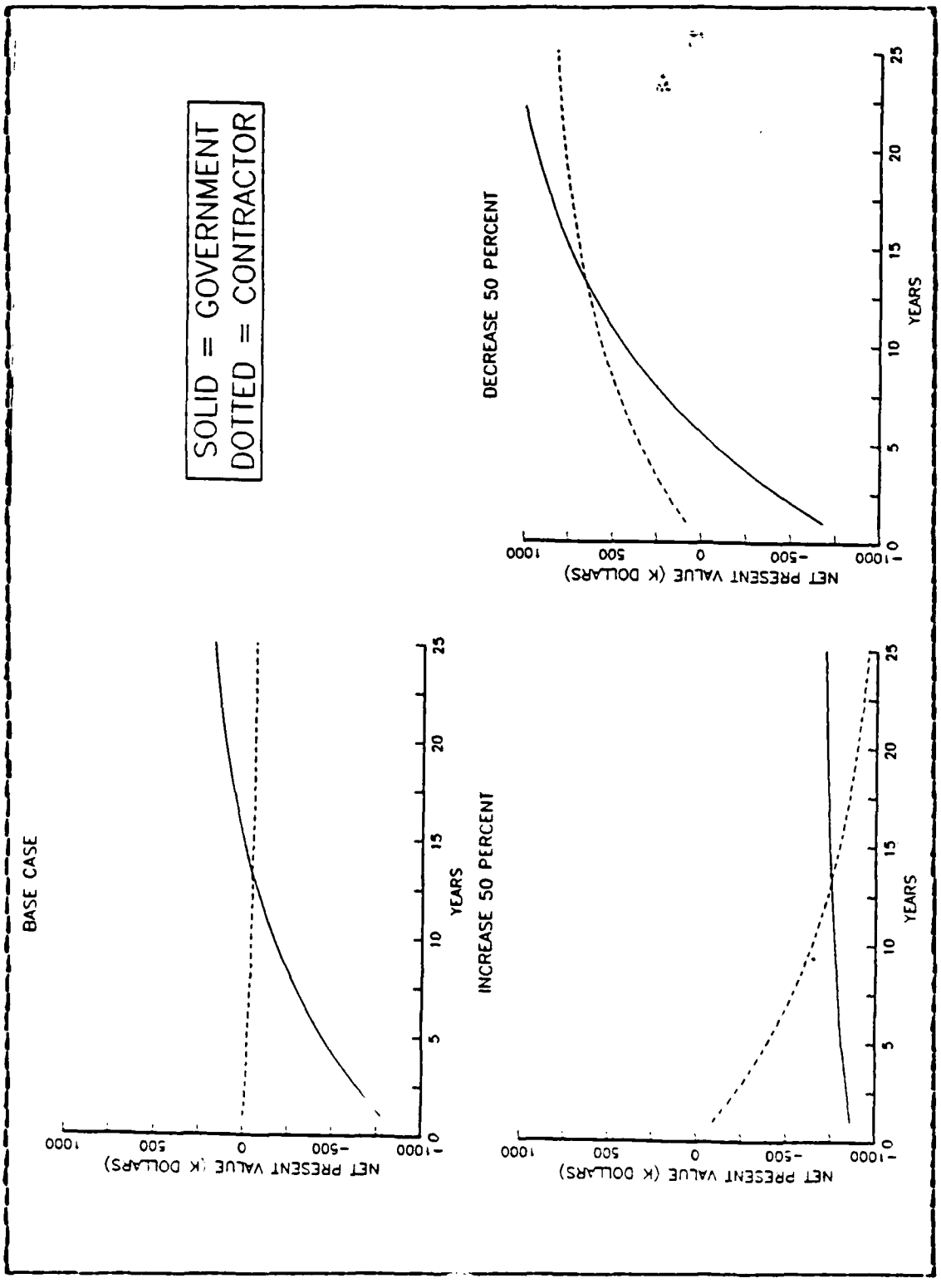

Figure 5.5 Ranking as a Function of Operating Costs.

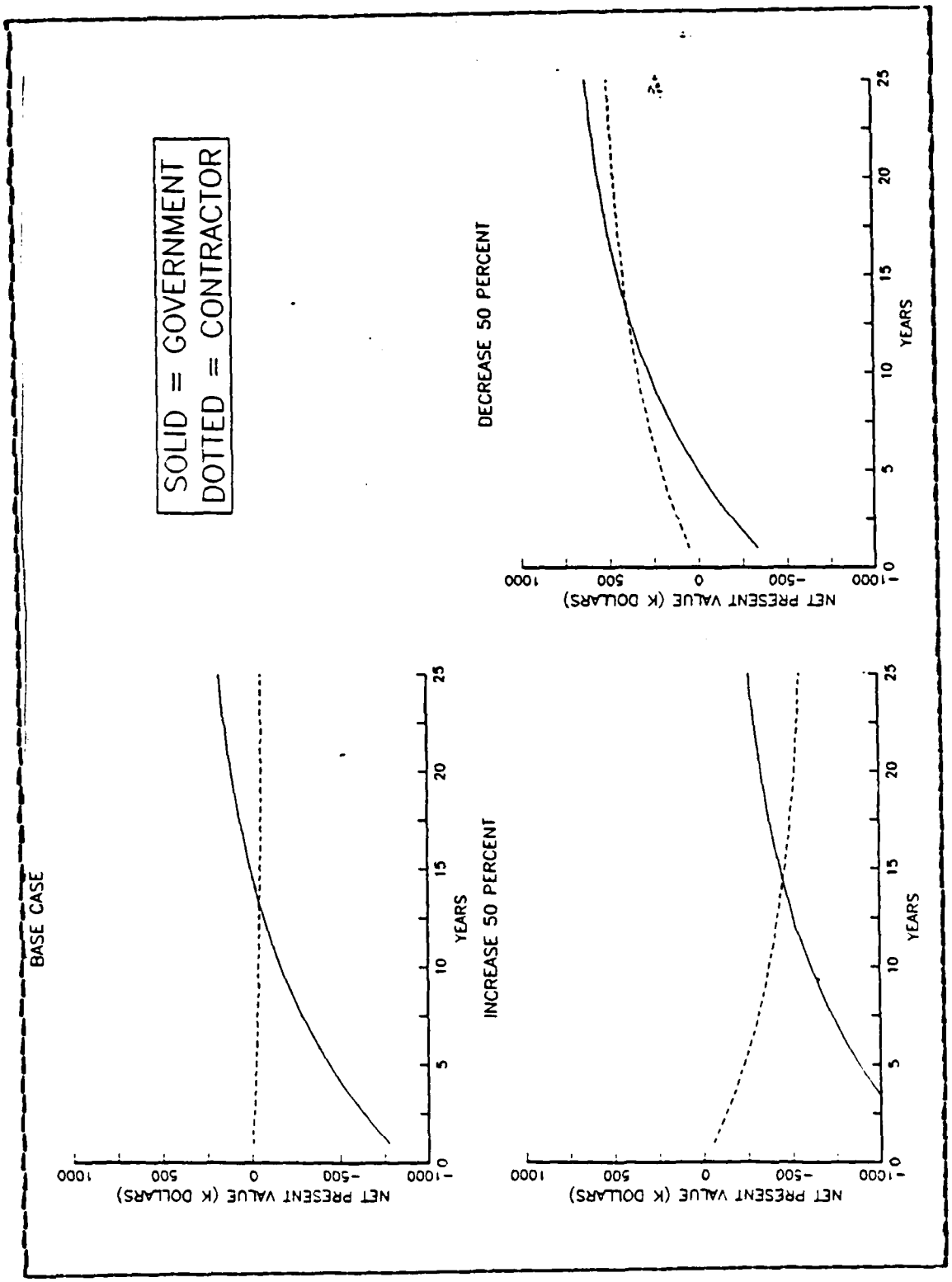

Figure 5.6 Ranking as a Function of Initial Investment.

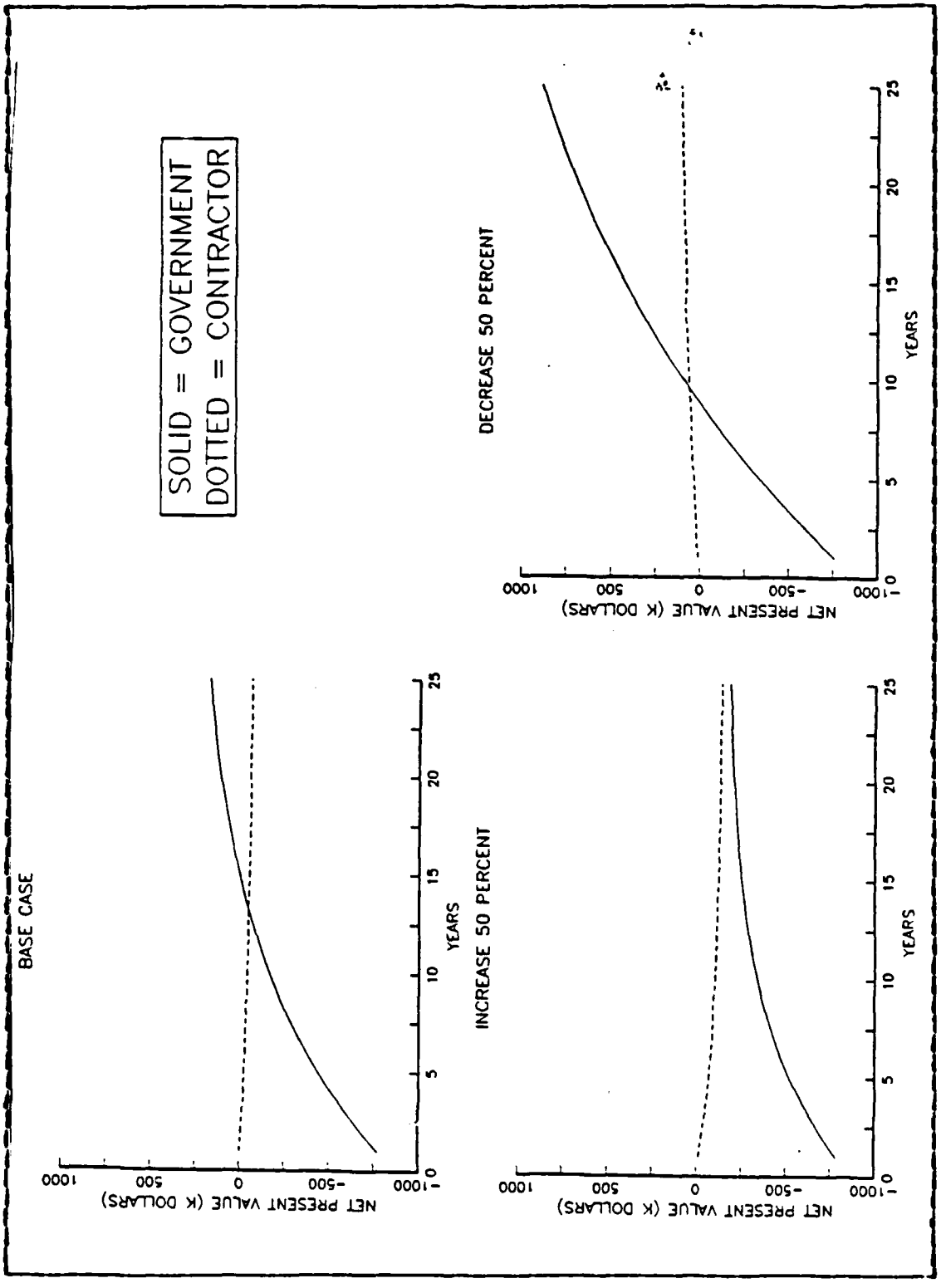

Figure 5.7 Ranking as a Function of Discount Rate.

alternatives. With an increase of 50 percent, there is no crossover point. In this case, the contractor cash flow will always show as a better alternative than the government cash flow. With a decrease of 50 percent in the discount rate, the crossover point drops to approximately nine years so the government cash flow is the preferred alternative.

C. MONTE CARLO TECHNIQUE

1. Background

The Monte-Carlo technique is a method of calculating a distribution curve for the output of the model. The method is quite simple in concept. For each input parameter, a distribution function is assigned. A random variable is selected from the distribution function. After all parameters have been selected, the model is run and the output recorded. After the simulation is performed a histogram is created that roughly describes the distribution function of the output.

The Monte-Carlo feature is included in the IFPS program. This package does, however, have on major drawback, in that the maximum number of iteration used to create a distribution function is limited to 1000. This number is further reduced if the economic lifetime of the project is long or has many input parameters. With four input parameters and a 25 year life cycle, the cash flows in this analysis could be subjected to only 300 iterations before overloading the computer memory available.

As was the case with the base cash flow, no detailed historical records were available for costs. Consequently the distribution functions used are based on personal discussions with engineers.

2. Monte Carlo Simulation, Government Cash Flow

In the government model two parameters were considered quite sensitive: 1) operating cost and 2) initial investment. For initial investment the density function used is a triangular with apex at 950,000 dollars and endpoints at 880,000 and 1,000,000 dollars. Figure 5.8 provides a histogram of the range of values assigned to investment cost during the simulation.

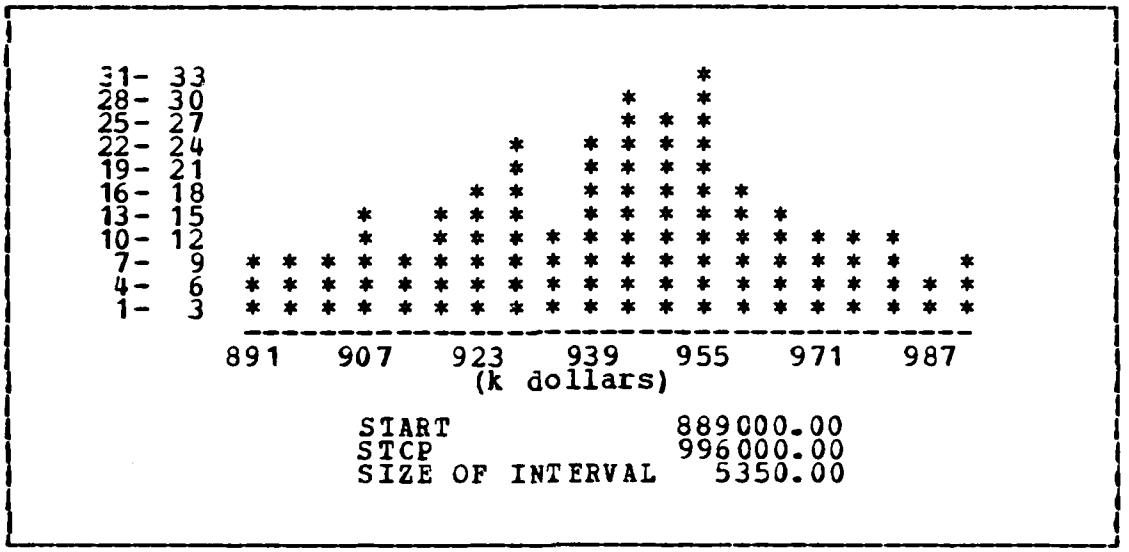

Figure 5.8 Density Function for Initial Investment Government Cash Flow.

The function used for operating cost is a normal distribution with mean 178,000 dollars and standard deviation of 20,000 dollars. Figure 5.9 is a histogram of the values assigned for operating cost during the simulation.

Figure 5.10 is the density function for NPV generated by the Monte-Carlo simulation. The distribution, although a rough approximation with only 300 iterations, is quite normally distributed in appearance. Table VII are summary statistics that support the observation of normal

distribution appearance. Skewness is 0 and kurtosis is 2.7, as compared to skewness of 0 and kurtosis of 3.0 for the idealized normal distribution. The most significant factor is the multiplicative effect that small variation in the input have on the output. In this case, standard deviations of approximately 20,000 dollars for both inputs resulted in a standard deviation of approximately 200,000 in the output.

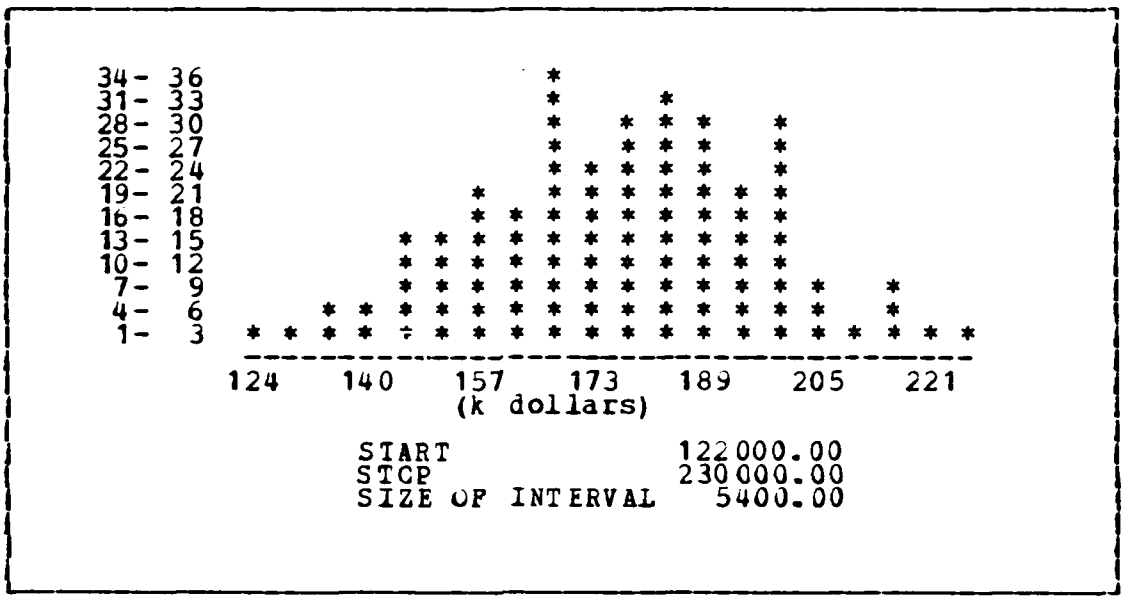

Figure 5.9 Density Function For Operating Costs Government Cash Flow.

3. Monte Carlo Simulation, Contract Cash Flow

The contractor model is simulated using three inputs 1) loan amount, 2) interest on loan and 3) operating cost. A triangular density with apex at 880,000 dollars and endpoints at 880,000 and 1,000,000 was used to generate the loan amount. Figure 5.11 is a histogram of the values selected for input. For the interest rate, a uniform distribution ranging from 10 to 15 percent is used. The numbers generated are shown in Figure 5.12 .

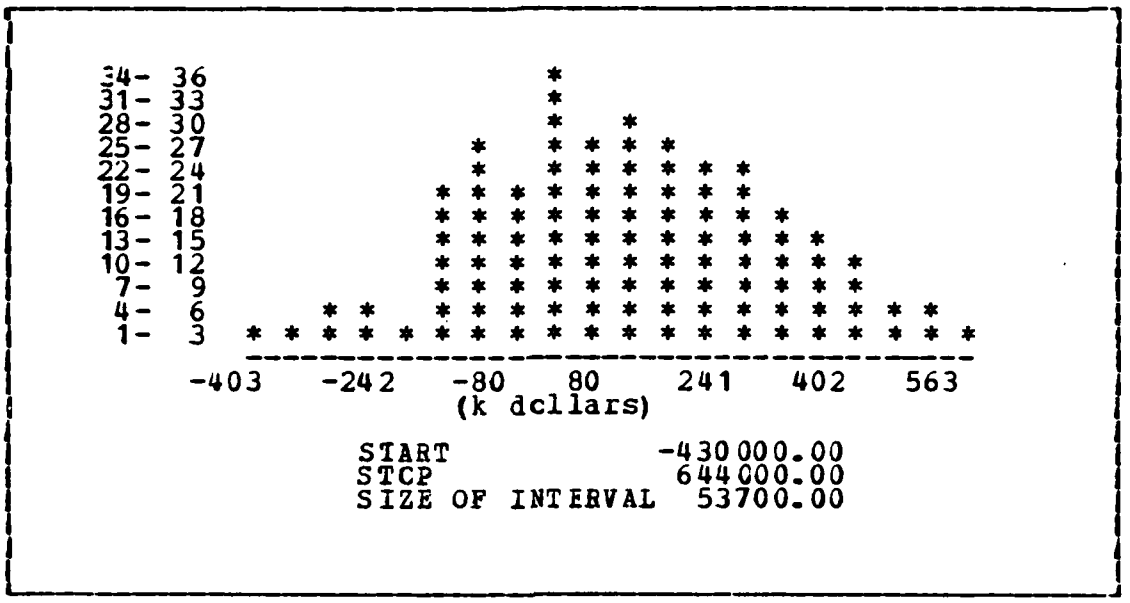

Figure 5.10 Density Function for NPV Government Cash Flow.

TABLE VII

DISTRIBUTION STATISTICS, GOVERNMENT CASH FLOW

MEAN	STD DEV	SKEWNESS	KURTOSIS	10% TO 90% CONFIDENCE INTERVAL FOR MEAN	
INITIAL INVESTMENT					
**********					
942966	24505	-.1	2.4	941155	944777
COST TO OPERATE					
**********					
176685	19805	.0	2.7	175222	178149
NPV					
**********					
127250	201610	.0	2.7	112351	142149

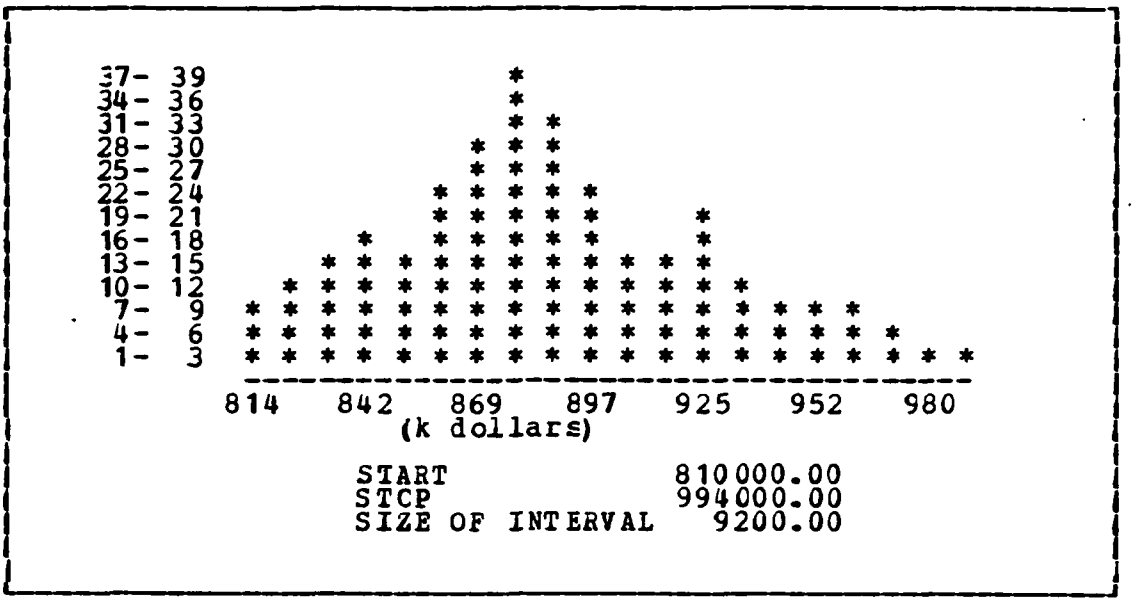

Figure 5.11 Density Function for Loan Amount Contract Cash Flow.

For cost to operate a normal distribution with mean of 178,000 dollars and a standard deviation of 20,000 dollars is used. Figure 5.13 portrays the values generated for operating cost. The resulting NPV values generated by the simulation are displayed in Figure 5.14 . This generated density function is skewed to the right. Table VIII shows the measured amounts of skewness and kurtosis. As seen in the government cash flow case, the most noticeable feature is the increase in standard deviation for the output generated by relativly "small" deviations in the input.

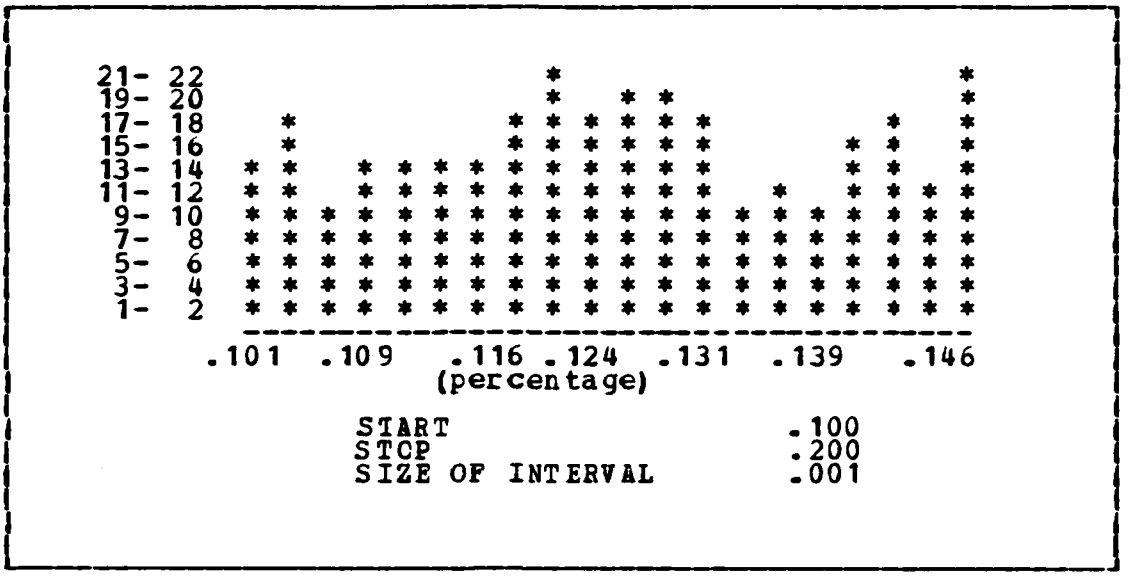

Figure 5.12 Density Function for Interest on Loan Contract Cash Flow.

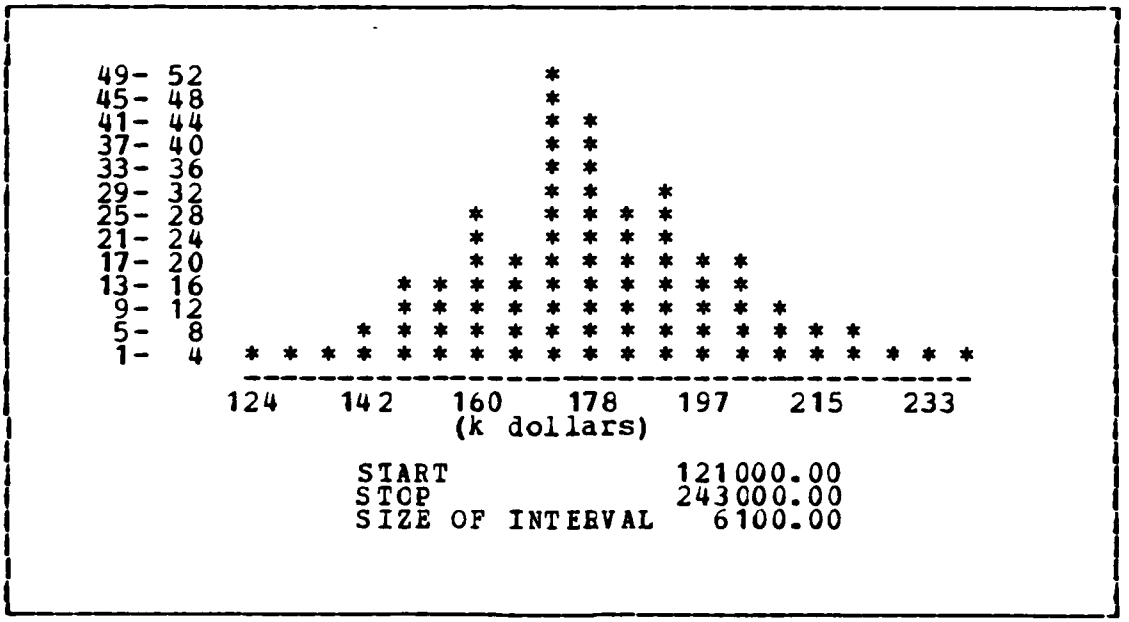

Figure 5.13 Density Function for Operating Cost Contract Cash Flow.

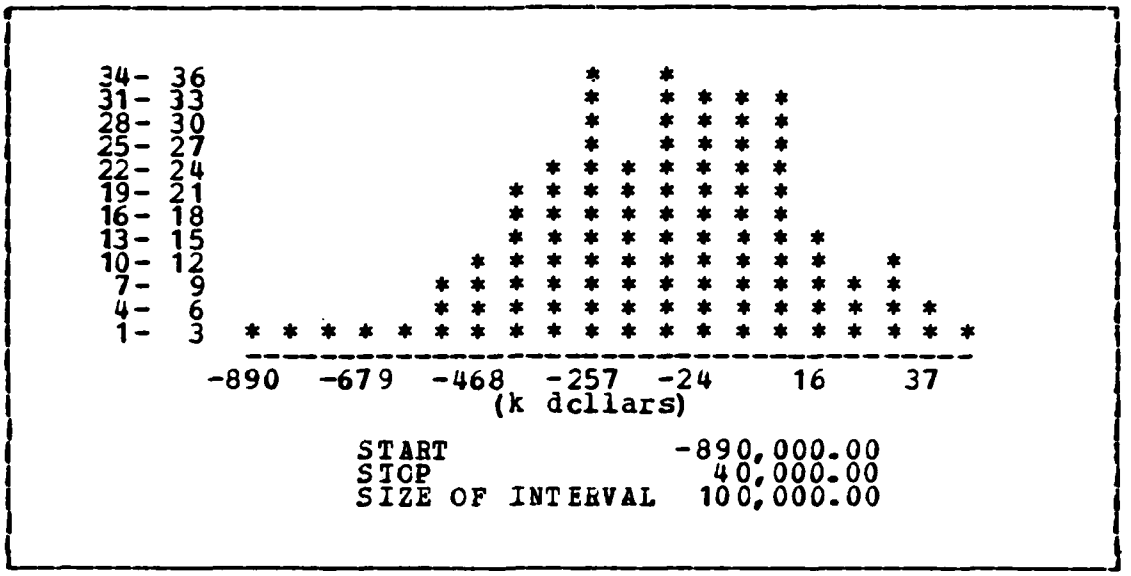

Figure 5.14 Density Function for NPV Contract Cash Flow.

TABLE VIII

DISTRIBUTION STATISTICS, CONTRACT CASH FLOW

MEAN	STD DEV	SKEWNESS	KURTOSIS	10% TO 90% CONFIDENCE INTERVAL FOR MEAN	
LOAN					
**********					
886674	38688	.3	2.6	883815	889533
LINTEREST					
**********					
0.1254	.0144	.0	1.9	.1243	.1264
COST TO OPERATE					
**********					
178095	20728	.1	3.2	176563	179627
NPV					
**********					
-115644	241938	-.3	3.2	-133524	-97765

VI. CONCLUSIONS

Leasing has been justified at the Federal Government level as a method for reducing costs. The NPV model used in this analysis has selected government operation of a child care center facility over contract operation. However, the model has a major weakness when selecting between two alternative cash flows. Sensitivity analysis shows that the discount rate, not magnitude of cash flows, is the primary parameter that affects the selection.

Private industry, local municipalities, and state government have used leasing as a method to acquire subsidies from the Federal Government. There is no reduction in cost if one federal agency, in this case the Department of the Navy, transfers tax incentives to private industry, who in turn reduces the amount of revenue for another agency, the Department of the Treasury.

Thus the appearance of savings only results from the limitations of the model used, rather than from real economic gains utilizing underlying subsidies.

TABLE IX

OUTPUT FOR GOVERNMENT CASH FLOW, FIRST FIVE YEARS

YEARS	1	2	3	4	5
ESTAELISH COLUMNS (YEARS)					
INPUT PARAMETERS					
INITIAL INVESTMENT	880000	0	0	0	0
NUMBER OF CHILDREN	100	100	100	100	100
COST PER CHILD	260	260	260	260	260
COST TO OPERATE	178000	178000	178000	178000	178000
COST OF ONE TIME MAINT	0	0	0	0	2500
SALVAGE VALUE	0	0	0	0	0
DISCOUNT RATE	.1000	.1000	.1000	.1000	.1000
CALCULATE RECEIPTS					
RECEIPTS	312000	312000	312000	312000	312000
CALCULATE EXPENSES					
EXP	1058000	178000	178000	178000	178000
CALCULATE NET PRESENT VALUE					
NPV	-774364	-678331	-591028	-511662	-439511

TABLE X

OUTPUT FOR CONTRACT CASH FLOW
FIRST FIVE YEARS

YEARS	1	2	3	4	5
SETUP FOR 25 YEARS					
INPUT PARAMETERS					
LOAN	880000	0	0	0	0
NONLOAN	0	0	0	0	0
LINTEREST	.1200	.1200	.1200	.1200	.1200
LIFE OF LOAN	25	25	25	25	25
INITIAL INVESTMENT	880000	0	0	0	0
NUMBER OF CHILDREN	100	100	100	100	100
COST PER CHILD	260	260	260	260	260
COST TO OPERATE	178000	178000	178000	178000	178000
COST OF ONE TIME MAINT	0	0	0	0	2500
DISCOUNT RATE	.1000	.1000	.1000	.1000	.1000
SALVAGE VALUE	0	0	0	0	0
TOTAL YEARLY RECEIPTS					
RECEIPTS	312000	312000	312000	312000	312000
AMORTIZED LOAN PAYMENT					
PAYM	111220	111220	111220	111220	111220
INTR	105280	104527	103678	102722	101644
PRIN	5940	6693	7542	8499	9577
BAL	874060	867366	859824	851325	841748
TOTAL EXPENSES					
EXP	289220	289220	289220	289220	291720
NPV OF PROJECT					
NPV	-5584	-10661	-15276	-19471	-24993

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