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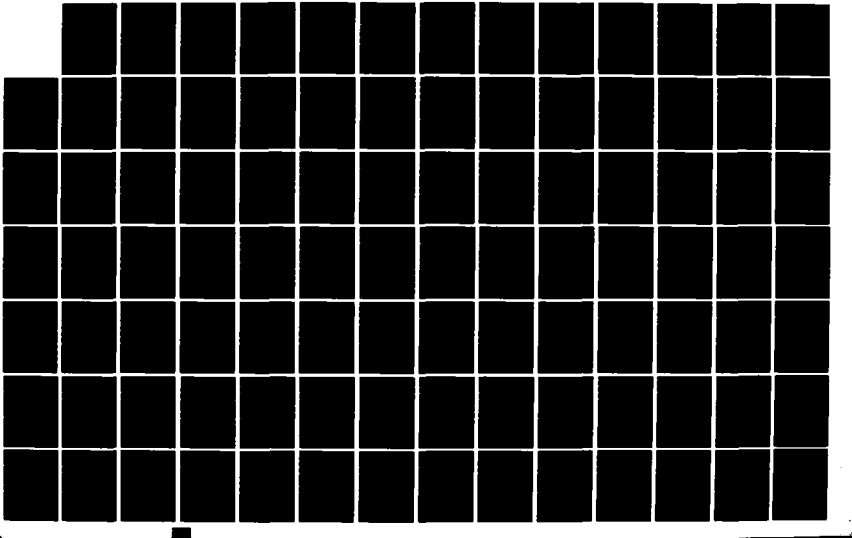

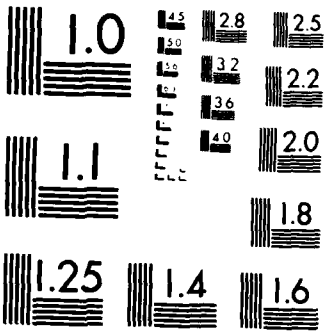

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# A GUIDE FOR AIR FORCE LEASE VERSUS BUY DECISIONS

THESIS

AFIT/GOR/OS/84D-11 James S. Shedden

Captain, USAF

AFIT/GOR/OS/84D-11

# A GUIDE TO AIR FORCE LEASE VERSUS BUY DECISIONS

THESIS

Presented to the Faculty of the School of Engineering
of the Air Force Institute of Technology
Air University
in Partial Fulfillment of the
Requirements for the Degree of
Master of Science

by

James S. Shedden, B.S.
Capt USAF

Graduate Operations Research

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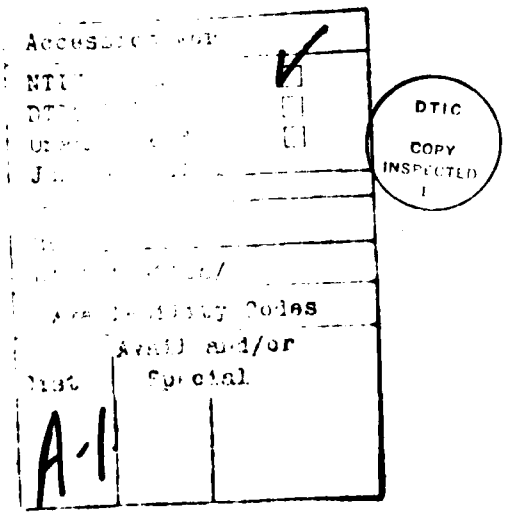
# Preface

The purpose of this study was to examine current methods of performing Air Force lease versus buy analyses. This is needed due to the controversy concerning the recent Air Force decision to lease 120 aircraft to replace the aging fleet of CT-39.

In performing this review I had a great deal of help from others. I am thankful to Maj Feldman and Dr. Cain for their guidance, Lt Col Owens and Barbarra Ressutto (of the Cost Analysis Division, Pentagon) for literature concerning the CT-39 decision, and my wife, Cheryl, for her continued support. I would also like to thank the following people for their assistance: Mr. Jeff White from Program Analysis & Evaluation at the Pentagon, Mrs. LaBrenda Stodghill from the Joint Committee on Taxation, Mr. Mike Esposito from the Office of Management and Budget, and Mr. Seymore Fiekowski from the Treasury Department.




James S. Shedden

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## Abstract

This paper reviewed prior Air Force cost-benefit analysis procedures for a lease versus buy decision. Specifically, it looked at the analysis supporting the Air Force's decision to lease 120 replacement aircraft for the CT-39 fleet.

The CT-39 analysis was an attempt at a pre-tax methodology that did not accurately capture all the lost revenue at the Treasury resulting from the depreciation deductions available with a lease. The methodology proposed in this study used an after-tax methodology to ensure a government perspective was being taken. The results of the analysis indicate that an Air Force perspective always results in a decision to lease, but the government perspective results in a decision to buy at discount rates below 8 percent and a decision to lease at rates above 8 percent.

# I. Background

The Economic Recovery Tax Act of 1981 (ERTA) was a broad change in tax laws designed to increase capital accumulation in the private sector and thus spur economic growth. There were, however, two changes that had an unintended effect of decreasing tax revenues and increasing the federal deficit. The estimated impact is approximately 18.5 billion dollars (1:154). Specifically, these changes were the faster depreciation schedule known as the Accelerated Cost Recovery System (ACRS) and the increased availability of investment tax credits (ITC).

Prior to 1981, the depreciation schedule was straight line for the life of the equipment, with a 20 percent residual value. The term residual value refers to the market value of the equipment after its expected life. For example, a 20 year aircraft valued at $1 million would have an annual depreciation amount of $40,000.00=(80%/20 x 1,000,000). This $40,000 depreciation will apply to each of the first 20 years of the aircraft. The schedule prescribed by ACRS compresses the entire depreciation of the aircraft into the first five years for this category of equipment. The rates for each of the first five years are as follows: year one = 15 percent, year two = 22 percent, and years three through five = 21 percent. The sum of each of these depreciation percentages is 100,

thus the aircraft are fully depreciated in the first five years with no residual value remaining. Under ACRS, the first year depreciation amount for the same aircraft would be $150,000.00, nearly four times the amount granted under the straight line methodology. The following example compares both depreciation schedules over the entire 20 years from a net present value approach. A discount rate of 15 percent is used, obtained from the July 1984 Federal Reserve Bulletin, to represent the corporate cost of borrowing money.

ACCELERATED COST RECOVERY SYSTEM VERSUS
STRAIGHT-LINE DEPRECIATION METHODS

PURCHASE PRICE..... 1000000
NUMBER OF YEARS..... 20
DISCOUNT RATE..... .15

| YEAR: | ACRS: | STRAIGHT-LINE: |
|---|---|---|
| 1 | 150000.00 | 40000.00 |
| 2 | 220000.00 | 40000.00 |
| 3 | 210000.00 | 40000.00 |
| 4 | 210000.00 | 40000.00 |
| 5 | 210000.00 | 40000.00 |
| 6 | | 40000.00 |
| 7 | | 40000.00 |
| 8 | | 40000.00 |
| 9 | | 40000.00 |
| 10 | | 40000.00 |
| 11 | | 40000.00 |
| 12 | | 40000.00 |
| 13 | | 40000.00 |
| 14 | | 40000.00 |
| 15 | | 40000.00 |
| 16 | | 40000.00 |
| 17 | | 40000.00 |
| 18 | | 40000.00 |
| 19 | | 40000.00 |
| 20 | | 40000.00 |
| NET P.V. | 749784.23 | 340542.55 |

As depicted in this example the net present value of the tax benefits from ACRS depreciation is 120 percent greater than that obtained using the straight-line depreciation. In other words, the tax benefits more than double using ACRS.

The investment tax credits apply to property used for the express purpose of generating income. Their purpose was to reduce the income tax liability of the taxpayer and thereby encourage their investment in capital goods. "When enacting the investment credit, Congress expressly disallowed it for property used by governmental units and tax-exempt organizations, which of course, have no income tax liability to reduce" (1:124). The major change in the 1981 tax codes pertain to rehabilitation credits, which fall under the category of investment tax credits. These also are not available to tax-exempt entities, but can be claimed by corporations that lease buildings to the tax-exempt units, and then spend money rehabilitating the building. Current law still generally disallows the investment tax credit for property leased to the government, but does allow for the rehabilitation credits. These changes in the tax code created a problem for the Treasury Department. Equipment that had previously been sold to tax-exempt entities could now be leased, thus securing these lucrative tax benefits and providing additional profits for the lessor (contractor) as well as cost savings for the lessee (government agency). All this

would be at the expense of the Treasury Department, who is providing the tax benefits and sharing the burden of financing the equipment. "As a general rule, governmental units and tax-exempt organizations are not entitled to depreciation deductions or investment credits for property owned by them" (2:1131). This seems to make sense, as the governmental organization pays no tax in the first place.

These tax benefits were of such a large magnitude that it allowed contractors to lease to the tax-exempt entities at rates well below the equivalent purchase price of the equipment. In other words, assume the rental rate under straight-line depreciation was $100 per year. This rate would represent the amount a contractor would be indifferent to leasing or selling at the stated purchase price since the net present value of the stream of rental payments would exactly equal the purchase price. Now, with ACRS, the point where the contractor becomes indifferent to leasing or selling would be at a rental rate below $100 since this stream of payments is now being supplemented by the larger tax benefits associated with ACRS. Typically, a contractor could retain approximately 30 to 35 percent of the tax benefits and pass along the remaining 65 to 70 percent to the tax exempt entity in the form of lower rents. This breakdown of tax benefits is based on the contract for the Navy's TAKX program, which is discussed later. Actually, if the contractor retained only 1 percent they would still be better off. "From a

tax perspective, leasing allows certain tax benefits (such as ACRS deductions) to flow through (in the form of reduced rents) to nontaxable entities that are not eligible for such benefits on their own account" (2:1132). Therefore, by enjoying these lucrative tax benefits one governmental department can pass a significant portion of a program's financing burden to another governmental department, namely the Treasury.

To qualify for these tax benefits the lease must be legal as viewed by the courts and the Internal Revenue Service (IRS). The question of a legitimate lease concerns itself mainly with determining ownership of the equipment. Both the courts and the IRS focus on the substance of the transaction rather than the form. "In general, for Federal income tax purposes, the owner of property must possess meaningful burdens and benefits of ownership. The lessor must be the person who suffers, or benefits, from fluctuations in the value of the property" (1:1132). Thus, anything that would shift either the financial risk or potential gains from the lessor to the lessee would not qualify the contract as a legitimate lease and would not entitle the lessor to the tax benefits of a lease (ACRS and ITC). For example: "...if the lessor has a contractual right to require the lessee to purchase the property at the end of the lease (a put), the transaction could be denied lease treatment because the 'put' eliminates the lessor's risk of loss in value of the

[property] and the risk there will be no market for the property at the end of the lease" (2:1132). Since this legal description of a lease is fairly general, it would not be too difficult for a lawyer to structure a legal leasing arrangement contract that qualifies for the tax benefits. Therefore, more leasing contracts have been generated and many sale-lease-back arrangements attempted.

Although the Department of Defense (DOD) was the small "tip" of a very large iceberg, it took center stage as this situation began getting attention from Congress and the press. On February 28 1983, Navy and Air Force representatives appeared at a hearing before the Subcommittee on Oversight of the Committee on Ways and Means. The Navy was the major witness answering criticism from both Congress and the press for their TAKX Pre-positioning Ships Program. The TAKX program provided 13 ships to support the Navy's Rapid Deployment Forces. The press had termed this a "raid on the Treasury". The Navy used long-term leasing arrangements as opposed to the traditional procurement channels of writing a Request For Purchase Proposal (RFPP) and competing for funds through the Congressional appropriations process. "...The Navy's use of long-term leases effectively circumvents the congressional authorization/appropriations process and impedes timely and effective legislative review" (3:1). Funding for the leases came out of a revolving "industrial fund" used for general operations and maintenance (O&M).

The O&M fund is a pool of money used for supporting the overall operation and maintenance of that branch of the Armed Forces. Due to its very broad and general nature it is subject to very little scrutiny by Congress during the appropriations process. "In a more parochial vein, there is serious concern in this subcommittee about the use of significant O&M funding for the capital costs of major assets normally funded out of the procurement accounts" (3:2). Results of the Navy's economic analysis show a leasing cost of $140.56 million per vessel and a purchase cost of $184.01 million per vessel. Their analysis, taking into account the Treasury's loss in revenue resulting from leasing, still indicates a cheaper lease price (3:41). It should be pointed out that these numbers are a bit suspect since the Navy fired the first consulting firm that determined leasing to be more costly than buying. "The Defense Department hired a consultant to prove its own case, and when that consultant reported that leasing was more costly, it fired that firm and hired another one, and the second one came back with a better answer" (4:126).

The results given by the Treasury Department are quite different however. Although none of the details of the analysis were given, the results are presented here to simply show the magnitude of the difference between the Navy's and Treasury's studies. "Analysis of that agreement indicates that the government will pay about

$199 million in present value to charter a TAKX that it could have purchased for $178.2 million. The Navy will save an estimated $37 million in on-budget expenditures; however, there will be an estimated revenue loss of $57.8 million arising from the arrangement. The excess cost of chartering, $20.8 million, is thus estimated to be about 11.7 percent greater than the purchase price" (5:2). The response provided by the Navy: "Such an analysis, of course, assumes that the taxes payable by the potential investors in a TAKX charter would not otherwise be sheltered, which is a doubtful proposition. It can fairly be expected that the private sector lease financing sources would find alternative transactions producing tax benefits" (3:41). In other words, the Navy is admitting that the tax benefits generated by leasing are nothing more than a tax shelter for the corporation. Since there is such an abundance of available tax shelters for corporations, the revenue loss at the Treasury would have resulted from some other scheme anyway. Therefore, the Navy did no wrong. These are example responses by the Navy. Although everything regarding the Navy's TAKX program was legal it seems apparent that the lower cost to the Navy is at the expense of a higher cost to the taxpayer.

The Air Force did not go the same route that the Navy chose. On July 26, 1982 an unsolicited bid was sent from Cessna to the Air Force for the lease of a replacement

aircraft for the aging CT-39 aircraft. The Air Force went through the traditional Request for Purchase route requiring Congressional approval and allowing for competitive bidding. As a result, the Air Force did not receive a great deal of attention at the Congressional hearing in 1983. The CT-39 replacement was later opened for competitive bid resulting in 80 C-21A aircraft being leased from Leer Corporation and 40 C-12F aircraft being leased from Beechcraft. This program went on contract in September of 1983. The major difference between the TAKX and the CT-39 programs is that the funding for the CT-39 replacement was subject to the direct scrutiny of the Congressional appropriations process, whereas, the TAKX funding did not undergo this direct Congressional scrutiny. Since the Air Force went through the traditional procurement route Congress had the opportunity to specifically evaluate the CT-39 program. Although the funding also came from O&M money, the fiscal year 1984 appropriations bill contains specific wording including CT-39 funds in the O&M funding section. The Navy, on the other hand, did not bring the TAKX program to Congress' attention by using the traditional procurement procedures and did not get specific wording including the TAKX funds as part of the O&M money. Although the Air Force was very "up-front" in their handling of the financing of the CT-39 program, a significant burden of the funding fell upon the Treasury Department, as will be shown.

As previously stated, DOD was just a small portion of a large problem estimated at 18.5 billion dollars. Schemes could be developed for any tax-exempt entity no matter how large or small. One example cited Bennington College in Vermont planning an arrangement to sell its entire college campus to an alumni group, then leasing it back, for the sole purpose of securing the tax benefits. Both the alumni group and the college would profit handsomely from the lease at the total expense of the Treasury Department and the American taxpayer. Other examples involve the Clinch River Breeder Reactor, the Orange Bowl, and a solar heating system at the United States Air Force Academy being written as service contracts . These all represent examples of planned sales from non-taxable entities to taxable entities and then leasing the property back. The examples were presented orally by representatives of the Joint Commitee on Taxation. When it got to the point of lawyers advertising as federal leasing arrangement experts, the officials in Washington realized the urgent need for either a change in the tax laws, or the need for defense analysts and all government agencies to take a broader perspective, to include the ramifications at the Treasury Department.

## II. The Corporate View

The Corporation has a definite advantage in using the ACRS depreciation schedule over the previous schedules available. The cash flows from depreciation being compressed from a 20 year interval using straight-line into a five year interval become very significant when viewed from a net present value basis. The following example illustrates how both the contractor and the Air Force can achieve a higher net present value resulting from a lease contract and the associated ACRS benefits. The example also shows the magnitude of the ACRS benefits when compared to the pre-1981 benefits associated with the straight line methodology.

In this hypothetical case, contractor XYZ is a jet aircraft manufacturer competing for an Air Force contract. The purchase price for the aircraft is $1,000,000, and its expected life is 20 years. Here we assume a constant discount rate of 15 percent over the 20 year period, obtained from the Federal Reserve Bulletin of July 1984, (6:A24) to represent the cost of borrowing money for the XYZ corporation, the future value formula is:

$$\$1,000,000 \times (1.0 + .15)^{20} = \$16,366,537.$$

In other words, the value of today's $1,000,000 in 20

years, invested at 15 percent, will be $16,366,537. Now, using the formula for accumulated value, it can be shown what XYZ would be willing to accept as an equivalent annual lease payment from the Air Force. The formula is shown below:

$$\text{Accumulated Value (AV)} = L \times [((1+i)^N - 1)/i] \quad (7:70)$$

where L is the periodic lease payment, N is the number of periods, and i is the discount rate. In our example:

$$AV = \$16,366,537 = L \times [((1+.15)^{20} - 1)/.15]$$

$$\$16,366,537 = L \times 102.44358$$

$$\$159,761.47 = L$$

Therefore, the Air Force's equivalent annual lease payment would have to be $159,761.47 for the one aircraft with a $1,000,000 purchase price. This simply means the contractor would be indifferent to receiving the annual lease payment of $159,761.47 for 20 years or selling today for $1,000,000.

Using the same formula with a cost of capital (borrowing) of 14 percent (again from the Federal Reserve Bulletin for July 1984) we arrive at a lease payment of $150,986. The one percent difference in discount rates

(15-14) represents the risk premium a contractor pays for money versus what the government would pay. This represents what the Air Force would be willing to rent the aircraft at to be indifferent to buying or leasing. Since the government cost of capital is less than the cost to the XYZ corporation, the Air Force is only willing to pay a price that is less than the price XYZ will accept.

Now we can add the ACRS deductions, available to leases, to our example. Here, as in the Navy's TAKX program, we assume that XYZ will retain approximately 35 percent of the tax benefits and the Air Force will receive the other 65 percent in the form of lower lease payments. "For example, the staff's analysis of the TAKX agreement described in this pamphlet indicates that about 64 percent of the associated revenue loss will benefit the Navy and 36 percent will benefit third parties" (5:3). Based on the ACRS schedule and a 35/65 division of the tax benefits for XYZ and the Air Force respectively the results are:

| year | ACRS percentage | deduction | XYZ | Air Force |
|---|---|---|---|---|
| 1 | 15 | 150,000 | 52,500 | 97,500 |
| 2 | 22 | 220,000 | 77,000 | 143,000 |
| 3 | 21 | 210,000 | 73,500 | 136,500 |
| 4 | 21 | 210,000 | 73,500 | 136,500 |
| 5 | 21 | 210,000 | 73,500 | 136,500 |

In this-year dollars:

| | net present value (15%) | |
|---|---|---|
| year | XYZ | Air Force |
| 1 | 45,652.16 | 84,782.59 |
| 2 | 58,223.09 | 108,128.59 |
| 3 | 48,327.43 | 89,750.93 |
| 4 | 42,023.85 | 78,044.28 |
| 5 | 36,542.51 | 67,864.66 |
| Total | $230,769.04 | $428,571.05 |

Summing the net present values of the tax benefits results in a total of $230,769.04 for XYZ and $428,571.05 passed on to the Air Force in the form of reduced lease payments. Assuming XYZ has a 46 percent tax rate, their net after-tax gain would be $106,153.75. The Air Force savings will be $197,142.68. In percentage terms the XYZ corporation can achieve a 19.66 percent (106/540) increase in after-tax net present value, resulting from ACRS. This percentage requires some explanation. The example used is laid out on the next page.

XYZ Corporation

Buy alternative:

| step | | |
|---|---|---|
| 0 | $1,000,000 | profits |
| 1 | -$460,000 | taxes |
| 2 | $540,000 | net after tax profits |

Lease alternative:

| step | | |
|---|---|---|
| 3 | $1,000,000 | |
| 4 | -$230,769 | not taxed under ACRS - from page 14 |
| 5 | $769,231 | taxed at 46 percent |
| 6 | -$353,846 | taxes |
| 7 | $415,384 | |
| 8 | +$230,769 | nontaxed revenue |
| 9 | $646,153 | net after tax revenues |

comparing the two:

| step | | |
|---|---|---|
| 10 | $646,153 | |
| 11 | -$540,000 | |
| 12 | $106,153 | increase in profits from leasing |
| 13 | $106,153/$540,000 = .1966 = 19.66 % | |

If we first take the case of the purchase, the XYZ Corporation receives revenues of $1,000,000 which is all taxed at 46 percent. This results in $460,000 in taxes and $540,000 in net after tax profits. Now, if we look at the lease, the XYZ Corporation still receives $1,000,000 in revenues (in net present value). However, under ACRS $230,769 is not subject to any taxation, leaving $769,231, in step five, to be taxed at 46 percent. The result is taxes of $353,846 and net after tax profits of $646,153 ($230,769 plus ($769,231 minus $353,846)). Comparing the net after tax profits of both the buy and lease cases we see that the lease is $106,153 more profitable than the buy (646,153 minus 540,000). Calculating the percentage :

($106,153/$540,000) * 100 = 19.66 percent

Now we can look at the simultaneous impact on the cost to the Air Force. Again, an example will be discussed in detail on the following page.

Air Force

Lease alternative

step

| | | |
|---|---|---|
| 1 | $1,000,000 | original cost for purchase |
| 2 | -$197,142 | cost savings from leasing |
| 3 | $802,858 | net cost of leasing |

4 $802,858 * (1 + .15) 20 = $13,140.005 future value to the XYZ Corporation

5 AV = $13,140,005 = L * [((1+.15)-1)/.15]

6 $13,140,005 = L * 102.44358

7 $128,265.77 = L = A.F. annual lease payments to the XYZ Corporation

| | | |
|---|---|---|
| 8 | 6.623131 | present value factor of $1 per period for 20 periods at 14 percent |
| 9 | $128,265 | annual lease payments |
| 10 | $849,520 | present value, to the Air Force, of the annual lease payments |
| 11 | $1,000,000 | |
| 12 | -$849,520 | |
| 13 | $150,480 | net cost savings to the Air Force resulting from leasing |

14 $150,480/$1,000,000 = .15 = 15 %

We start by subtracting the Air Force savings of $197,142 from the original purchase price of $1,000,000 resulting in a cost of $802,858. Using the present value and accumulated value formulas, in steps four through seven, the Air Force's annual lease payments after ACRS would now be $128,265.67. This is what the Air Force must pay annually for 20 years. The cost of capital to the government is 14 percent. In net present value terms the payments of $128,265 discounted at 14 percent for 20 years is $849,520. This represents the true cost to the Air Force. Therefore, the savings to the Air Force is $150,480 ($1,000,000 minus $849,520). Calculating the percentage savings we have:

($150,480/$1,000,000) * 100 = 15 percent.

ACRS makes leasing to tax exempt entities a very attractive alternative to a contractor. Not only can he increase his profits, but he can also assemble a very competitive contract proposal.

If we now consider the same example using a pre 1981 depreciation schedule known as straight line depreciation, we can see the magnitude of the 1981 tax law change allowing ACRS. Straight line simply allows for 80 percent of the original value to be depreciated in equal yearly amounts for the anticipated life of the equipment. In our example, .8/20 years equals an annual depreciation rate of

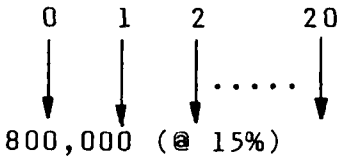
.04 (4 percent). The total annual depreciation would then be $40,000 (.04 x 1,000,000), of which $14,000 would go to the XYZ corporation, and $26,000 would go to the Air Force. Summing the net present values of $14,000 every year for the next 20 years and using a discount factor of 15 percent, results in an increase in profits of $87,630.64 to the XYZ corporation and a savings of $162,742.60 which is passed on to the Air Force. Again, assuming a 46 percent tax rate for XYX, the after-tax increase to XYZ would be $40,310.94 and the savings to the Air Force would be $74,861.60. The significant point though, is that the savings to the Air Force dropped from about a 15 percent savings to a 7.5 percent savings. In the case of the Navy's TAKX program, the 15 percent savings is what allowed the price of the vessels to fall below the operations and maintenance ceilings and thus, be funded by their revolving "industrial fund".

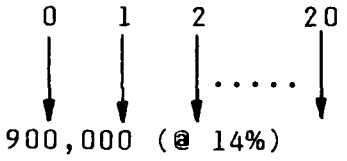
The total after-tax net present value of the ACRS deductions is $303,296.43 and the total for straight line is $115,172.54. Therefore, ACRS more than doubled the present value of the tax benefits available using the traditional straight line method. This large an increase in tax benefits accounts for the proliferation in contractors submitting lease proposals to the defense department. The reason that leasing was not so appealing with straight-line, which also had a significant amount of depreciation, can be traced to the risk premium that

corporation's must pay for the use of money. The following argument depicts this more clearly. Say the XYZ Corporation had the same aircraft to sell for one million dollars and could claim an ACRS deduction for $200,000 on the lease of the aircraft. The difference then is $800,000, which represents the net present value of the lease payments discounted at 15 percent (the XYZ Corporation's cost of capital) which makes them indifferent to leasing or selling. From the Air Force's point-of-view the annual lease payments discounted at 14 percent (the government cost of capital) will result in a net present value above $800,000, say at $900,000. The ACRS deductions are large enough to make-up for the difference between the corporate cost of capital and the government cost of capital. When looking at the straight-line schedule, the original deduction would have been less than half the ACRS deduction. For simplicity lets say it was $100,000, resulting in $900,000 that XYZ must get in net present value terms for the lease payments (discounted at 15%). After computing the annual lease payments for the Air Force that will yield $900,000 the Air Force can then determine its net present cost. Now, however, the discount rate is 14 percent to reflect the government cost of capital. After discounting, the net present value comes out in excess of the original $1,000,000 purchase price and the Air Force decision is to buy the aircraft. Here, the straight-line deductions are

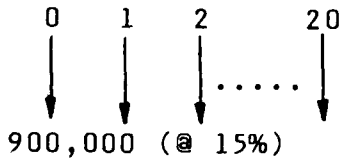
not large enough to make-up the difference in the discount rates. This example is depicted below.

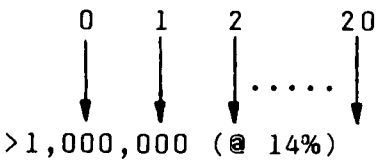
| | |
|---|---|
| Purchase Price | $1,000,000 |
| ACRS | -200,000 |
| | $800,000 |




| | |
|---|---|
| Purchase Price | $1,000,000 |
| Straight-line | -100,000 |
| | $900,000 |



The large ACRS deductions also accounts for the number of sale-lease back "gimmicks" attempted, similar to Bennington College in Vermont. It should also be pointed out that the aircraft do not qualify for the investment tax credits, since they are not real property. Adding these tax benefits would make leasing real property even more appealing to both the lessor and the lessee.

# III. Cost-Benefit Analysis

"Benefit-cost analysis is a tool for determining whether projects or programs are economically efficient, that is, whether they generate social benefits in excess of social costs without regard (at this stage) to the distribution of those benefits and costs" (7:13). The term economically efficient simply refers to society being made better off. It is central to the general area of study called welfare economics which attempts to answer the question: "What is the best allocation of resources from a social point of view?" (8:541). In economic terms we are attempting to maximize society's utility function.

In layman's terms, cost-benefit analysis attempts to choose those projects that will allow society to reach its highest level of utility. It is not concerned with equity, or the distribution of wealth within society. Rather, the fundamental decision rule of welfare economics is to maximize the overall wealth of society. It implicitly assumes that this will maximize society's utility for the simple reason that there is more wealth to distribute.

There are three sound economic principles related to any cost benefit analysis. They are as follows: all reasonable alternatives are analyzed, each alternative is

analyzed in terms of its full life cycle, and all dollars are represented by their present value (9:3). Any analysis that violates one of these three principles would not be valid. If a reasonable alternative was not considered in the analysis, then the alternative selected may not be the best course of action. To be valid the analysis must be complete. The second principle would be violated if a portion of the project's life cycle were not included in the analysis. Since there will be costs and benefits associated with any project until it is terminated, failure to include all costs and benefits for the life of the project will alter the results and invalidate the analysis. Finally, any dollar comparisons that are not in present terms would be misleading. This concept will be discussed more directly in the Net Present Value (NPV) section. Although cost benefit analysis can enlighten us on the issues, it does not provide us with a truly unambiguous solution to public expenditure problems. In spite of years of refinement in the theory of cost benefit analysis no one has succeeded in making it totally impartial (10:410). In other words, the analysts' previous experience enters into the study whenever value judgements are required. Cost-benefit analysis attempts to quantify as much of the analysis as possible, thus removing much of the subjectivity and its associated error. The general method is to determine all benefits and costs associated with the alternative throughout

its full life cycle, convert the benefits and costs into dollars, calculate the present value of the benefits and costs, and determine the net present value by subtracting the present value of costs from the present value of benefits. Positive net benefits represent viable projects. A viable project is simply one where the net benefits exceed the net costs, thus one would prefer doing the project rather than doing nothing. From strictly a net benefit point of view, larger net benefits represent better projects. In other words, if one must choose a single project, and there are an unlimited supply of resources, the best choice would be that project with the largest net benefits.

Probably the most difficult part of a cost benefit analysis, and where most of the error enters into the analysis, is in determining accurate figures for the costs and benefits associated with the project. The benefits may already be in dollar terms or they may have to be estimated by making subjective value judgments about the worth of an intangible object (e.g. targets killed). In this case the decision maker's bias set enters into the analysis. By bias set I mean that an Air Force General in Tactical Air Command would probably place a higher value on targets killed than a federal employee working in the Office of Management and Budget. His past experience helps shape what he believes is important, and that will affect the analysis through the various value judgements

he makes. The analysis is most effective when benefits are in terms of physical yield. "If precise quantification of benefits is impossible, perhaps a relationship can be established among the alternatives" (11:6-5). In other words, benefits from one alternative are used as a baseline from which other alternatives' benefits are compared. When this technique is not possible the least desirable approach is used. This is to simply list all alternatives in order of preference regarding their benefits. Those benefits that are too subjective to rank order should simply be identified to ensure that the decision-maker does not overlook them in his final decision. All the problems with converting subjective estimates of benefits into dollar figures are eliminated when performing a lease versus buy analysis. In this classic type of cost-benefit analysis the benefits are identical for both alternatives being considered, only the method of financing (cost) changes.

Costs are usually less subjective than benefits, but can also require value judgments. Examples include air pollution, water pollution, safety levels, noise level, and public acceptance. In terms of public acceptance, the cost of building an Air Force runway near a children's hospital would be higher than building it in farmland. The exact amount of community support associated each of these alternatives would be difficult to determine. More objective costs include the large initial outlay for a

project and a series of operating costs. "Operating costs (incurred only once the project is underway) are normally divided into variable and fixed components, the former covering such things as raw material and labor inputs required for manufacture, which will vary directly with the volume of production, while the latter will include maintenance, administration and managerial charges, etc. which will be relatively fixed with respect to the volume of production (but may vary with scale of operation)" (12:8).

The methodology of cost benefit analysis does not insure that society will reach its highest level of utility. A decision maker's lack of knowledge and personal bias set will not allow him to make perfect assumptions regarding society's welfare.

There are three general limitations that cost-benefit analyses are subject to. First, priorities among various objectives are not normally established. For example, if there are a number of sub-objectives these all carry the same amount of importance. No weighting is used to differentiate the relative importance of the sub-objective to the decision-maker. Cost-benefit analysis usually attempts to satisfy a given objective in the most cost-effective means.

Second, the analysis itself is not a decision-making process and must not be thought of this way. It is however, an input to the decision-making process. The

decision maker must weigh the results of the analysis against other factors, such as safety, health, environmental impacts, etc. By quantifying those areas that are quantifiable, the decision-maker can focus his judgment more keenly on those areas where it is needed.

Finally, the analysis cannot yield good results without getting good input data first. Careful formulation of assumptions and accurate estimates of all costs and benefits are essential to any meaningful results (11: 1-3).

## Present Value

One of the required economic principles for a valid cost-benefit analysis is that all dollars be represented by their present value. Dollars alone do not provide a "common denominator" for measurement. It is fairly obvious to anyone who has managed money that 100 dollars one year from now will buy less than it will today. One may expect inflation to reduce the value of the dollar. Even without the effects of inflation one could invest the money and receive a sum of $100 * (1+r), where r is the current real interest rate, one year in the future (12:10). Therefore, a project costing $1 billion in 1984 cannot be compared with a project costing $2 billion spread-out over 1984-1989 without first discounting all dollars in the net cash flow back to the year 1984. The term positive rate of discount (or discount rate) is used to represent the concept that a lower present value is placed on a given sum of money the further into the future one expects to accrue it (12:10). "Discounting is the inverse of compounding. Whereas, in compounding one moves from the present into the future, in discounting the movement is from the future back to the present" (11:8-3). Thus the term present value is used to represent the monetary worth of a project's cost and benefits measured

in today's dollars. For example, if one wants to know the present value of 100 dollars received in one year's time, and if the relevant discount rate is denoted by r, then:

$$P_{1984} = \$100_{1985}/(1+r) \qquad (12:10)$$

If r=10 percent, then:

$$P_{1984} = \$100_{1985}/(1+.10) = \$90.91$$

In other words, 100 dollars received one year from today would be worth $90.91 (with a discount rate of 10 percent). The quantity $1/(1+r)$ is known as the Present Worth Factor and in this example is equal to 1/1.1 or .9091. Writing $P_v$ for the present value and $P_0$, $P_1$,..., $P_t$ for the stream of payments accruing from now to the end of year t, the general form of the discounting expression becomes:

$$P_v = P_0+P_1/(1+r)^1+P_2/(1+r)^2+ \ldots P_t/(1+r)^t$$

or more compactly:

$$P_v = \sum_{t=0}^{T} P_t/(1+r)^t$$

What is important to remember about the above formula is that the use of a single discounting parameter, r, assumes that the time value of benefits falls at a constant rate..." (12:11).

All this assumes discrete compounding. In the case of continuous compounding $e^i$ is the value that one dollar will grow to in one year with continuous compounding. More formally, if we start with annual compounding

$$V(1) = V_0 (1+i)$$

where i is the simple annual interest rate, V(0) is the initial amount of money, and V(1) is the value after the first year. Now, with semi-annual compounding:

$$V(2) = V_0(1+i/2)(1+i/2) = V_0(1+i/2)^2$$

which can be re-written as the general formula:

$$V(m) = V_0(1+i/m)^m$$

where m is the number of annual compounding periods. If we let m approach infinity, for continuous compounding, we get:

$$\lim_{m \to \infty} [1+(i/m)]^m = e^i$$

and:

$$V(m) = V_0 e^{i}$$

After t years the one dollar will grow to $e^{it}$ dollars. Suppose we didn't start with one dollar, but we actually had A dollars. The amount would now be $Ae^{it}$ dollars. Our general expression for V(m) then becomes:

$$V(m) = Ae^{it} \qquad (13:276)$$

Conversely, the present value, A, can be represented as:

$$A = V(m)e^{-it}$$

Here, the i represents the discount rate ( this can be thought of as a rate of decay).

If we take the above formula for the present value and allow for a rate of revenue inflows, $R_t$ , rather than one lump sum at a future time, and let an infinitesimal time interval pass (dt). The amount of revenues during the interval (t,t+dt) can be written as $R_t dt$ and discounting at a nominal rate of r per year, its present value is $R_t e^{-it} dt$. The sum of its present values is the integral:

$$A = \int_0^N R_t e^{-it} dt$$

over some time horizon N in the future. Integrating, (assuming $R_t$ is constant over time) we get:

$$A = R \int_0^N e^{-it} dt$$

$$A = R_t[(-1/i)\ e^{-it}] \text{ from 0 to N}$$

$$A = -R_t/i\ (e^{-iN}-1)$$

$$A = R_t/i\ (1-e^{-iN}) \qquad (13:416)$$

This formula represents the present value of a stream of inflows ($R_t$, in dollars per year) for N years using continuous discounting at the rate of i.

In summary, the discount factor is an interest rate sensitive number used in calculations of net present value. Discount factors represent the cost of capital and differ depending on who is borrowing the money. "For the Federal government, the interest on United States Treasury notes and bonds represents the cost of capital" (14:2). Later I will briefly discuss the current arguments

regarding the selection of the government discount rate. For private companies, the nominal discount rate used is often the interest rate at which bank loans are available (12:11-12). In actual fact, the appropriate discount rate is some weighted average of the corporation's liabilities and equity.

## Tax Neutral Society

"How must income be defined if present discounted valuations of all assets, and therefore, all optimization decisions are to be independent of the tax rate each person is subject to " (15:604)? A tax neutral society will leave the optimization decisions unchanged after taxes. This is important, since a corporation's optimization decisions should not be determined by the particular tax system that happens to be in effect. Say four projects, A,B,C, and D, were being considered. Ranked on a pre-tax evaluation from highest to lowest net present value, they are A-C-B-D. After applying the taxes and calculating the after-tax net present values, the tax neutral regime will result in the exact same ordering A-C-B-D. A regime that was not tax neutral could change the ordering to say A-D-C-B, thus the corporations optimization decision would be based on the tax system in effect. In order to maintain the same ordering before tax and after tax, the system must tax only the revenue and not the principal. By revenue, I mean the gross flow of money coming into the corporation, while principal is the initial cash outlay for a project/equipment. In the example above, project D had unproportionately less principal being taxed than did projects C and B. Less principal being taxed results in a larger cash flow in the

earlier years. Thus, the tax system increased the net present value of project D relative to projects C and B, and could change the corporation's optimization decision. To tax only revenue, the tax system must make some allowance for a depreciation deduction. The following analytical argument shows why this is necessary.

Let:

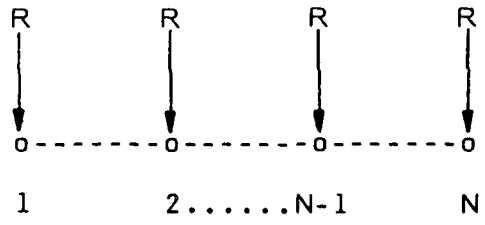
R = the return stream per year (period),

N = the number of years,

$V_N$ = the present value of the return stream at the end of year N, and

i = the discount rate.

The diagram of the cash flow appears as the following:




Now, we can represent the present value at the end of year

zero as being the present value at the end of year one discounted for one year plus the return for that year. This looks like:

$$V_0 = \frac{V_1}{1+i} + \frac{R}{1+i}$$

or:

$$V_0 + iV_0 = V_1 + R$$

From this the economic depreciation can be expressed as:

$$V_1 - V_0 = iV_0 - R$$

Solving for R we have:

$$R = iV_0 - (V_1 - V_0)$$

In other words, the cash flow is equal to the return on

investment plus the economic depreciation. Therefore, any cash flow can be separated into a return on investment and an amount of economic depreciation.

The same results can be achieved from the continuous discounting formula. Here, we let:

$V_t$ = the present value at time t,

$R_t$ = the cash flow in period t, and

$\frac{dV_t}{dt}$ = the economic depreciation in period t.

From our previous derivation we showed that the present value of a cash flow with continuous discounting is expressed as:

$$V_0 = \int_0^N R_t e^{-it} dt$$

Now if we start at time t and allow x time units to pass we have:

$$V_t = \int_t^N R(x)e^{i(t-x)}dx \qquad (16:470)$$

where R(x) is the value of the revenue stream at time x. This integral can be better explained by breaking it down into two terms.

$$V_t = \int_t^N R(x)e^{-ix}\, e^{it}\, dx$$

Looking at the cash flow diagram:

0 t x

The term $R(x)^{-ix}$ converts the revenue stream at time x into its present value equivalent at time zero and $e^{it}$ takes this sum and calculates the future value at time t.

Since we have defined economic depreciation as the

rate of change in the present value of the revenue stream relative to time, we can find this by taking the partial derivative of $V_t$ with respect to t. Or:

$$\frac{dV_t}{dt}$$

Substituting our expression for $V_t$ we get:

$$\frac{dV_t}{dt} = \frac{d}{dt} \int_t^N R(x) e^{i(t-x)} dx$$

This expression can be integrated using Leibnitz's rule, yielding:

$$\frac{dV_t}{dt} = \int_t^N R(x) i e^{i(t-x)} dx + R(N) e^{i(t-N)} \frac{dN}{dt}$$

$$- R(t) e^{i(t-t)} \frac{dt}{dt}$$

Since the partial of N (a constant) with respect to t is zero the middle term is eliminated. The partial of t with respect to itself is one, resulting in:

$$\frac{dV_t}{dt} = i \int_t^N R(x) e^{i(t-x)} dx - R(t) e^0$$

Substituting our original expression for $V_t$ we get:

$$\frac{dV_t}{dt} = iV_t - R(t)$$

and solving for R(t), the cash flow, we get:

$$R(t) = iV_t - \frac{-dV_t}{dt}$$

This is the same result we got from the discrete case. Again, the cash flow in period t is composed of the return on the investment plus economic depreciation.

The point to all this is that a tax neutral society must incorporate a tax system that allows for a certain amount of economic depreciation to avoid taxing the original principal investment. "The essential point is that allowing a deduction for economic depreciation is necessary to avoid taxing capital (a negative tax subsidy), in much the same way that requiring a lender to pay tax only on the interest portion of the loan payment he receives is necessary to avoid converting a tax on income into a tax on principal" (17:3).

## Air Force Versus Government Perspective

There are two general methods of performing the cost-benefit analysis, for a government lease, that will ensure a Treasury perspective. The Treasury perspective simply means that any revenue loss to the Treasury, resulting from a decision to lease, will be captured in the analysis. These two methods are pre-tax and after-tax. The pre-tax methodology shall be discussed first. If we start with the periodic (annual) lease payment of $L_t$, we get:

$$V_0 = \sum_{t=0}^{n} \frac{L_t}{(1+d)^t}$$

where $V_0$ is the present value of the lease payments and d is the government's discount rate. This is how the Air Force would calculate the lease cost. Now we must add in

the revenue loss, to the Treasury, of the two tax benefits. The investment credit is simply subtracted from the corporation's amount of taxes due and thus is added to the Treasury's cost. The result is:

$$V_0 = \sum_{t=0}^{n} \frac{L_t + I_t/(1-T)}{(1+d)^t}$$

where T represents the corporate tax rate.

Division by (1-T) is necessary since one dollar before tax is equal to (1-T) dollars after tax. A simple example will clarify this. Suppose a corporation has gross income of 100 dollars and a tax rate of 46 percent.

| | |
|---|---|
| Income | $100 |
| Taxes | -46 |
| ITC | + 1 |
| | $55 |

$1/(1+.46) = $1.85

| | |
|---|---|
| Income | $101.85 |
| Taxes | -46.85 |
| | $55.00 |

Converting the one dollar ITC after tax into its pre-tax equivalent we divide it by (1+T), or (1+.46), resulting in 1.85 dollars. This is added to the gross income of 100 dollars totalling 101.85 dollars. The 101.85 dollars is then taxed at 46 percent to yield 46.85 dollars in taxes. Thus, the net after-tax income is again 55 dollars.

Adding the amount of depreciation, $A_t$, associated with ACRS less economic depreciation ($D_t$) we get:

$$V_0 = \sum_{t=0}^{n} \frac{L_t + I_t/(1-T) + [T/(1-T)](A_t - D_t)}{(1+d)^t}$$

Multiplying $A_t$ by T is necessary, since the depreciation is a tax deduction. Without the deduction

the corporation would have been paying T times the amount of the deduction. Since this amount is what the corporation would have had to pay, it also represents the cost to the Treasury of leasing and making the deduction available. Another example should clarify this. Again, we will start with gross income of 100 dollars and include a one dollar depreciation allowance, resulting in taxable income of 99 dollars as shown below:

| | |
|---|---|
| Income | $100.00 |
| Depreciation | -1.00 |
| Taxable income | 99.00 |
| Taxes (@ 46%) | 45.54 |

After-tax income = 100 - 45.54 = $54.46

Thus, the net after-tax income is 54.46 dollars. Multiplying the 1 dollar by T/(1-T) to get its pre-tax equivalent we get:

(1)(.46)/(1-.46) = .46/.54 = .85

for a total of 100.85 dollars of pre-tax gross income.

| | |
|---|---|
| Income 100 + (1)(.46/.54) | = $100.85 |
| Taxes (@46%) | -46.39 |
| After-tax income | $54.46 |

The 100.85 dollars taxed at 46 percent yields 46.39 dollars in taxes. Once again, the net after-tax income is 54.46 dollars.

Now if we look at the after-tax methodology, we would start with the same lease payment $L_t$, which again represents the lease cost to the Air Force. Now the Treasury will be receiving a reflow from taxes paid on the corporation's revenues. To take a government perspective this must be captured. Letting $R_v$ be the corporation's revenue stream we have:

$$R_v = L_t - T(L_t - D_t)$$

where $D_t$ is the allowance for economic depreciation that ensures we are only taxing revenue and not the principal. Here we are striving to maintain a "tax-neutral" system in an effort to avoid taxing principal, as discussed in the earlier proofs. To this we add the tax benefits which results in:

$$V_t = L_t - T(L_t - D_t) + I_t + T(A_t - D_t)$$

The term $(A_t - D_t)$ can be looked at as the amount of depreciation in excess of economic depreciation, or simply a tax subsidy. $V_t$ is the value of the revenue stream at time t. Multiplying the terms we get:

$$V_t = L_t - TL_t + TD_t + I_t + TA_t - TD_t$$

$$V_t = (1-T)L_t + I_t + TA_t$$

The discount rate used for converting to present value must be adjusted to reflect the after-tax cost of capital. "If the government's cost of borrowing is d and the rate of tax is $\overline{T}$, then the government pays d in interest for each dollar it borrows, and receives $\overline{T}$ [*times*] *d* back as tax on interest income. Its cost of borrowing, after taxes, is $(1-\overline{T})d$" (17:A7). The $\overline{T}$ is the average tax rate of the holder of a government bond.

Therefore, the after-tax expression for the total discounted cost of a government lease, $C_g$, is the

following:

$$C_g = \sum_{t=0}^{n} \frac{(1-T)L_t + I_t + TA_t}{[1+(1-\bar{T})d]^t} \qquad (17:7)$$

In conclusion both the pre-tax and after-tax calculations yield the same results, but only under the very stringent conditions that economic depreciation $(V_t - V_{t-1})$ actually equals $D_t$ in the pre-tax calculation and that the correct discount rate has been used in the after-tax calculation. Since, economic depreciation is a function of unobservable market values in the future it becomes immeasurable and we will use the after-tax methodology. "The pre-tax method discounts before-tax outlays at a before-tax discount rate, while the after-tax method discounts after-tax outlays at an after-tax discount rate" (11:29). The difference in the pre-tax cost of capital and the after-tax cost can be summed-up as the following: "The pre-tax cost of funds is larger than the after-tax cost by the amount of taxes paid on the interest income received by the owners of government bonds" (11:29). Basically, it is this difference in discount rates that makes both methods

result in the same answers.

The question of what discount rate to use to represent the government cost of borrowing is a current topic of debate. The two general schools of thought will be briefly presented in the next section. Since the discount rate issue could qualify as a separate thesis in itself, this thesis will simply touch on the surface in order to provide a little background for the reader.

## The Discount Rate Debate

The tax system is the mechanism that routes the funds from private to public sectors. The two schools of thought are the social time preference position and the opportunity cost position.

The time preference practitioners contend that the private sector is more short-term oriented and does not adequately provide for the future generations. The solution to this problem is to route more money from the private sector to the public sector by using a smaller discount rate in the public sector than is observed in the private sector. At a lower discount rate, the projects will have larger net present values, a greater number of projects will be accepted, and future generations will benefit from the additional projects funded. Economists supporting this position such as Martin S. Feldstein, maintain that the discount rate should reflect society's rate of time preference of money. The time preference of money is basically the amount of present consumption forgone (or traded) for future consumption.

In the opportunity cost position, the government functions to maximize the current generation's welfare. Here, the appropriate discount rate to use is the current rate of return observed in the private sector. Practitioners of this theory find two major flaws with the time preference theory. First, we cannot assume society

will want to provide more for future generations, and secondly, if we do advocate a time preference theory, how then could any governmental body determine how far below the private sector's discount rate the public rate should be. Or, how much of the future generation's welfare should today's generation finance.

There have been several studies between 1969 and 1976 to determine the appropriate DOD discount rate. Such economists as Haveman, Ram, Jenkins, Stockfisch, Seagraves, Sandmo, Dreze, and Burgress have resulted in a range of real discount rates from 7 to 13 percent. Their differences are basically related to different assumptions. Haveman assumed that additional government revenue will be financed completely through personal income tax, thus the appropriate rate of return is a weighted average of various consumer borrowing rates (since the money would have been growing at this rate had it not been taxed away from the consumer). He results in a real rate of 7 percent which is compatible with the time preference position. Stockfisch computed the pre-tax rate of return in both the corporate and non-corporate sectors and took a weighted average of the two. He results in a real rate of 10.4 percent which supports more of a social opportunity cost position. This is also very close to the current rate being used - 10 percent, which is set by OMB circular A-94 dated March 1972.

In conclusion, the discount rate does not help

determine the level of defense capabilities desirable. Once a certain level is set, the discount rate, through a cost-benefit analysis, will help determine the most efficient way of obtaining those capabilities (i.e. lease or buy, project A or project B, etc.). "Economists disagree on whether public investment [causes the elimination of] private investment, and if it does, how much is taken away from each sector" (18:26).

## IV. Air Force Cost-Benefit Analysis for CT-39

In the following section, the model used for the cost-benefit analysis conducted by the Air Force for the replacement of the CT-39 aircraft will be presented. This analysis is very similar to what went forward to Congress; the only difference being four of the parameters that were inputs to the model. These parameters are: the cost of operating and supporting (O&S) the existing fleet of CT-39s, the lease cost, the purchase cost, and the amount of capital recovery. Capital recovery is the portion of the lease cost that is purely for leasing the aircraft. The total lease cost is made up of an amount of contractor logistics support (CLS) plus what is termed capital recovery. The Air Force will contract-out the CLS in both the buy and lease cases; therefore, to determine the amount of CLS to apply to the buy alternative the quoted lease price had to be broken-down into its two components. This particular analysis was used as a check to see if updated contractor data would alter the results of the original study that went to Congress. Table I shows the cost-benefit analysis. The Visicalc model (and terms) used to generate this is in appendix A. Visicalc is one of many "spreadsheet" applications for microcomputers. Table II takes the results of table I and converts the dollar figures into net present value terms.

Table I

| | |
|---|---|
| CT-39 O&S | 1190.63 |
| LEASE.... | 598.98 |
| PURCHASE | 3.41 |
| RECOVERY | 238.00 |
| TAX RATE | .46 |
| FLY HRS.. | 700.00 |
| QUANTITY | 120.00 |
| DISC RATE | 0.10 |

Operational Support Airlift
(dollars in millions)

Lease Versus Buy New Aircraft

| | Air Force Cost | | Tax Impact | | | Govt Cost | |
|---|---|---|---|---|---|---|---|
| Year | Lease | Buy | ACRS | St Line | Net | Lease | Buy |
| 1 | 89.99 | 329.23 | -8.46 | -1.13 | -7.33 | 97.33 | 329.23 |
| 2 | 79.97 | 231.47 | -20.87 | -3.38 | -17.49 | 97.46 | 231.47 |
| 3 | 72.18 | 63.29 | -35.53 | -6.02 | -29.52 | 101.70 | 63.29 |
| 4 | 66.61 | 46.62 | -40.23 | -7.52 | -32.71 | 99.33 | 46.62 |
| 5 | 66.61 | 46.62 | -39.48 | -7.52 | -31.96 | 98.58 | 46.62 |
| 6 | 66.61 | 46.62 | -27.64 | -7.52 | -20.12 | 86.73 | 46.62 |
| 7 | 66.61 | 46.62 | -15.79 | -7.52 | -8.27 | 74.89 | 46.62 |
| 8 | 66.61 | 46.62 | 0.00 | -7.52 | 7.52 | 59.09 | 46.62 |
| 9 | 66.61 | 46.62 | 0.00 | -7.52 | 7.52 | 59.09 | 46.62 |
| 10 | 66.61 | 46.62 | 0.00 | -7.52 | 7.52 | 59.09 | 46.62 |
| 11 | 66.61 | 46.62 | 0.00 | -7.52 | 7.52 | 59.09 | 46.62 |
| 12 | 66.61 | 46.62 | 0.00 | -7.52 | 7.52 | 59.09 | 46.62 |
| 13 | 66.61 | 46.62 | 0.00 | -7.52 | 7.52 | 59.09 | 46.62 |
| 14 | 66.61 | 46.62 | 0.00 | -7.52 | 7.52 | 59.09 | 46.62 |
| 15 | 66.61 | 46.62 | 0.00 | -7.52 | 7.52 | 59.09 | 46.62 |
| 16 | 66.61 | 46.62 | 0.00 | -7.52 | 7.52 | 59.09 | 46.62 |
| 17 | 66.61 | 46.62 | 0.00 | -7.52 | 7.52 | 59.09 | 46.62 |
| 18 | 66.61 | 46.62 | 0.00 | -7.52 | 7.52 | 59.09 | 46.62 |
| 19 | 66.61 | 46.62 | 0.00 | -7.52 | 7.52 | 59.09 | 46.62 |
| 20 | 66.61 | 46.62 | 0.00 | -7.52 | 7.52 | 59.09 | 46.62 |
| 21 | 46.63 | 32.64 | 0.00 | -6.71 | 6.71 | 39.92 | 32.64 |
| 22 | 26.65 | 18.65 | 37.6 | -5.32 | 42.92 | -16.27 | 18.65 |
| Total | 1447.85 | 1467.84 | -150.41 | -150.41 | -0.00 | 1447.86 | 1467.84 |

In Table I the CT-39 O&S cost is expressed in dollars per flying hour and is equivalent to the CLS of the replacement aircraft. The lease cost and recovery amount are also in dollars per flying hour. The purchase cost is expressed in millions of dollars and the flying hours is the total annual number of hours per aircraft. Column one is simply the years of the contract. Column two shows the Air Force's cost of leasing the replacement aircraft for the CT-39 (from a pre-tax approach). Basically, the fleet of 120 CT-39s is being replaced by 120 new aircraft being phased-in over a four year period as shown below.

Aircraft in Active Force

| year | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| CT-39s | 120 | 84 | 48 | 20 | 0 |
| new aircraft | 0 | 36 | 72 | 100 | 120 |
| total | 120 | 120 | 120 | 120 | 120 |
| | | | | | |
| no. purchased | 0 | 36 | 36 | 28 | 20 |

In years one and two, 36 aircraft are coming in per year while 36 of the CT-39s are leaving the Air Force inventory. Years three and four have replacements of 28 and 20 respectively. The calculation of the lease multiplies the number of new aircraft by the sum of the fuel cost to fly the aircraft and the contractors fees for leasing and maintaining the aircraft. This number is

then added to the operation and support costs (O&S) for the remaining CT-39s. The formula for the first entry, 89.99, appears as:

```
36*((B7*B3/1000000)+(165*B7*1.176/1000000))
+84*B2*B7/1000000
```

where B7 (700) is the number of flying hours per aircraft per year, B3 (598.98) is the composite cost of leasing the aircraft and its required maintenance in dollars per hour, and B2 (1190.63) is the hourly cost of operating and supporting the current CT-39. The 36 is the number of replacement aircraft, while the 84 is the number of active CT-39s. The new aircraft will burn 165 gallons of fuel per hour at a current price of $1.176 per gallon. The Air Force buy column uses a very similar calculation. Here the Air Force buys 72 aircraft at the start of year one, but due to spaced deliveries will only operate 36. The chart below shows the purchase and use rate.

Aircraft in Active Force

| year | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| CT-39s | 120 | 84 | 48 | 20 | 0 |
| new aircraft | 0 | 36 | 72 | 120 | 120 |
| total | 120 | 120 | 120 | 140 | 120 |
| no. purchased | 0 | 72 | 48 | 0 | 0 |

If you notice, the total for year three is 140. This is an error. The number of new aircraft should be 100, not 120, making the total come out to 120. For the buy column the contractor logistics support (CLS), or maintenance, is added to the purchase price. Again this figure is added to the cost to operate and support the remaining fleet of CT-39s. The formula for year one appears as:

```
36*((B7(B3-B5)/1000000)+(165*B7*1.176/1000000))
+72*B4+84*B2*B7/1000000
```

where B4 (3.41) is the purchase price of the new aircraft in millions of dollars and B5 (238.00) is the portion of the composite lease price that is purely the lease, in dollars per hour (i.e. B3-B5 equals the contractor logistics support price only). Therefore, in the case of a buy, we would still be purchasing logistics support. The next column shows the tax benefits associated with ACRS. The ACRS rates of .15, .22, .21, .21, and .21 for years one through five respectively are multiplied by the quantity of aircraft, the purchase price, and the corporation's tax rate. Year two, for example, would show the 36 aircraft bought that year times .15 (times the purchase price and tax rate) plus the 36 aircraft bought the prior year times .22 (times the purchase price and tax rate). This formula appears as:

(.22*B4*36*B6)+(.15*B4*36*B6)

where B6 is the corporate tax rate (.46). The 37.6 at year 22 represents a 20 percent residual value assumed under straight-line. This 37.6 million dollars is based on the assumption that the aircraft can be sold for 20 percent of their original value after 20 years. This may or may not be a valid assumption to make in a high technology field such as this.

The straight-line column is similar, but uses a flat rate of 4 percent as discussed earlier. Also, there are fewer aircraft eligible for write-off. Under the IRS ruling, known as the half-year convention, only half of the aircraft delivered in the first half of the year are eligible under straight-line. Therefore, year one has 18 (half of 36) and year two would have the 36 from year one and 18 from year two, or 54 total. This formula is:

(.04*54*B4*B6).

The -6.71 and -5.32 million dollar figures for years 21 and 22 respectively were added to make the sum of the straight-line depreciation deductions equal the sum of the ACRS depreciation deductions. This is an error and the deductions should have continued at a flat rate of 4 percent with 102 aircraft in year 21, 66 in year 22, 34 in year 23, and 10 in year 24. The 150 million dollar totals

for both the ACRS and Straight-line columns represents 80 percent of the original purchase price of the 120 aircraft. The phasing of the aircraft is also in error. The CT-39 analysis shows a depreciation rate of 18, 54, 96, and 120 aircraft in years one through four. This rate does not track with their purchase rate. The correct rate should be 18, 54, 86, and 110 for the first four years. The next column is titled net impact. This shows the net tax benefits in a theoretically tax neutral society (allowing for economic depreciation) where straight-line depreciation is assumed to be equal to economic depreciation. In other words ACRS minus straight-line is equal to the net impact. This net impact is then added to the Air Force lease price to yield the government lease price. The government buy column is exactly equal to the Air Force buy column.

I have shown samples of the formulas used to generate the first or second entries of each column. The rest of the column entries used the same type of formulas with different numbers for phasing in and out the aircraft and for the different write-off rates prescribed by ACRS.

Table II shows the cumulative costs in terms of today's dollars, or net present value.

Table II

Operational Support Airlift
(cumulative net present costs in millions of dollars)
Lease Versus Buy
Discounted Costs at a Constant
.1 Real Discount Rate

| | Air Force Cost | | Tax Impact | | | Govt Cost | |
|---|---|---|---|---|---|---|---|
| Year | Lease | Buy | ACRS | St-Line | Net | Lease | Buy |
| 1 | 81.81 | 299.30 | -7.69 | -1.03 | -6.67 | 88.48 | 299.30 |
| 2 | 147.91 | 490.59 | -24.94 | -3.82 | -21.12 | 169.02 | 490.59 |
| 3 | 202.14 | 538.14 | -51.64 | -8.34 | -43.29 | 245.43 | 538.14 |
| 4 | 247.63 | 569.99 | -79.12 | -13.48 | -65.64 | 313.27 | 569.99 |
| 5 | 289.00 | 598.93 | -103.63 | -18.15 | -85.48 | 374.48 | 598.93 |
| 6 | 326.60 | 625.25 | -119.23 | -22.39 | -96.84 | 423.44 | 625.25 |
| 7 | 360.78 | 649.18 | -127.34 | -26.25 | -101.08 | 461.86 | 649.18 |
| 8 | 391.86 | 670.93 | -127.34 | -29.76 | -97.58 | 489.43 | 670.93 |
| 9 | 420.11 | 690.70 | -127.34 | -32.95 | -94.39 | 514.49 | 690.70 |
| 10 | 445.79 | 708.67 | -127.34 | -35.85 | -91.49 | 537.28 | 708.67 |
| 11 | 469.14 | 725.01 | -127.34 | -38.49 | -88.85 | 557.99 | 725.01 |
| 12 | 490.36 | 739.87 | -127.34 | -40.88 | -86.45 | 576.82 | 739.87 |
| 13 | 509.66 | 753.37 | -127.34 | -43.06 | -84.28 | 593.93 | 753.37 |
| 14 | 527.20 | 765.65 | -127.34 | -45.04 | -82.30 | 609.50 | 765.65 |
| 15 | 543.15 | 776.81 | -127.34 | -46.84 | -80.50 | 623.64 | 776.81 |
| 16 | 557.64 | 786.96 | -127.34 | -48.48 | -78.86 | 636.50 | 786.96 |
| 17 | 570.82 | 796.18 | -127.34 | -49.97 | -77.37 | 648.19 | 796.18 |
| 18 | 582.80 | 804.57 | -127.34 | -51.32 | -76.02 | 658.82 | 804.57 |
| 19 | 593.70 | 812.19 | -127.34 | -52.55 | -74.79 | 668.48 | 812.19 |
| 20 | 603.60 | 819.12 | -127.34 | -53.67 | -73.67 | 677.27 | 819.12 |
| 21 | 609.90 | 823.53 | -127.34 | -54.57 | -72.76 | 682.66 | 823.53 |
| 22 | 613.17 | 825.82 | -122.72 | -55.23 | -67.49 | 680.66 | 825.82 |

The results show that the Air Force lease cost of $613.17 million is $67 million less than the government lease cost of $680.66 million. The government costs show it is more expensive to buy than lease ($145 million more). In the original analysis, the input parameters for lease price, purchase price, recovery rate (excluding CLS), and the operating and support costs for the existing CT-39 are less than they are in this study. Its results were the same, but a little less dramatic. The Air Force lease was $49 million less than the government lease and it cost the government approximately $110 million more to buy than to lease the new aircraft. These were the results sent to Congress.

This analysis seems to have some fundamental flaws however. It is not clear why the government cost should be equal to the Air Force cost minus the difference between ACRS and straight-line depreciation. It is doubtful that the Treasury Department would agree that this represents their true cost. The methodology appears to be some form of pre-tax analysis, but that is not certain either. They never multiply the deduction by T/(1-T) to get its pre-tax equivalent. Table III will perform the after-tax analysis with a real discount rate of 10 percent and a government lease cost calculated as:

$$C_g = (1-T)L_t + TA_t$$

The discount rate must be converted to an after-tax rate as discussed previously. This is done by multiplying it by the quantity (1-T), where T is the tax rate of the holders of the government bonds. The entries previously noted will also be corrected. These are: the 120 new aircraft in year 3 for the purchase, the ACRS entry of $37.6 million in residual value, and the two straight-line entries of 6.71 and 5.32 for years 21 and 22 respectively.

Table IV shows the cumulative net present values of the pre-tax costs to the Air Force for both the lease and buy alternatives. To compare these costs to the after-tax costs to the government you must multiply by (1-T), where T is the corporation's tax rate. Finally, Table V shows the net present value of the after-tax costs to the government for both the lease and buy alternatives. The two totals for the government buy and lease are the numbers to compare to ensure a government perspective is being taken. The results show that: when taking an Air Force perspective the decision is to lease the aircraft, but when taking the government perspective the decision is to buy the aircraft. It should be noted that including the $37.6 million in salvage value only reduces the net present cost of the government lease by $8.5 million and the government perspective still yields a buy decision. Results of the CT-39 analysis, on the other hand, show that both the Air Force and the government would prefer to lease.

Table III

| | |
|---|---|
| CT-39 O&S | 1190.63 |
| LEASE.... | 598.98 |
| PURCHASE | 3.41 |
| RECOVERY | 238.00 |
| TAX RATE | .46 |
| FLY HRS.. | 700.00 |
| QUANTITY | 120.00 |
| DISC RATE | 0.10 |
| T bar | 0.30 |
| AFTER-TAX | 0.07 |

Operational Support Airlift
(dollars in millions)

Lease Versus Buy New Aircraft
After-tax

| | Air Force Cost | | | Govt Cost | |
|---|---|---|---|---|---|
| Year | Lease | Buy | ACRS | Lease | Buy |
| 1 | 89.99 | 329.23 | 8.46 | 57.06 | 177.78 |
| 2 | 79.97 | 231.47 | 20.87 | 64.05 | 124.99 |
| 3 | 72.18 | 55.52 | 35.53 | 74.51 | 29.98 |
| 4 | 66.61 | 46.62 | 40.23 | 76.21 | 25.18 |
| 5 | 66.61 | 46.62 | 39.48 | 75.45 | 25.18 |
| 6 | 66.61 | 46.62 | 27.64 | 63.61 | 25.18 |
| 7 | 66.61 | 46.62 | 15.79 | 51.76 | 25.18 |
| 8 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 9 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 10 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 11 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 12 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 13 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 14 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 15 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 16 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 17 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 18 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 19 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 20 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 21 | 46.63 | 32.64 | 0.00 | 25.18 | 17.62 |
| 22 | 26.65 | 18.65 | 0.00 | 14.39 | 10.07 |
| Total | 1447.85 | 1460.07 | 188.01 | 969.85 | 788.44 |

note: Government Buy column equals Air Force Buy column multiplied by (1-T).

Table IV

"Air Force Perspective"
Operational Support Airlift
(cumulative net present costs
in millions of dollars)
Lease Versus Buy
Discounted Costs at a Constant
.1 Real Discount Rate

| | Air Force Cost | |
|---|---|---|
| Year | Lease | Buy |
| 1 | 81.81 | 299.30 |
| 2 | 147.91 | 490.59 |
| 3 | 202.14 | 532.31 |
| 4 | 247.63 | 564.15 |
| 5 | 289.00 | 593.10 |
| 6 | 326.60 | 619.41 |
| 7 | 360.78 | 643.34 |
| 8 | 391.86 | 665.09 |
| 9 | 420.11 | 684.86 |
| 10 | 445.79 | 702.83 |
| 11 | 469.14 | 719.17 |
| 12 | 490.36 | 734.03 |
| 13 | 509.66 | 747.53 |
| 14 | 527.20 | 759.81 |
| 15 | 543.15 | 770.97 |
| 16 | 557.64 | 781.12 |
| 17 | 570.82 | 790.34 |
| 18 | 582.80 | 798.73 |
| 19 | 593.70 | 806.35 |
| 20 | 603.60 | 813.28 |
| 21 | 609.90 | 817.69 |
| 22 | 613.17 | 819.98 |
| TOTALS | 613.17 | 819.98 |

Table V

"Government Perspective"
Operational Support Airlift
(cumulative net present costs
in millions of dollars)
Lease Versus Buy
Discounted Costs at a Constant
.07 Real Discount Rate

| | Government Cost | |
|---|---|---|
| Year | Lease | Buy |
| 1 | 53.32 | 166.15 |
| 2 | 109.27 | 275.32 |
| 3 | 170.10 | 299.80 |
| 4 | 228.23 | 319.00 |
| 5 | 282.03 | 336.95 |
| 6 | 324.42 | 353.73 |
| 7 | 356.65 | 369.41 |
| 8 | 377.59 | 384.06 |
| 9 | 397.15 | 397.75 |
| 10 | 415.44 | 410.55 |
| 11 | 432.53 | 422.51 |
| 12 | 448.50 | 433.69 |
| 13 | 463.43 | 444.14 |
| 14 | 477.38 | 453.90 |
| 15 | 490.42 | 463.03 |
| 16 | 502.60 | 471.56 |
| 17 | 513.99 | 479.53 |
| 18 | 524.63 | 486.97 |
| 19 | 534.58 | 493.94 |
| 20 | 543.87 | 500.44 |
| 21 | 549.95 | 504.70 |
| 22 | 553.20 | 506.97 |
| TOTALS | 553.20 | 506.97 |

## V. CT-39 Analysis With New Tax Laws

A bill introduced by Congressman Pickle proposes broad changes to the tax code designed to eliminate the incentive for tax-exempt entities to lease property. This bill, numbered H.R. 3110, only makes minor changes to the investment tax credits. In general, it is stricter on its interpretation of a service contract, thus denying the ITC where the contract is more appropriately treated as a lease. Also, the rehabilitation credits would be denied where the rehabilitation expenditure is being financed by a tax-exempt industrial development bond.

The present laws for determining ownership of the property would remain unchanged. Therefore, the taxable entity could still be treated as the owner of the property. This, in turn, would mean the owner would qualify for the tax benefits.

The major change is in the method of depreciation. The new laws require straight-line depreciation over an extended recovery period and with no salvage value. The recovery period is determined by the ADR system, set in January of 1981, to be the mid-point life of the property or 125 percent of the term of the lease, whichever is greater (1:133). The ADR system is a set of tables that set allowance of deduction based on what category the

property falls into. The tables give three recovery periods for each category, of which the middle period will be used under the new laws. The contract for the CT-39 is a five year lease with the option to renew the lease. The analysis that went to Congress was based on four of these leases totalling 20 years. The five year category has a mid-point of 12 years. The recovery period used in the model developed later in this chapter is 12 years, since it is greater than 6.25 years (5 * 125 percent). These recovery periods are designed to leave the tax-exempt entity indifferent to leasing or buying the asset from a taxable entity. The intent is to remove the incentive to lease which will also remove the associated tax benefits, thus eliminating the situation where the Treasury shares another government agency's financing burden.

The provisions of this bill will apply to property placed in service by the taxpayer after May 23, 1983. The CT-39 program is protected by a type of grandfather clause termed a "transitional rule". "The bill does not apply to property used by a tax-exempt entity pursuant to one or more written contracts binding on May 23, 1983..." (1:152).

The question of the discount rate also needs mention. In the past, OMB circular A-94 has set this rate at a real rate of 10 percent. Based on conversations with representatives from the Treasury, OMB, and Joint

Committee on Taxation, the discount rate will soon be changed from 10 percent to the current Treasury bill (T-bill) rate for a bill with a maturity (life) equal to the life of the project. Currently this rate is about 14 percent for a 20 year T-bill.

This seems more appropriate, since the program will be financed by T-bills yielding 14 percent and not some 10 percent rate that has traditionally been used. However, the CT-39 analysis uses constant dollars that have not been adjusted for any anticipated inflation. Since the 10 percent rate is a real rate, it does not discount inflation and it should be used with constant dollars. The 14 percent, on the other hand, is a nominal rate that discounts both the real value (purchasing power) of the dollar and the impact of inflation. In order to use the nominal 14 percent rate with constant dollars the component of inflation must be subtracted out. The rule-of-thumb is to use a real discount rate with constant dollars or a nominal discount rate with then-year (future) dollars. The following argument depicts this a little more formally.

Let: $d_b$ = one current dollar at the beginning of the period,

$d_e$ = the amount of then-year dollars at the end of the period (then-year dollars);a person at the end of the period would be

indifferent between $d_b$ and $d_e$,

$c_e$ = the amount of constant (i.e. inflation-free) dollars at the end of the period,

R = the real (inflation-free) rate of interest,

r = the nominal (market) rate of interest, and

I = the expected rate of price change (inflation)

Then we have the following relationships:

(1) $c_e = d_b * (1+R)$

i.e. constant dollars at the end of the period equal todays dollars adjusted for the real rate of growth; since capital is productive there is competition for the use of the capital, which accounts for R;

(2) $d_e = c_e * (1+I)$

i.e. current dollars at the end of the period equal constant dollars at the end of the period, adjusted for expected inflation;

(3) $d_e = d_b * (1+r)$

i.e. current dollars at the end of the period equal current dollars at the beginning of the period, adjusted for both the real rate of growth and expected inflation.

Substituting (1) into (2), we have:

(4) $d_e = d_b * (1=R) * (1+I)$.

Substituting (3) into (4) and simplifying, we have:

(5) $(1+r) = (1+R) * (1+I)$,

or

(6) $(1+r) = R+I+RI$ (4:326)

Now, what we are trying to show is that constant dollars discounted by a real rate is equal to then-year dollars discounted by a nominal rate. The equation for the net present value is:

(7) $$NPV = \sum_{i=0}^{N} d_i/(1+r)^i$$

where N is the number of periods, r is the nominal discount rate, and $d_i$ is the income of then-year dollars at the end of year i. Converting then-year dollars into constant dollars, we have:

$$d_e = c_e * (1+I)$$

$$(8) \qquad d_e / (1+I) = c_e$$

Constant dollars, as we maintain, must be discounted by a real rate R. Its net present value calculation appears as:

$$(9) \qquad NPV = \sum_{1=0}^{N} c_i / (1+R)^i$$

where, $c_i$ is the income of constant dollars at the end of year i, and R is the real discount rate. Substituting (8) into (9), thus we are now using then-year dollars, we have:

$$NPV = \sum_{i=0}^{N} \frac{d_i / (1+I)^i}{(1+R)^i}$$

or:

$$NPV = \sum_{i=0}^{N} \frac{d_i}{(1+I)^i * (1+R)^i}$$

By definition, $(1+r) = (1+I) * (1+R)$, so we can substitute $(1+r)$ into the denominator and get:

$$NPV = \sum_{i=0}^{N} d_i / (1+r)^i$$

This is equal to what we started with, so constant dollars discounted by a real rate is exactly equal to then-year dollars discounted by a nominal rate.

Table VII uses a real rate of 11 percent, assuming inflation of three percent. Since the discount rate is not certain, but varies with the economy and the activity of the Federal Reserve the next chapter shows some sensitivity analysis over a range of discount rates.

The analysis shown in Table VI makes a number of changes to the previous analysis. The error pointed out in chapter four of operating 120 new aircraft in the third year of the buy column was changed to its correct entry of 100 aircraft. The entry of $37.6 million in year 22

Table VI

| | |
|---|---|
| CT-39 O&S | 1190.63 |
| LEASE.... | 598.98 |
| PURCHASE | 3.41 |
| RECOVERY | 238.00 |
| TAX RATE | .46 |
| FLY HRS.. | 700.00 |
| QUANTITY | 120.00 |
| T-BILL RT | 0.14 |
| INFLATION | 0.03 |
| PRE-TAX | 0.11 |
| T bar | 0.30 |
| AFTER-TAX | 0.08 |

New
Operational Support Airlift
(dollars in millions)

Lease Versus Buy New Aircraft
after-tax

| | Air Force Cost | | | Govt Cost | |
|---|---|---|---|---|---|
| Year | Lease | Buy | Strt Line | Lease | Buy |
| 1 | 89.99 | 329.23 | 2.35 | 50.95 | 177.78 |
| 2 | 79.97 | 231.47 | 7.05 | 50.24 | 124.99 |
| 3 | 72.18 | 55.52 | 12.53 | 51.51 | 29.98 |
| 4 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 5 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 6 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 7 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 8 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 9 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 10 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 11 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 12 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 13 | 66.61 | 46.62 | 10.97 | 46.94 | 25.18 |
| 14 | 66.61 | 46.62 | 6.27 | 42.24 | 25.18 |
| 15 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 16 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 17 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 18 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 19 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 20 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 21 | 46.63 | 32.64 | 0.00 | 25.18 | 17.62 |
| 22 | 26.65 | 18.65 | 0.00 | 14.39 | 10.07 |
| Total | 1447.85 | 1460.07 | 180.18 | 962.02 | 788.44 |

note: Government Buy column equals Air Force Buy multiplied by (1-T).

of the ACRS column was eliminated, assuming no residual value after 20 years. The analysis also incorporates the new tax laws requiring straight-line depreciation and a discount rate equal to the current T-bill rate for a bond with a life equal to the life of the property being leased. This resulted in the real discount rate of 10 percent being replaced with a nominal rate of 14 percent. Finally, the basic calculation that converts the Air Force lease cost to a government lease cost was changed. This new after-tax cost to the government, $C_g$, is represented below:

$$C_g = (1-T)*L_t + T*A_t$$

where, T is the corporations tax rate, $L_t$ is the Air Force lease cost, and $A_t$ is the amount of depreciation. The discount rate also changed to account for the after-tax reflow of revenue to the Treasury from taxes paid on the interest income to holders of government bonds. This is shown below:

$$(1-\bar{T})\ d$$

Where $\bar{T}$ is the tax rate of the bondholders (estimated at 30 percent) and d is the discount rate (.14). This analysis is shown in Table VI.

The Air Force lease and buy costs are calculated the

same way they were in the first analysis, again using constant dollars. The straight-line column depreciates 100 percent of the aircraft in equal annual amounts over the first 12 years of the aircraft's life. The 12 year period is set by IRS tables. The aircraft are being leased at the exact same rates as they were in the first analysis (i.e. year 1=36, year 2=36, year 3=28, and year 4=20). The formula for year two is:

.083333*B4*54*C6

where .083333 is one twelvth, B4 is the purchase price, 54 is the sum of 36 in year one and 18 in year two (using the half-year convention), and C6 is the corporation's tax rate. The entire program for Table VI is in appendix B.

The column titled government lease is calculated by the following formula:

(1-C6)*B20+D20

where C6 is the corporation's tax rate, B20 is the cost of the Air Force lease, and D20 is the amount of depreciation deduction. The government buy column is basically just the Air Force buy converted to an after-tax figure. This is done by multiplying it by (1-T).

Table VII shows the cumulative net present costs, based on an Air Force perspective.

Table VII

"Air Force Perspective"
New
Operational Support Airlift
(cumulative net present costs
in millions of dollars)
Lease Versus Buy
Discounted Costs at a Constant
.11 Real Rate

| | Air Force Cost | |
|---|---|---|
| Year | Lease | Buy |
| 1 | 81.07 | 296.60 |
| 2 | 145.98 | 484.46 |
| 3 | 198.76 | 525.06 |
| 4 | 242.64 | 555.77 |
| 5 | 282.17 | 583.44 |
| 6 | 317.79 | 608.37 |
| 7 | 349.87 | 630.82 |
| 8 | 378.78 | 651.05 |
| 9 | 404.82 | 669.28 |
| 10 | 428.28 | 685.70 |
| 11 | 449.41 | 700.49 |
| 12 | 468.46 | 713.81 |
| 13 | 485.61 | 725.82 |
| 14 | 501.06 | 736.64 |
| 15 | 514.99 | 746.38 |
| 16 | 527.53 | 755.16 |
| 17 | 538.83 | 763.07 |
| 18 | 549.01 | 770.19 |
| 19 | 558.18 | 776.61 |
| 20 | 566.44 | 782.39 |
| 21 | 571.65 | 786.04 |
| 22 | 574.34 | 787.92 |
| TOTALS | 574.34 | 787.92 |

Table VIII shows the cumulative net present costs, based on a Treasury perspective.

Table VIII

"Government Perspective"
New
Operational Support Airlift
(cumulative net present costs
in millions of dollars)
Lease Versus Buy
Discounted Costs at a Constant
.077 Real Rate

| | Government Cost | |
|---|---|---|
| Year | Lease | Buy |
| 1 | 47.30 | 165.07 |
| 2 | 90.61 | 272.83 |
| 3 | 131.85 | 296.83 |
| 4 | 170.23 | 315.54 |
| 5 | 205.87 | 332.92 |
| 6 | 238.95 | 349.05 |
| 7 | 269.68 | 364.03 |
| 8 | 298.20 | 377.93 |
| 9 | 324.69 | 390.85 |
| 10 | 349.28 | 402.84 |
| 11 | 372.12 | 413.97 |
| 12 | 393.32 | 424.31 |
| 13 | 411.22 | 433.91 |
| 14 | 426.17 | 442.82 |
| 15 | 437.99 | 451.09 |
| 16 | 448.97 | 458.77 |
| 17 | 459.16 | 465.91 |
| 18 | 468.63 | 472.53 |
| 19 | 477.41 | 478.68 |
| 20 | 485.57 | 484.39 |
| 21 | 490.88 | 488.10 |
| 22 | 493.69 | 490.07 |
| TOTALS | 493.69 | 490.07 |

The results indicate that with a discount rate of 14 percent (current rates for long term Treasury bills), inflation of three percent, and a bondholders' tax rate of 30 percent, it costs the government 3 million dollars less to buy than it costs to lease the aircraft. Therefore, the government decision is to buy the aircraft. Table V also resulted in a government decision to buy the aircraft. Results of both these analyses differ from those of the CT-39 analysis that went forward to Congress. In that study the Air Force and government reached the same decision to lease the aircraft. In the next chapter, I will present figures for government lease and buy costs and Air Force costs with various combinations of discount rates and bondholder tax rates. I will also make a few concluding comments.

# VI. Sensitivity Analysis

Sensitivity analysis is a very important step in the analysis process. It plays at least two important roles: it provides information on how the results will change with changes in the parameters/assumptions, and it gives the decision-maker more confidence in the decision he makes. For a cost-beneift analysis, one definition of sensitivity analysis is: "The study of the variation of costs in relation to changing assumptions" (19:192).

In this analysis, those parameters most likely to change were varried . They are the Air Force discount rate (which is the Treasury bill rate minus the inflation rate) and the bondholders' tax rate. Table IX, on the following page, shows the results of this analysis.

Table IX

Sensitivity Analysis

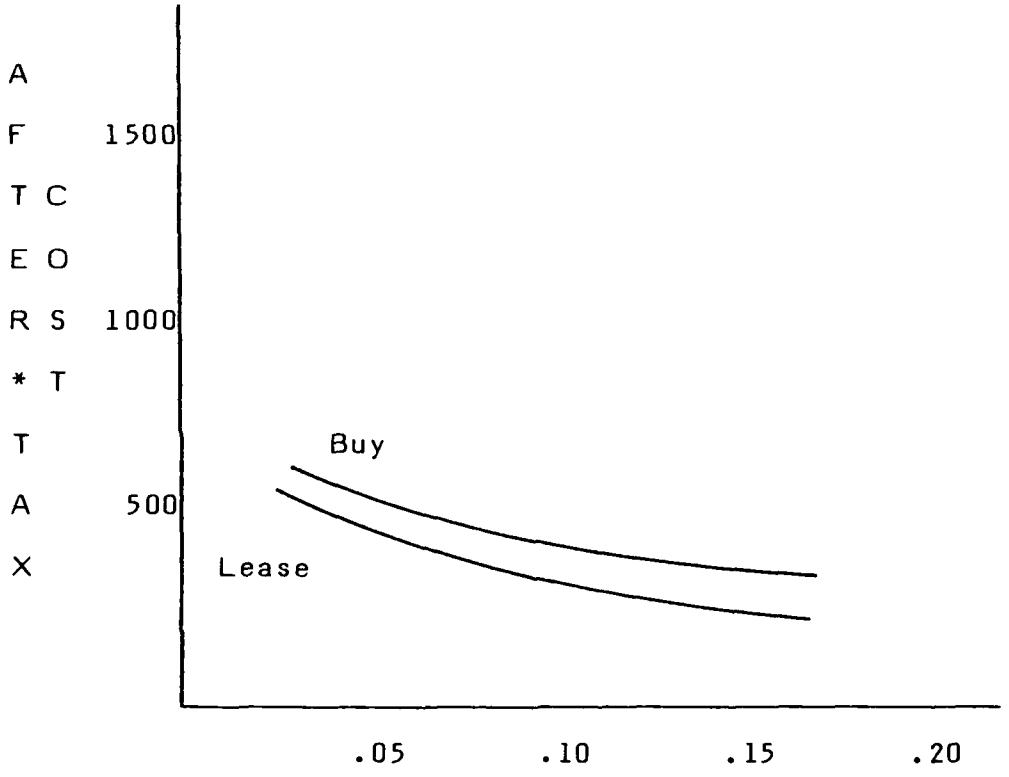
| Air Force Disc. Rt (pre-tax) | Bdholder Tax Rt | Gov't Disc. Rt (after-tax) | Air Force (after-tax) | | Government (after-tax) | |
|---|---|---|---|---|---|---|
| | | | Lease | Buy | Lease | Buy |
| 0.03 | 0.40 | .018 | | | 805.89 | 689.41 |
| 0.03 | 0.30 | .021 | 578.02 | 635.93 | 783.52 | 675.21 |
| 0.03 | 0.20 | .024 | | | 762.05 | 661.58 |
| 0.07 | 0.40 | .042 | | | 649.98 | 590.30 |
| 0.07 | 0.30 | .049 | 410.96 | 506.97 | 613.05 | 566.74 |
| 0.07 | 0.20 | .056 | | | 579.27 | 545.13 |
| 0.10 | 0.40 | .060 | | | 561.25 | 533.58 |
| 0.10 | 0.30 | .070 | 331.11 | 442.79 | 519.86 | 506.97 |
| 0.10 | 0.20 | .080 | | | 483.11 | 483.23 |
| 0.14 | 0.40 | .084 | | | 469.57 | 474.44 |
| 0.14 | 0.30 | .098 | 259.31 | 382.35 | 426.71 | 446.47 |
| 0.14 | 0.20 | .112 | | | 389.93 | 422.21 |
| 0.18 | 0.40 | .108 | | | 399.89 | 428.80 |
| 0.18 | 0.30 | .126 | 211.41 | 339.51 | 358.17 | 401.01 |
| 0.18 | 0.20 | .144 | | | 323.34 | 377.41 |

The results indicate it is always more costly for the government to lease the aircraft than it is for the Air Force to lease them. For example, with an Air Force discount rate of seven percent and a bondholders' tax rate of 30 percent the government lease cost is 202 million dollars more than the Air Force lease cost. The difference is obviously the lost revenue resulting from the still significant tax benefits of straight-line

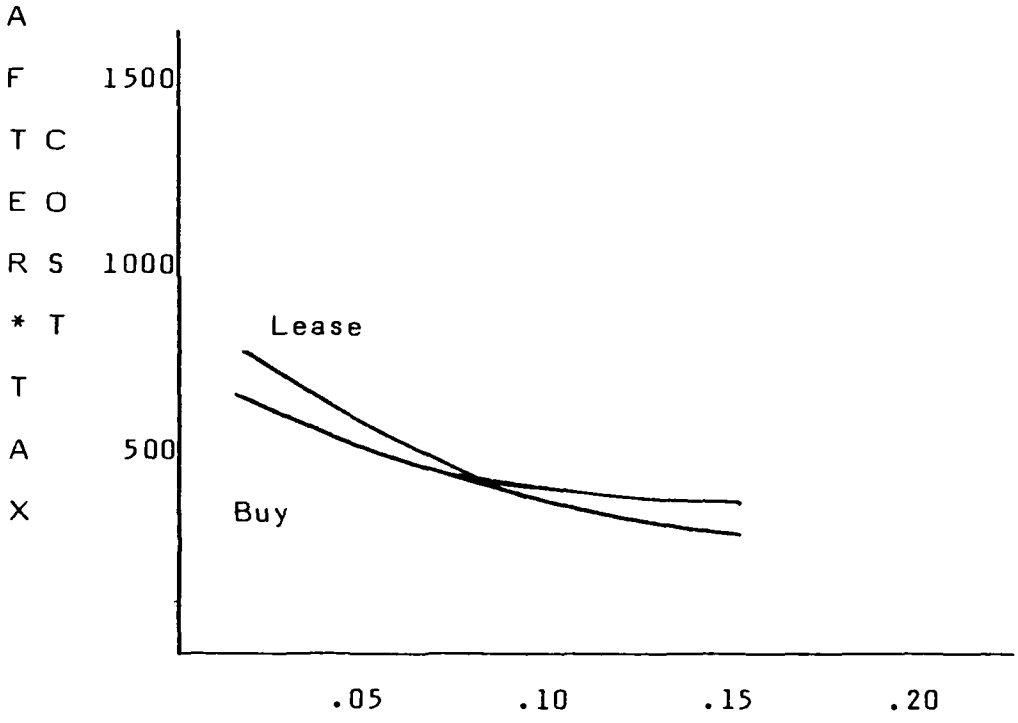
depreciation. Therefore, a valid Air Force cost-benefit analysis must ensure a Treasury perspective by including the effects of the lost revenue experienced at the Treasury Department. In all cases with the government discount rate set above 8 percent, it was less costly for the government to lease than to buy the aircraft, and in all cases where the rate was below 8 percent, it was more costly to lease. Therefore, the discount rate where the government becomes indifferent to leasing or buying is at 8 percent. The reason this occurs is because the buy alternative has a much larger initial outlay of money than does the lease. The lease has a much smaller initial outlay and allows much of the payment to be deferred to later years. Much of the buy payments will only be discounted over the first two years, while the payments with the lease are being discounted over a longer number of years. At higher discount rates the lease payments will be reduced to a lower net present value than the buy payments. In economic terms, at higher discount rates the opportunity cost (next best alternative) of the money is greater, thus the foregone use of the money becomes more costly. At lower discount rates the cost savings resulting from deferred payment with a lease become less significant and fail to offset the lost revenue at the Treasury.

Graphically, the results are depicted in the following two charts. Costs are in millions of dollars.

Air Force Perspective



Government Perspective




In conclusion, there is clear evidence that, at after-tax discount rates below 8 percent (or an Air Force rate of 10 percent and a bondholders' tax rate of 30 percent; see Table IX), there is a difference in the decision reached based on whether an Air Force perspective or government perspective is taken. The new tax laws reduced the magnitude of the difference between the two perspectives, but a difference still does exist. At the

lower discount rates the Air Force decision is to lease the aircraft while the government would prefer to buy. To be a truly accurate and unbiased analysis a government perspective must be taken by capturing the lost revenue at the Treasury.

The CT-39 analysis resulted in a government decision to lease the aircraft. The after-tax analysis, taking a government perspective, and incorporating the new tax laws resulted in a government decision to buy the aircraft. Therefore, the change in tax laws have not eliminated the need for the Air Force to establish a standard approach to lease versus buy analyses. The CT-39 will result in a government decision to buy the aircraft whenever the after-tax discount rate drops below eight percent. Even if high-cost leasing contracts like the CT-39 do not surface there are many lower budget items that the Air Force leases, such as automatic data processing equipment.

The new tax laws seemed to create a temporary 'fix' to the problem of the Air Force (all government agencies) conducting cost-benefit analyses based on an Air Force perspective. As long as the interest rates are at fairly high levels these problems will appear to have been corrected. At lower interest rates many more situations will occur where an Air Force perspective will yield a decision to lease, while the government perspective results in a buy decision. With the current drop in interest rates this problem seems likely to resurface.

What is needed is a standard methodology that is both easy to implement at the grassroots level and that takes a truly government perspective.

## Appendix A -- Visicalc Program for CT-39 Analysis

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|

Operational Support Airlift
(dollars in millions)

Lease Versus Buy New Aircraft

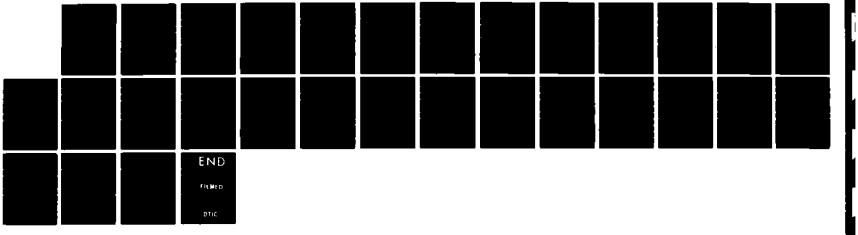
| | Air Force Cost | | Tax Impact | | | Govt Cost | |
|---|---|---|---|---|---|---|---|
| Year | Lease | Buy | ACRS | St Line | Net | Lease | Buy |
| 1 | 89.99 | 329.23 | 8.46 | 1.13 | 7.33 | 97.33 | 329.23 |
| 2 | 79.97 | 231.47 | 20.87 | 3.38 | 17.49 | 97.46 | 231.47 |
| 3 | 72.18 | 63.29 | 35.53 | 6.02 | 29.52 | 101.70 | 63.29 |
| 4 | 66.61 | 46.62 | 40.23 | 7.52 | 32.71 | 99.33 | 46.62 |
| 5 | 66.61 | 46.62 | 39.48 | 7.52 | 31.96 | 98.58 | 46.62 |
| 6 | 66.61 | 46.62 | 27.64 | 7.52 | 20.12 | 86.73 | 46.62 |
| 7 | 66.61 | 46.62 | 15.79 | 7.52 | 8.27 | 74.89 | 46.62 |
| 8 | 66.61 | 46.62 | 0.00 | 7.52 | 7.52 | 59.09 | 46.62 |
| 9 | 66.61 | 46.62 | 0.00 | 7.52 | 7.52 | 59.09 | 46.62 |
| 10 | 66.61 | 46.62 | 0.00 | 7.52 | 7.52 | 59.09 | 46.62 |
| 11 | 66.61 | 46.62 | 0.00 | 7.52 | 7.52 | 59.09 | 46.62 |
| 12 | 66.61 | 46.62 | 0.00 | 7.52 | 7.52 | 59.09 | 46.62 |
| 13 | 66.61 | 46.62 | 0.00 | 7.52 | 7.52 | 59.09 | 46.62 |
| 14 | 66.61 | 46.62 | 0.00 | 7.52 | 7.52 | 59.09 | 46.62 |
| 15 | 66.61 | 46.62 | 0.00 | 7.52 | 7.52 | 59.09 | 46.62 |
| 16 | 66.61 | 46.62 | 0.00 | 7.52 | 7.52 | 59.09 | 46.62 |
| 17 | 66.61 | 46.62 | 0.00 | 7.52 | 7.52 | 59.09 | 46.62 |
| 18 | 66.61 | 46.62 | 0.00 | 7.52 | 7.52 | 59.09 | 46.62 |
| 19 | 66.61 | 46.62 | 0.00 | 7.52 | 7.52 | 59.09 | 46.62 |
| 20 | 66.61 | 46.62 | 0.00 | 7.52 | 7.52 | 59.09 | 46.62 |
| 21 | 46.63 | 32.64 | 0.00 | 6.71 | 6.71 | 39.92 | 32.64 |
| 22 | 26.65 | 18.65 | 37.60 | 5.32 | 42.92 | 16.27 | 18.65 |
| Total | 1447.85 | 1467.84 | 150.41 | 150.41 | 0.00 | 1447.86 | 1467.84 |

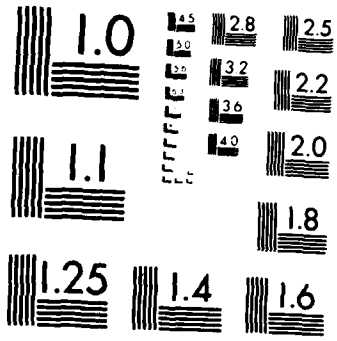
| | B |
|---|---|
| 20 | 89.99 |
| 21 | 79.97 |
| 22 | 72.18 |
| 23 | 66.61 |
| 24 | 66.61 |
| 25 | 66.61 |
| 26 | 66.61 |
| 27 | 66.61 |
| 28 | 66.61 |
| 29 | 66.61 |
| 30 | 66.61 |
| 31 | 66.61 |
| 32 | 66.61 |
| 33 | 66.61 |
| 34 | 66.61 |
| 35 | 66.61 |
| 36 | 66.61 |
| 37 | 66.61 |
| 38 | 66.61 |
| 39 | 66.61 |
| 40 | 46.63 |
| 41 | 26.65 |

```
B20     =36*((B7*B3/1000000)+(165*B7*1.176/1000000))+84*B2*B7/1000000
B21     =72*((B7*B3/1000000)+(165*B7*1.176/1000000))+48*B2*B7/1000000
B22     =100*((B7*B3/1000000)+(165*B7*1.176/1000000))+20*B2*B7/1000000
B23     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B24     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B25     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B26     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B27     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B28     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B29     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B30     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B31     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B32     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B33     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B34     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B35     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B36     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B37     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B38     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B39     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B40     =84*((B7*B3/1000000)+(165*B7*1.176/1000000))
B41     =48*((B7*B3/1000000)+(165*B7*1.176/1000000))
```

AD-A151 874 A GUIDE FOR AIR FORCE LEASE VERSUS BUY DECISIONS(U) AIR 2/2
FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF
ENGINEERING J S SHEDDEN DEC 84 AFIT/GOR/OS/84D-11

UNCLASSIFIED F/G 15/5 NL





| | |
|---|---|
| C20 | 329.23 |
| C21 | 231.47 |
| C22 | 63.29 |
| C23 | 46.62 |
| C24 | 46.62 |
| C25 | 46.62 |
| C26 | 46.62 |
| C27 | 46.62 |
| C28 | 46.62 |
| C29 | 46.62 |
| C30 | 46.62 |
| C31 | 46.62 |
| C32 | 46.62 |
| C33 | 46.62 |
| C34 | 46.62 |
| C35 | 46.62 |
| C36 | 46.62 |
| C37 | 46.62 |
| C38 | 46.62 |
| C39 | 46.62 |
| C40 | 32.64 |
| C41 | 18.65 |

```
C20   =36*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))+72*B4+84*B2*B7/1000000
C21   =72*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))+48*B4+48*B2*B7/1000000
C22   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))+20*B2*B7/1000000
C23   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C24   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C25   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C26   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C27   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C28   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C29   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C30   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C31   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C32   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C33   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C34   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C35   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C36   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C37   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C38   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C39   =B8*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C40   =84*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C41   =48*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
```

| | D<br>ACRS |
|---|---|
| 20 | 8.46 |
| 21 | 20.87 |
| 22 | 35.53 |
| 23 | 40.23 |
| 24 | 39.48 |
| 25 | 27.64 |
| 26 | 15.79 |
| 27 | 0.00 |
| 28 | 0.00 |
| 29 | 0.00 |
| 30 | 0.00 |
| 31 | 0.00 |
| 32 | 0.00 |
| 33 | 0.00 |
| 34 | 0.00 |
| 35 | 0.00 |
| 36 | 0.00 |
| 37 | 0.00 |
| 38 | 0.00 |
| 39 | 0.00 |
| 40 | 0.00 |
| 41 | 37.60 |

```
D20      =(.15*B4*36*B6)
D21      =(.22*B4*36*B6)+(.15*B4*36*B6)
D22      =(.21*B4*36*B6)+(.22*B4*36*B6)+(.15*B4*48*B6)
D23      =(.21*B4*72*B6)+(.22*B4*48*B6)
D24      =(.21*B4*1.0*B6)
D25      =(.21*B4*84*B6)
D26      =(.21*B4*48*B6)
D27      =0.00
D28      =0.00
D29      =0.00
D30      =0.00
D31      =0.00
D32      =0.00
D33      =0.00
D34      =0.00
D35      =0.00
D36      =0.00
D37      =0.00
D38      =0.00
D39      =0.00
D40      =0.00
D41      =(.2*B8*B4*B6)
D42       SUM(D20:D41)
```

| St Line | E |
|---|---|
| 20 | 1.13 |
| 21 | 3.38 |
| 22 | 6.02 |
| 23 | 7.52 |
| 24 | 7.52 |
| 25 | 7.52 |
| 26 | 7.52 |
| 27 | 7.52 |
| 28 | 7.52 |
| 29 | 7.52 |
| 30 | 7.52 |
| 31 | 7.52 |
| 32 | 7.52 |
| 33 | 7.52 |
| 34 | 7.52 |
| 35 | 7.52 |
| 36 | 7.52 |
| 37 | 7.52 |
| 38 | 7.52 |
| 39 | 7.52 |
| 40 | 6.71 |
| 41 | 5.32 |

```
E20      =(.04*18*B4*B6)
E21      =(.04*54*B4*B6)
E22      =(.04*96*B4*B6)
E23      =(.04*120*B4*B6)
E24      =(.04*120*B4*B6)
E25      =(.04*120*B4*B6)
E26      =(.04*120*B4*B6)
E27      =(.04*120*B4*B6)
E28      =(.04*120*B4*B6)
E29      =(.04*120*B4*B6)
E30      =(.04*120*B4*B6)
E31      =(.04*120*B4*B6)
E32      =(.04*120*B4*B6)
E33      =(.04*120*B4*B6)
E34      =(.04*120*B4*B6)
E35      =(.04*120*B4*B6)
E36      =(.04*120*B4*B6)
E37      =(.04*120*B4*B6)
E38      =(.04*120*B4*B6)
E39      =(.04*120*B4*B6)
E40      =6.71
E41      =5.32
```

| | F Net |
|---|---|
| 20 | 7.33 |
| 21 | 17.49 |
| 22 | 29.52 |
| 23 | 32.71 |
| 24 | 31.96 |
| 25 | 20.12 |
| 26 | 8.27 |
| 27 | -7.52 |
| 28 | -7.52 |
| 29 | -7.52 |
| 30 | -7.52 |
| 31 | -7.52 |
| 32 | -7.52 |
| 33 | -7.52 |
| 34 | -7.52 |
| 35 | -7.52 |
| 36 | -7.52 |
| 37 | -7.52 |
| 38 | -7.52 |
| 39 | -7.52 |
| 40 | -6.71 |
| 41 | -42.92 |

```
F20       =D20-E20
F21       =D21-E21
F22       =D22-E22
F23       =D23-E23
F24       =D24-E24
F25       =D25-E25
F26       =D26-E26
F27       =D27-E27
F28       =D28-E28
F29       =D29-E29
F30       =D30-E30
F31       =D31-E31
F32       =D32-E32
F33       =D33-E33
F34       =D34-E34
F35       =D35-E35
F36       =D36-E36
F37       =D37-E37
F38       =D38-E38
F39       =D39-E39
F40       =D40-E40
F41       =D41-E41
```

| | G<br>Lease |
|---|---|
| 20 | 97.33 |
| 21 | 97.46 |
| 22 | 101.70 |
| 23 | 99.33 |
| 24 | 98.58 |
| 25 | 86.73 |
| 26 | 74.89 |
| 27 | 59.09 |
| 28 | 59.09 |
| 29 | 59.09 |
| 30 | 59.09 |
| 31 | 59.09 |
| 32 | 59.09 |
| 33 | 59.09 |
| 34 | 59.09 |
| 35 | 59.09 |
| 36 | 59.09 |
| 37 | 59.09 |
| 38 | 59.09 |
| 39 | 59.09 |
| 40 | 39.92 |
| 41 | -16.28 |

```
G20     =B20-F20
G21     =B21-F21
G22     =B22-F22
G23     =B23-F23
G24     =B24-F24
G25     =B25-F25
G26     =B26-F26
G27     =B27-F27
G28     =B28-F28
G29     =B29-F29
G30     =B30-F30
G31     =B31-F31
G32     =B32-F32
G33     =B33-F33
G34     =B34-F34
G35     =B35-F35
G36     =B36-F36
G37     =B37-F37
G38     =B38-F38
G39     =B39-F39
G40     =B40-F40
G41     =B41-F41
```

| | H<br>Buy |
|---|---|
| 20 | 329.23 |
| 21 | 231.47 |
| 22 | 63.29 |
| 23 | 46.62 |
| 24 | 46.62 |
| 25 | 46.62 |
| 26 | 46.62 |
| 27 | 46.62 |
| 28 | 46.62 |
| 29 | 46.62 |
| 30 | 46.62 |
| 31 | 46.62 |
| 32 | 46.62 |
| 33 | 46.62 |
| 34 | 46.62 |
| 35 | 46.62 |
| 36 | 46.62 |
| 37 | 46.62 |
| 38 | 46.62 |
| 39 | 46.62 |
| 40 | 32.64 |
| 41 | 18.65 |

```
H20     =C20
H21     =C21
H22     =C22
H23     =C23
H24     =C24
H25     =C25
H26     =C26
H27     =C27
H28     =C28
H29     =C29
H30     =C30
H31     =C31
H32     =C32
H33     =C33
H34     =C34
H35     =C35
H36     =C36
H37     =C37
H38     =C38
H39     =C39
H40     =C40
H41     =C41
```

## Appendix B -- Visicalc Program for New Analysis

A B C D E F G

New
Operational Support Airlift
(dollars in millions)

Lease Versus Buy New Aircraft
after-tax

| Year | Air Force Cost | | Strt Line | Govt Cost | |
|---|---|---|---|---|---|
| | Lease | Buy | | Lease | Buy |
| 1 | 89.99 | 329.23 | 2.35 | 50.95 | 177.78 |
| 2 | 79.97 | 231.47 | 7.05 | 50.24 | 124.99 |
| 3 | 72.18 | 63.29 | 12.53 | 51.51 | 29.98 |
| 4 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 5 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 6 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 7 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 8 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 9 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 10 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 11 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 12 | 66.61 | 46.62 | 15.67 | 51.64 | 25.18 |
| 13 | 66.61 | 46.62 | 10.97 | 46.94 | 25.18 |
| 14 | 66.61 | 46.62 | 6.27 | 42.24 | 25.18 |
| 15 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 16 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 17 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 18 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 19 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 20 | 66.61 | 46.62 | 0.00 | 35.97 | 25.18 |
| 21 | 46.63 | 32.64 | 0.00 | 25.18 | 17.62 |
| 22 | 26.65 | 18.65 | 0.00 | 14.39 | 10.07 |
| Total | 1447.85 | 1467.84 | 194.28 | 1807.63 | 1467.84 |

| | B |
|---|---|
| 20 | 89.99 |
| 21 | 79.97 |
| 22 | 72.18 |
| 23 | 66.61 |
| 24 | 66.61 |
| 25 | 66.61 |
| 26 | 66.61 |
| 27 | 66.61 |
| 28 | 66.61 |
| 29 | 66.61 |
| 30 | 66.61 |
| 31 | 66.61 |
| 32 | 66.61 |
| 33 | 66.61 |
| 34 | 66.61 |
| 35 | 66.61 |
| 36 | 66.61 |
| 37 | 66.61 |
| 38 | 66.61 |
| 39 | 66.61 |
| 40 | 46.63 |
| 41 | 26.65 |

```
B20     =36*((B7*B3/1000000)+(165*B7*1.176/1000000))+84*B2*B7/1000000
B21     =72*((B7*B3/1000000)+(165*B7*1.176/1000000))+48*B2*B7/1000000
B22     =100*((B7*B3/1000000)+(165*B7*1.176/1000000))+20*B2*B7/1000000
B23     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B24     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B25     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B26     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B27     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B28     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B29     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B30     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B31     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B32     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B33     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B34     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B35     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B36     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B37     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B38     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B39     =B8*((B7*B3/1000000)+(165*B7*1.176/1000000))
B40     =84*((B7*B3/1000000)+(165*B7*1.176/1000000))
B41     =48*((B7*B3/1000000)+(165*B7*1.176/1000000))
```

| | |
|---|---|
| C20 | 329.23 |
| C21 | 231.47 |
| C22 | 63.29 |
| C23 | 46.62 |
| C24 | 46.62 |
| C25 | 46.62 |
| C26 | 46.62 |
| C27 | 46.62 |
| C28 | 46.62 |
| C29 | 46.62 |
| C30 | 46.62 |
| C31 | 46.62 |
| C32 | 46.62 |
| C33 | 46.62 |
| C34 | 46.62 |
| C35 | 46.62 |
| C36 | 46.62 |
| C37 | 46.62 |
| C38 | 46.62 |
| C39 | 46.62 |
| C40 | 32.64 |
| C41 | 18.65 |

```
C20   =36*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))+72*B4+84*B2*B7/1000000
C21   =72*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))+48*B4+48*B2*B7/1000000
C22   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))+20*B2*B7/1000000
C23   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C24   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C25   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C26   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C27   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C28   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C29   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C30   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C31   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C32   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C33   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C34   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C35   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C36   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C37   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C38   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C39   =88*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C40   =84*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
C41   =48*((B7*(B3-B5)/1000000)+(165*B7*1.176/1000000))
```

| | D Strt Line |
|---|---|
| 20 | 2.35 |
| 21 | 7.05 |
| 22 | 12.53 |
| 23 | 15.67 |
| 24 | 15.67 |
| 25 | 15.67 |
| 26 | 15.67 |
| 27 | 15.67 |
| 28 | 15.67 |
| 29 | 15.67 |
| 30 | 15.67 |
| 31 | 15.67 |
| 32 | 10.97 |
| 33 | 6.27 |
| 34 | 0.00 |
| 35 | 0.00 |
| 36 | 0.00 |
| 37 | 0.00 |
| 38 | 0.00 |
| 39 | 0.00 |
| 40 | 0.00 |
| 41 | 0.00 |

```
D20     =.083333*B4*18*B6
D21     =.083333*B4*54*B6
D22     =.083333*B4*96*B6
D23     =.083333*B4*120*B6
D24     =.083333*B4*120*B6
D25     =.083333*B4*120*B6
D26     =.083333*B4*120*B6
D27     =.083333*B4*120*B6
D28     =.083333*B4*120*B6
D29     =.083333*B4*120*B6
D30     =.083333*B4*120*B6
D31     =.083333*B4*120*B6
D32     =.083333*B4*84*B6
D33     =.083333*B4*48*B6
D34     =0.00
D35     =0.00
D36     =0.00
D37     =0.00
D38     =0.00
D39     =0.00
D40     =0.00
D41     =0.00
```

| | G Lease |
|---|---|
| 20 | 50.95 |
| 21 | 50.24 |
| 22 | 51.51 |
| 23 | 51.64 |
| 24 | 51.64 |
| 25 | 51.64 |
| 26 | 51.64 |
| 27 | 51.64 |
| 28 | 51.64 |
| 29 | 51.64 |
| 30 | 51.64 |
| 31 | 51.64 |
| 32 | 46.94 |
| 33 | 42.24 |
| 34 | 35.97 |
| 35 | 35.97 |
| 36 | 35.97 |
| 37 | 35.97 |
| 38 | 35.97 |
| 39 | 35.97 |
| 40 | 25.18 |
| 41 | 14.39 |

```
G20     =(1-C6)*B20+D20
G21     =(1-C6)*B21+D21
G22     =(1-C6)*B22+D22
G23     =(1-C6)*B23+D23
G24     =(1-C6)*B24+D24
G25     =(1-C6)*B25+D25
G26     =(1-C6)*B26+D26
G27     =(1-C6)*B27+D27
G28     =(1-C6)*B28+D28
G29     =(1-C6)*B29+D29
G30     =(1-C6)*B30+D30
G31     =(1-C6)*B31+D31
G32     =(1-C6)*B32+D32
G33     =(1-C6)*B33+D33
G34     =(1-C6)*B34+D34
G35     =(1-C6)*B35-D35
G36     =(1-C6)*B36-D36
G37     =(1-C6)*B37-D37
G38     =(1-C6)*B38-D38
G39     =(1-C6)*B39-D39
G40     =(1-C6)*B40-D40
G41     =(1-C6)*B41-D41
```

| | H<br>Buy |
|---|---|
| 20 | 177.78 |
| 21 | 124.99 |
| 22 | 29.98 |
| 23 | 25.18 |
| 24 | 25.18 |
| 25 | 25.18 |
| 26 | 25.18 |
| 27 | 25.18 |
| 28 | 25.18 |
| 29 | 25.18 |
| 30 | 25.18 |
| 31 | 25.18 |
| 32 | 25.18 |
| 33 | 25.18 |
| 34 | 25.18 |
| 35 | 25.18 |
| 36 | 25.18 |
| 37 | 25.18 |
| 38 | 25.18 |
| 39 | 25.18 |
| 40 | 17.62 |
| 41 | 10.07 |

```
H20     =(1-C6)*C21
H21     =(1-C6)*C21
H22     =(1-C6)*C22
H23     =(1-C6)*C23
H24     =(1-C6)*C24
H25     =(1-C6)*C25
H26     =(1-C6)*C26
H27     =(1-C6)*C27
H28     =(1-C6)*C28
H29     =(1-C6)*C29
H30     =(1-C6)*C30
H31     =(1-C6)*C31
H32     =(1-C6)*C32
H33     =(1-C6)*C33
H34     =(1-C6)*C34
H35     =(1-C6)*C35
H36     =(1-C6)*C36
H37     =(1-C6)*C37
H38     =(1-C6)*C38
H39     =(1-C6)*C39
H40     =(1-C6)*C40
H41     =(1-C6)*C41
```

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# VITA

Captain James S. Shedden was born on 12 December 1954 in New London, Ohio. He graduated from high school in Maumee, Ohio in 1973 and attended the United States Air Force Academy from which he received the degree of Bachelor of Science in Organizational Behavior in June 1977. Upon graduation, he received a commission in the USAF. He was stationed at Sheppard AFB, Texas where he served as an instructor for a Computer Operations Officer course, Chief of Operations for the base Data Processing Installation, and Computer Systems Analyst for the 3785th Field Training Group until entering the Air Force Institute of Technology, in June of 1983.

Permanent address: 5801 Golden Oak
Dayton,Oh 45424

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This work reviewed prior Air Force cost-benefit analysis procedures for a lease versus buy decision. Speciffically, it looked at the analysis supporting the Air Force's decision to lease 120 replacement aircraft for the CT-39 fleet.

The analysis used an after-tax methodology to ensure a government perspective was taken. The CT-39 analysis was a form of pre-tax methodology that did not accurately capture all the lost revenue at the Treasury resulting from the depreciation deductions available with a lease. The results of the analysis indicate that an Air Force's perspective always results in a decision to lease but the government perspective results in a decision to buy at discount rates below 8 percent and a decision to lease at rates above 8 percent.

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