BUDGETARY COST SAVINGS TO THE DEPARTMENT OF DEFENSE RESULTING FROM FOREIGN MILITARY SALES

Staff Working Paper

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PREFACE

This paper was written in response to a request from the House Armed Services Committee for an analysis of the effect of changes in U.S. policies regarding arms sales abroad. Specifically, the paper examines and projects the cost savings from the foreign military sales program on the basis of data analysis of 35 weapon systems.

This report was prepared by James R. Capra, Robert E. Schafer, and Patrick L. Renehan of the Budget Analysis Division of the Congressional Budget Office. The authors would like to acknowledge the assistance of Terry Nelson and Ramon Espinosa of the Budget Analysis Division and Sheila Kean Fifer of the National Security Division.

A related CBO staff working paper, Foreign Military Sales and U.S. Weapons Costs, examines the circumstances in which budgetary savings result from the foreign military sales program.

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SUMMARY

One of the elements of current debate on U.S. policies regarding the sale of arms abroad has been the economic consequences of significant changes in the foreign military sales (FMS) program. Assessment of these consequences centers on two issues: the budgetary cost savings to the U.S. which result from foreign military sales and the macroeconomic effects of such sales. This study addresses the first of these issues, the budgetary cost savings. A later analysis will focus on the macroeconomic effects of foreign military sales.

This study quantifies the budgetary cost savings attributable to foreign military sales and estimates the dollar value of savings associated with an $8 billion sales program under certain assumptions about the mix of sales among the categories of weapons, services, and construction. The results are based on analysis of data from sales of 35 major weapon systems.

Among the findings of the study are the following:

- An $8 billion sales program will, on the average, generate $560 million in cost savings annually. This estimate assumes the current mix of sales of weapons, services, and construction. The estimate also assumes that the U.S. would not significantly alter the defense production base in the absence of foreign military sales.

- Of the $560 million in savings, approximately $160 million represents savings which are attributable to research and development (R&D) recoupments, a category of savings which is insensitive to assumptions about the U.S. production base and the pace of U.S. procurement in the absence of foreign military sales.

- Assuming the current mix of sales, a decrease in the level of sales from the $8 billion level would result in a proportional decrease in the savings. For example, a $4 billion sales program would on the average result in savings of $280 million annually.

The analysis in this study begins by classifying savings into five major categories: R&D recoupments, learning curve effects and economies of scale, overhead, production line gap, and other. R&D recoupments refer to the R&D surcharge which is added to the purchase price of a

weapon system sold to a foreign buyer in order to recoup some of the resources which the U.S. put into the development of the weapon. Savings from learning curb effects are those savings which result from the lower average costs associated with a longer production run, while economies of scale refer to the lower average costs due to a larger rate of production. Overhead savings refer to the fact that foreign buyers may partially pay for indirect costs, such as facilities costs, that would have otherwise been borne solely by the U.S. Government. Savings from avoiding production line gaps occur when a foreign sale allows a contractor to keep a production line open for a subsequent U.S. buy, thus enabling the U.S. to avoid production line termination and setup costs. Other savings is a residual category for those savings which do not fall in the first four categories.

The study contains estimates of savings for 35 major weapon systems due to foreign military sales over the 1972-1981 time period. These savings are partitioned into the five major categories of savings. The estimates show that the most significant savings are due to R&D recoupment and overhead savings.

The study notes that not all foreign military sales result in cost savings. For example, sales of training or other types of services do not in general result in cost savings to the U.S. For the current mix of sales the study estimates that only fifty percent of foreign military sales result in cost savings to the U.S. For those sales which can generate savings, the study estimates that on the average one dollar of sales results in fourteen cents in savings to the U.S., of which four cents represent R&D recoupments. These estimates are based on analysis of the data for the 35 major weapon systems.

The study concludes with estimates of savings under alternative levels and alternative mixes of foreign military sales.

INTRODUCTION

This is a report on the financial aspects of the sale of U.S. arms abroad. Specifically, this report deals with the budgetary cost savings to the U.S. Department of Defense which are generated by foreign military sales. Based on the current mix of sales of weapons, services, and construction, an $8 billion sales program would on the average generate $560 million in savings annually. This estimate of savings presumes then the U.S. would not significantly alter the defense production base in the absence of foreign military sales. If only research and development (R&D) savings are considered, an $8 billion sales program would on the average generate $160 million in R&D recoupments. If the mix of sales were to remain the same but the foreign military sales program were reduced, the savings would be reduced proportionally. For example, a $4 billion program would on the average generate $280 million in total savings of which $80 million represents R&D recoupments.

The report first discusses the types of savings which can be generated and classifies savings into five groups or categories. Next, data on past and projected savings for 35 selected weapon systems are presented. This is followed by a discussion of what kinds of foreign military sales for fiscal year 1975 had the potential to generate savings. Finally, an estimate is made of the dollar value of savings for an $8 billion sales program based on data for 35 major weapon systems and on two alternative mixes of sales.

This paper focuses on government-to-government arms sales and for the most part does not discuss commercial sales. As will become clear upon discussion of the types of budgetary savings which can be generated by foreign military sales, commercial arms sales have little potential for generating budgetary savings to the Department of Defense.

This report does not address the questions of whether foreign arms sales further U.S. security interests nor does it discuss the macroeconomic effect of foreign military sales. This latter subject will be the topic of a later report.

CATEGORIES OF SAVINGS

The savings generated by foreign military sales can be classified into five major categories. Following is a brief definition and characterization of each category. A more detailed discussion of these categories, especially research and development (R&D) recoupments and "learn-curve effects," leading to lower unit costs, can be found in CBO staff working paper, Foreign Military Sales and U. S. Weapons Costs.

Research and Development Recoupment

The first and most readily identifiable saving from foreign military sales is R&D recoupment. R&D recoupment refers to the R&D surcharge which is added to the purchase price of a weapon system sold to a foreign buyer. This surcharge represents R&D expenses which would otherwise have been borne by the U.S. alone, and consequently would appear to be a clear cut example of a cost saving. The magnitude of R&D recoupment varies, of course, with the weapon system.[1]

Learning Curve Effects and Economies of Scale

Savings from learning curve effects refer to those savings which result from a longer production run for weapon systems, especially aircraft and missiles. As described in "Military Equipment Cost Analysis," it is a relatively well-documented fact that in the absence of other factors the cumulative average cost of aircraft and missiles decreases as the total number produced increases.[2] Factors which are frequently mentioned as being responsible for this decreasing average cost are job familiarization by workmen, general improvement in total coordination, and development of more efficiently produced subassemblies. If the sale of arms to a foreign country makes it possible for some of the items produced for the U.S. to be purchased at a lower average cost due to learning curve effects, then the foreign sale in fact produces cost savings.

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1. For a detailed discussion of the guidelines for setting the size of the R&D surcharge, see: CBO staff working paper, Foreign Military Sales and U.S. Weapons Costs (May 1, 1976), p. 7; and DoD Directive 5105.38 (Aug. 11, 1971: amended May 10, 1973).

2. Rand Corporation, Military Equipment Cost Analysis (Santa Monica, Calif.: Rand Corporation, June 1971).

Economies of scale refer to the economic principle which states that, under some circumstances, expanding the rate of production (for example, fully utilizing an existing production facility) can result in lower average costs. Again, if a foreign sale enables U.S. weapons to be purchased at a lower average cost, then the foreign sale can be said to generate cost savings.

Despite the general agreement among analysts that learning curve effects and economies of scale can generate cost savings, such savings are relatively difficult to estimate since accounting records do not facilitate isolation of these savings from other savings, such as overhead savings.

Overhead

Another source of potential cost savings is related to overhead costs. In general, not all of the costs which are charged to a contractor for a weapon system are attributable to the materials and labor which are going into that weapon system. The contractor also bears certain indirect costs that are passed on to his customers. To the extent that foreign buyers pay for indirect costs that would have otherwise been borne by the U.S. Government, foreign military sales generate overhead savings.

Overhead costs can be classified in many ways. One particularly useful classification is that between fixed and variable overhead costs. Fixed overhead costs are costs which do not vary with the number of goods produced; that is, they are costs which are relatively insensitive to changes in the volume of sales. The costs of facilities or of a fixed staff of design engineers are examples. Variable overhead costs are those which do vary with the volume of sales. To the extent that the costs of facilities or the size of the staff of design engineers vary with the volume of sales, these costs can be said to be variable.

Foreign military sales generate overhead cost savings when they make it possible for fixed overhead charges to be paid partially by foreign buyers rather than solely by the U.S. Government. Unfortunately, these savings are relatively difficult to estimate. An upper bound on such savings would be the amount of overhead costs paid by foreign buyers. However, it should be noted that, to the extent that these overhead costs are not fixed or would be borne by other than U.S. Government business (e.g., private buyers such as commercial airlines), they do not represent savings which are the result of foreign military sales.

The attribution of significant overhead savings to foreign military sales assumes that in the absence of foreign sales the U.S. would not significantly change its production base. A rationale for this is the argument that the U.S. production base is sized to meet emergency requirements and would not be reduced in peacetime in the absence of foreign

military sales.

The sharing of overhead costs is one savings which could theoretically result from a commercial foreign military sale as well as a government-to-government sale. For example, if a foreign country is buying equipment directly from a contractor and the contractor is simultaneously producing a weapon system for the U.S., then the commercial sale may result in the U.S. having to pay lower overhead costs than would have otherwise have been the case. It does not appear at first glance that commercial sales very often result in savings of this type. The only example identified to date is the C-130 aircraft.

Production Line Gap

The next major category of cost savings which may result from foreign military sales is associated with the closing and opening of production lines with concomitant setup and termination costs. If a foreign sale allows a contractor to keep a production line open for a subsequent U.S. buy, then it would appear that the foreign sale generates some cost savings. Like other savings, those associated with avoiding gaps in production lines are difficult to validate. A major difficulty is that they depend on a comparison of current, proposed, and hypothetical production plans. For example, it is clearly not the case that every time a foreign sale occurs in the middle of two production runs for the U.S., the U.S. would have incurred costs for a production line gap were it not for the foreign sale. In certain instances, the U.S. would most likely have merged the two production runs into one were it not for the foreign buy.

Other

There are other savings which may result from foreign military sales. Most of these fall into the category of nonrecurring costs which the U.S. Government is able to share with foreign buyers. For example, suppose the U.S. wants to expand or accelerate the production of tanks from thirty to forty per month. Also, suppose the acceleration causes the opening of a new production line capable of producing an additional thirty tanks per month. Setting up a new production line involves certain nonrecurring costs for tooling and so forth. If a foreign buyer decides to purchase twenty tanks per month and assumes a prorata share of the nonrecurring costs of setting up the new production line, then the foreign sale generates savings.

SAVINGS ESTIMATES FOR 35 MAJOR WEAPON SYSTEMS

The Department of Defense has provided estimates of savings generated by foreign military sales for 35 major weapon systems. The savings, calculated in current dollars, are for past sales, in the fiscal years 1972-76 period, and future sales, in the fiscal years 1977-81 period. Tables 1 through 3 contain DoD's estimates of savings according to the categories of R&D recoupment, learning curve, overhead, production line gap and other. Table 3 also contains estimates of dollar value of the sales which generated or will generate the savings.

Past and Projected Savings

The savings listed in tables 1 through 3 are aggregate numbers and are not in constant dollars. This means that the effect of inflation on the estimates is indeterminate. In order to account for the effects of inflation it is necessary to break out savings by year. DoD was unable to provide a yearly listing of savings for each of the systems listed in tables 1 through 3. After negotiation between representatives of the DoD and the Congressional Budget Office, DoD agreed to provide a yearly listing of savings for five selected weapon systems. These listings, in current and constant dollars, are contained in table 4.

Quality of Estimates

The estimates of savings and sales in tables 1 through 3 were made by the Army, Navy, and Air Force. Although time and resources did not permit a detailed validation of all the services' estimates, CBO staff held extensive discussions with personnel responsible for the estimates for six of the systems: the M60 tank, the TOW missile system, the H-1 helicopter series, the HARPOON missile, the F-4E aircraft, and the F-16 aircraft. These discussions focused on the methodology used for estimating both cost savings and sales. In the case of the Army systems, field personnel provided extensive backup for the estimates. In the view of the CBO staff involved, the savings and sales estimates for the six systems are reasonable, given the time and resources available. Although the remaining systems were not investigated in detail, service personnel were asked general questions on the estimates. There is no evidence that the methodology used to compute savings and sales for the remaining systems differed in substance from that used on the six selected systems.

TABLE 1. PAST SAVINGS FISCAL YEARS 1972-76

(Millions of Current Dollars)

System	Total Savings	Research and Development	Learning Curve	Overhead	Production Line Gap	Other
M60A1, Combat Tank	124.1	1.9	0,0	59.5	0.0	62.7
M72B, Combat Engineer Vehicle	1.1	0.0	0.0	0.7	0.0	0.4
M60A1, Tank Chassis for AVLB Launcher	2.0	0.1	0.0	1.5	0.0	0.4
AVLB Launcher	0.2	0.0	0.0	0.0	0.0	0.1
AVL Bridge	0.1	0.0	0.0	0.0	0.0	0.1
M113A1 APC - Family roll-up	27.4	0.0	7.7	15.6	2.5	1.6
SP8" M110 Howitzer	14.5	0.7	5.4	6.7	1.6	0.0
M578 Recovery Vehicle	5.8	0.6	4.2	0.5	0.6	0.0
SP 155MM,M109A1B Howitzer	16.5	1.4	0.0	13.6	1.5	0.0
M88A1 Recovery Vehicle	0.0	0.0	0.0	0.0	0.0	0.0
AA,SP,M163 (VULC) Gun	5.8	0.0	0.0	5.3	0.5	0.0
H1 Helicopter Series	36.4	4.9	0.3	31.3	0.0	0.0
Dragon	0.0	0.0	0.0	0.0	0.0	0.0
Tow	89.6	25.5	21.8	5.7	0.0	36.6
Chapparal Launcher	0.0	0.0	0.0	0.0	0.0	0.0
Chapparal (GM)	0.0	0.0	0.0	0.0	0.0	0.0
Hawk Missile System	25.3	8.3	5.7	11.3	0.0	0.0
Lance Missile System	10.0	4.0	0.0	0.0	6.0	0.0
Phoenix	19.1	15.5	1.2	0.3	0.0	2.1
Sidewinder (AIM-9L)	0.0	0.0	0.0	0.0	0.0	0.0
P-3	1.2	1.2	0.0	0.0	0.0	0.0
S-3A	0.0	0.0	0.0	0.0	0.0	0.0
E-2C	0.0	0.0	0.0	0.0	0.0	0.0
F-14	229.2	168.6	20.6	40.1	0.0	0.0
A-7	1.5	0.2	1.3	0.0	0.0	0.0
Harpoon	22.0	3.4	4.6	10.2	0.0	3.8
F-15	0.0	0.0	0.0	6.0	0.0	0.0
F-16	0.0	0.0	0.0	0.0	0.0	0.0
F-5E/F	40.0	18.8	8.0	9.6	0.0	3.6
AWACS	0.0	0.0	0.0	0.0	0.0	0.0
AIM-9B Mod. to AIM-9S	0.0	0.0	0.0	0.0	0.0	0.0
Maverick	5.6	5.6	0.0	0.0	0.0	0.0
F-4E	299.4	25.4	1.2	263.8	9.0	0.0
Pave Spike	0.0	0,0	0.0	0,0	0.0	0.0
EOGB II	5.9	0.0	0.5	0.0	0.0	5.4

Source: Department of Defense

TABLE 2. ESTIMATED FUTURE SAVINGS FISCAL YEARS 1977-81

(Millions of current dollars)

System	Total Savings	Research and Development	Learning Curve	Overhead	Production Line Gap	Other
M60A1, Combat Tank	335.7	3.9	0.0	216.2	0.0	115.6
M72B, Combat Engineer Vehicle	11.4	0.3	0.0	7.2	0.0	3.9
M60A1, Tank Chassis for AVLB Launcher	7.2	0.2	0.0	5.8	0.0	1.3
AVLB Launcher	0.3	0.0	0.0	0.0	0.0	0.3
AVL Bridge	0.4	0.0	0.0	0.0	0,0	0.4
M113A1 APC - Family roll-up	91.3	0.0	26.9	54.7	9.5	0,2
SP8" M110 Howitzer	0.2	0.2	0.0	0.0	0.0	0,0
M578 Recovery Vehicle	5.1	0.6	1.7	2.8	0.0	0.0
SP 155MM, M109A1B Howitzer	53.9	2.3	5.9	37.3	8.4	0,0
M88A1 Recovery Vehicle	5.7	0.0	0.0	5.7	0,0	0.0
AA,SP,M163 (VULC) Gun	17.9	0.0	0.0	15.1	2,8	0.0
H1 Helicopter Series	27.1	3.9	0.7	19.0	3.5	0.0
Dragon	40.7	20.7	17.5	2,5	0.0	0.0
Tow	75.9	23.6	31.4	8.0	5.0	7.9
Chapparal Launcher	17.0	4.5	8.6	1.6	2.3	0.0
Chapparal (GM)	11.6	3.7	2.7	1.5	3.7	0.0
Hawk Missile System	63.5	23.4	9.5	30.6	0.0	0.0
Lance Missile System	60.0	6.0	0.0	0.0	54.0	0.0
Phoenix	13.5	0.0	4.5	1.2	0.0	7.8
Sidewinder (AIM-9L)	6.1	0.0	6.1	0.0	0.0	0.0
P-3	6.8	4.8	0.0	2.0	0.0	0.0
S-3A	13.5	7.5	0.0	2.0	0.0	4.0
E-2C	16.6	6.8	0.0	9.8	0.0	0.0
F-14	0.0	0.0	0.0	0.0	0.0	0.0
A-7	4.1	0.5	3.6	0.0	0.0	0.0
Harpoon	94.5	49.7	20.0	10.3	0.0	14.5
F-15	70.1	40.0	30.1	0.0	0.0	0.0
F-16	126.0	67.7	43.7	14.6	0.0	0.0
F-5E/F	67.0	23.0	11.6	24.9	0.0	7.5
AWACS	338.6	219.8	118.8	0.0	0.0	0.0
AIM-9B Mod. to AIM-9S	3.0	0.4	0.0	0.0	0.0	2.6
Maverick	114.8	17.2	58.5	0.0	34.1	5.0
F-4E	113.6	10.8	0.0	102.8	0.0	0.0
Pave Spike	1.0	1.0	0.0	0.0	0.0	0.0
EOGB II	1.5	.7	0.0	0.0	0.0	0.7

Source: Department of Defense

TABLE 3. ESTIMATED TOTAL SAVINGS AND SALES FISCAL YEARS 1972-81

(Millions of Current Dollars)

System	Total Sales	Total Savings	Research and Development	Learning Curve	Overhead	Production Line Gap	Other
M60A1, Combat Tank	1,232.7	459.8	5,8	0.0	275.7	0.0	178.3
M72B, Combat Engineer Vehicle	26.9	12.4	0,3	0.0	7.9	0.0	4.2
M60A1, Tank Chassis for AVLB Launcher	46.9	9.2	0,3	0.0	7.3	0.0	1.7
AVLB Launcher	53.1	0.4	0.0	0.0	0,0	0.0	0.4
AVL Bridge	10.5	0.5	0,0	0,0	0.0	0.0	0.5
M113A1 APC - Family roll-up	1,346.2	118.7	0.0	34.6	70,3	12.0	1.8
SP8" M110 Howitzer	21.8	14.7	0.8	5,4	6.7	1.6	0.0
M578 Recovery Vehicle	50.9	10.8	1,1	5,9	3.3	0.6	0.0
SP 155MM, M109A1B Howitzer	241.1	70.4	3,7	5.9	50.9	9.8	0.0
M88A1 Recovery Vehicle	84.9	5.7	0.0	0,0	5.7	0.0	0.0
AA,SP,M163 (VULC) Gun	205.8	23.7	0.0	0,0	20.4	3.3	0.0
H1 Helicopter Series	601.0	63.5	8,8	1,0	50,3	3.5	0.0
Dragon	291.0	40.7	20.7	17,5	2.5	0.0	0.0
Tow	670.7	165.5	49.1	53,2	13,7	5.0	44.5
Chapparal Launcher	133.0	17.0	4.5	8,6	1.6	2.3	0.0
Chapparal (GM)	58.0	11.6	3.7	2,7	1.5	3,7	0.0
Hawk Missile System	181.1	88.8	31,7	15,2	41.9	0,0	0.0
Lance Missile System	297.0	70.0	10.0	0,0	0.0	60.0	0.0
Phoenix	193.0	32.6	15.5	5.7	1.5	0.0	9.9
Sidewinder (AIM-9L)	34.1	6.1	0,0	6,1	0.0	0,0	0.0
P-3	249.1	8.0	6.0	0,0	2.0	0.0	0.0
S-3A	350.0	13.5	7.5	0,0	2.0	0,0	4.0
E-2C	111.1	16.6	6.8	0.0	9.8	0,0	0.0
F-14	1,412.2	229.2	168.6	20.6	40.1	0,0	0,0
A-7	206.3	5.6	0,7	4.9	0.0	0.0	0,0
Harpoon	395.4	116.5	53.1	24.6	20.5	0.0	18.3
F-15	240.0	70.1	40.0	30,1	0.0	0.0	0.0
F-16	885.6	126.0	67.7	43.7	14.6	0.0	0.0
F-5E/F	1,683.6	107.0	41.8	19.6	34.5	0.0	11.1
AWACS	3,476.0	338.6	219.8	118.8	0.0	0.0	0.0
AIM-9B Mod. to AIM-9S	8.8	3.0	0.4	0.0	0.0	0.0	2.6
Maverick	241.5	120.4	22.8	58.5	0.0	34.1	5.0
F-4E	2,142.0	413.0	36.2	1.2	366.6	9.0	0.0
Pave Spike	20.0	1.0	1.0	0.0	0.0	0.0	0.0
EOGB II	14.3	7.4	0.0	1.3	0.0	0.0	6.2

Source: Department of Defense

TABLE 4

SAVINGS AND SALES IN CURRENT AND CONSTANT DOLLARS FISCAL YEARS 1972-81
(Millions of dollars)

System		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total
M60 TANK												
Savings	(current)	16.1	22.5	3.1	5.9	106.6	68.7	65.8	60.6	56.6	53.9	459.8
	(constant)	24.6	32.8	4.2	6.8	115.7	68.7	62.0	54.3	48.6	44.5	462.2
Sales	(current)	40.8	50.0	8.5	13.7	213.6	212.6	186.3	174.3	167.9	165.0	1,232.7
	(constant)	62.3	72.9	11.4	15.9	231.9	212.6	175.6	156.0	144.1	136.4	1,219.1
M113A1APC												
Savings	(current)	10.8	6.6	5.6	1.1	.8	9.7	14.6	16.9	16.6	24.0	106.7
	(constant)	16.4	9.6	7.5	1.3	.9	9.7	13.8	15.1	14.2	19.8	108.3
Sales	(current)	48.1	37.9	375.3	81.8	333.2	141.6	253.0	75.0	0	0	1,345.9
	(constant)	73.4	55.2	505.1	94.7	361.8	141.6	238.5	67.1	0	0	1,537.4
HARPOON												
Savings	(current)	0	0	0	0	22.0	27.0	20.1	15.1	14.1	18.2	116.5
	(constant)	0	0	0	0	23.9	27.0	18.9	13.5	12.1	15.0	110.4
Sales	(current)	0	0	0	0	86.2	109.4	60.2	39.2	37.1	63.3	395.4
	(constant)	0	0	0	0	93.6	109.4	56.7	35.1	31.8	52.3	378.9
£11												
Savings	(current)	0	0	168.6	22.8	38.0	0	0	0	0	0	229.4
	(constant)	0	0	226.9	26.4	41.3	0	0	0	0	0	294.6
Sales	(current)	0	0	1,412.2	0	0	0	0	0	0	0	1,412.2
	(constant)	0	0	1,900.7	0	0	0	0	0	0	0	1,900.7
MAVERICK												
Savings	(current)	0	0	0	5.6	13.0	37.4	29.0	20.5	10.1	4.8	120.4
	(constant)	0	0	0	6.5	14.1	37.4	27.3	18.4	8.7	4.0	116.4
Sales	(current)	0	0	0	69.5	4.3	83.6	84.1	0	0	0	241.5
	(constant)	0	0	0	80.4	4.7	83.6	79.3	0	0	0	248.0

Source: Department of Defense

Characteristics of Estimates

The following is a discussion of some of the characteristics of the estimates of savings and sales. In general, the estimates of R&D savings are the most straightforward. For most systems savings were based on a fixed charge per unit of equipment delivered. Learning curve estimates proved to be most elusive. For those systems for which learning curve savings were claimed, the assumed learning curves were between 90 and 92 percent; that is, at each doubling of the production quantity, the cumulative average cost would be 90 to 92 percent of its former value. For one system, the TOW missile system, it is likely that estimates of learning curve savings probably include some overhead savings. For other systems, the opposite may be the case, with overhead including some learning curve.

Overhead savings, together with R&D recoupments, comprise the bulk of the savings for the 35 weapon systems. Overhead savings for the Army appear at first glance to be relatively high. As a result, the CBO staff asked for and received further detail on the estimate of overhead for the M60 tank and the H-1 helicopter series. In each case, the Army apportioned overhead costs among different categories, such as general administration and overhead burden, and then estimated that only a percentage of these costs are fixed. The fixed percentage varied from 66 percent for overhead burden to 80 percent for general administration. As discussed earlier the basic assumption underlying these savings is that in the absence of foreign military sales the U.S. would not significantly alter its production base.

Savings associated with gaps in the production line do not comprise a significant part of the savings in tables 1 through 3 and consequently were not investigated in detail.

Savings which were classified as "other" were significant for only the M60 tank and the HARPOON missile (fiscal years 1977-81). In each case these amounts represented one-time, nonrecurring costs for expanding production facilities which the U.S. was able to charge foreign buyers. It is the view of the CBO staff that these savings are more questionable than the overhead and R&D savings since it appeared possible that expansion was to some extent to accommodate foreign military sales.

The sales estimates in table 3 reflect actual deliveries for fiscal years 1972-76 and anticipated deliveries for fiscal years 1977-81. It appears that the methodology used to project future sales was not consistent from system to system; however, for a given system the methodology used to project sales was consistent with that used to project savings.

SALES WHICH ARE LIKELY TO GENERATE SAVINGS

The current estimate of sales (orders) through the Foreign Military Sales Trust Fund for fiscal year 1977 is approximately $8.2 billion. However, not all foreign arms sales have the potential for generating cost savings. For example, a considerable part of the dollar value of foreign military sales represents the sale of services such as training and repair. These sales in general do not generate R&D recoupments, learning curve savings, overhead savings or production line gap savings. The purpose of this section is to discuss briefly the composition of foreign military sales, with special reference to the question of what types of sales generate savings.

Sales by Weapons Category

Aircraft

Aircraft clearly represent one category of sales which can potentially generate cost savings. The Department of Defense has been able to recoup R&D costs from the sale of aircraft, such as the F-14. Learning curve effects in the aircraft industry are well-documented. To the extent that the aircraft industry would operate at below production capacity in the absence of foreign military sales, the sale of aircraft has the potential for generating overhead savings. On the other hand, it should be noted that the sale of older, well-established aircraft types may generate significantly lower R&D recoupments. If the foreign sale takes place at the end of a production run, it will not generate learning curve savings. Also, if in the absence of foreign sales the aircraft industry were able to operate at capacity by selling to private industry, the overhead savings generated by foreign sales would be negligible.

Missiles

Missiles are very similar to aircraft in their potential to generate savings. Missiles produced in large quantities may have less potential for producing learning curve effects than aircraft unless the foreign sale comes relatively early in the production run. On the other hand, to the extent that missile production is a specialized industry with little potential for sales in the private marketplace and to the extent that the industry would operate at less than full capacity in the absence of foreign sales, missiles have a greater potential for generating overhead savings than aircraft.

Tanks and Tracked Vehicles

Tables 1 through 3 provide examples of the potential savings from the sale of tanks and tracked vehicles. Savings would generally take the form of R&D recoupments and overhead savings. It should be noted that the savings computed in tables 1 through 3 were based on the U.S. procurement schedule and the existing U.S. production base. If a different production schedule or a changed production base were assumed, the savings associated with foreign sales would change.

Communications Equipment

This category of sales includes items which range in complexity from sophisticated electronics gear to simple radios. No data was available on the savings associated with the sale of this type of equipment. However, it would appear that it offers the potential for at least some overhead savings and possibly some R&D recoupments.

Other Equipment

This category of sales is not well-defined. Consequently, it is not possible to evaluate its potential to generating savings. Insofar as the purchase of other equipment is subject to overhead charges, foreign sales may result in some savings.

Ships

Ships represent a category which probably offers little potential for savings due to foreign sales. Research and development costs for ships are not significant, at least for the types of ships which are being sold to foreign countries.[3] Learning curve effects have in general not been observed in the shipbuilding industry, largely due to the fact that to a very real extent each ship is unique. Overhead savings are a theoretical possibility. However, in recent years the shipbuilding industry has been operating at near capacity with large back orders. This means that the elimination of foreign sales would probably not result in more overhead being charged to U.S. Navy ships on a per ship basis.

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3. R&D costs for ships would be distinguished from the R&D costs for the weapon systems on the ships.

Ammunition

The sale of ammunition provides no opportunity for R&D recoupments. Also, due to the large quantities produced, ammunition sales do not in general lead to learning curve savings. Some overhead savings from ammunition sales are theoretically possible. However, the cases selected by the Department of Defense to illustrate savings did not include sales of ammunition.

Military Construction

Military construction in foreign countries is a growing part of foreign military sales. However, it offers little prospect for savings in U.S. military construction costs.

Services

This category of sales includes supply operations, training, repair and rehabilitation and other services. These sales do not generate R&D recoupments. There is no reason to expect that they would generate learning curve savings. Although it is possible that the sale of services like repair and rehabilitation might generate some overhead savings, DoD has provided no data on such savings and, given the magnitude of repair and rehabilitation sales, the significance of such savings would be limited.

Composition of Foreign Military Sales

Table 5 contains a historical breakout of foreign military sales by the type of sales. The table shows that prior to fiscal year 1975 an average of approximately 70 percent of foreign military sales were comprised of aircraft, missiles, vehicles and weapons and communications equipment. As discussed earlier these are the types of sales which can generate savings.

The mix of sales prior to fiscal year 1975 was associated with a somewhat lower sales program than in fiscal year 1975. For example, sales in fiscal year 1973 were approximately $3 billion compared to $9.5 billion in fiscal year 1975. In addition, the mix of sales changed significantly so that only approximately 50 percent of sales in fiscal year 1975 fall into the category of sales which have the potential to generate savings. The major factors in the changing mix of sales were increasing sales (on a percentage basis) of ships and ammunition and decreasing sales of aircraft.

Table 5

FOREIGN MILITARY SALES BY SALES CATEGORIES [a]
(Fiscal Years)

Category	Percent of Annual Sales [b] 1972	1973	1974	1975
Aircraft	53	53	45	27
Missiles	6	18	7	14
Vehicles & Weapons	9	13	12	7
Communications Equipment	3	3	2	2
Subtotal	71	77	66	51
Ships	2	2	12	15
Other Equipment	5	3	4	7
Subtotal	7	5	16	22
Ammunition	6	5	5	10
Construction	0	0	0	1
Repair and Rehabilitation	4	1	0	2
Supply Operations	3	3	4	4
Training	4	4	2	3
Other Services	7	5	6	9
Subtotal	24	17	17	29

a. Weapons system sales include sales of spare parts.

b. Totals may not add due to rounding.

ESTIMATION OF THE DOLLAR VALUE OF SAVINGS

An estimate of the dollar of the savings associated with foreign military sales is comprised of two components. The first is an estimate of the dollar value of sales which have the potential to generate savings. The second is an estimate of the dollar value of savings per dollar of sales for those sales having a potential to generate savings. The estimates given here represent long run average savings for an assumed mix of sales. The estimates discussed in this section should be considered to be steady state estimates in the sense that in any one year the savings could be quite different from those given here due to a different mix of sales and the variability of savings associated with the sale of any given item.

The Percentage of Sales Which Can Generate Savings

As discussed in the previous section, only some foreign military sales generate cost savings to the U.S. Government. Also, over the past few years, the mix of foreign military sales between those which do and those which do not generate savings has changed. For the purposes of this analysis, two alternative mixes of foreign military sales will be assumed, roughly equivalent to the percentages which pertained from fiscal year 1972 through fiscal year 1974 (Mix 2) and those for fiscal year 1975 (Mix 1).

	Mix 1	Mix 2
Percent Capable of Generating Savings	.5	.7
Percent not Capable of Generating Savings	.5	.3

Savings Per Dollar of Sales for Sales Which Generate Savings

The data from the 35 weapon systems in table 3 was analyzed in order to estimate the savings per dollar of sales for those sales with the potential to generate savings. As shown in table 6, the estimated average savings per dollar of sales for those sales with the potential to generate savings is $.14. Since estimates of overhead savings and to a lesser extent the remaining categories of savings rely on particular assumptions about the U.S. production base and the pace of U.S. procurement, the R&D savings have been separated from the other categories of savings. For R&D recoupments, the estimated average savings per dollar of sales is $.04. Table 6 also contains the standard error of the estimates.

TABLE 6

SAVINGS PER DOLLAR OF SALES FOR SALES WHICH GENERATE SAVINGS[a]

	Total Savings	R&D	Other Categories
Average Savings	$.14	$.04	$.10
Standard Error	.02	.01	.03

a. The estimates were computed using a logarithmic model of savings and sales. See the technical appendix for details on the estimator and on alternative estimators.

The estimates in table 6 were computed using the data on sales and savings in the fiscal years 1972-81 time period. When the data are subdivided into fiscal years 1972 - 76 and fiscal years 1977 - 81, the results for the two time periods are not significantly different in a statistical sense and in fact are practically identical, being within $.01 of each other for total savings and exactly equal for R&D savings.

Savings Under Current and Reduced Programs

Using the results in table 6 and the two assumed mixes of foreign military sales it is possible to estimate the average savings per dollar of sales for the total FMS program. Table 7 contains these estimates. They were derived by multiplying the savings per dollar of sales for sales which generate savings times the percentage of total sales which generate savings. Using the current mix of sales, with approximately 50 percent of sales having the potential to generate savings, total savings per dollar of sales are $.07 and R&D savings per dollar of sales are $.02.

THE EFFECT OF A BAN OR REDUCTION OF FOREIGN MILITARY SALES

The current level of foreign military sales is approximately $8 billion per year. Tables 8 and 9 contain estimates of total savings and R&D savings under an $8 billion sales program, using the current mix of sales (mix 1) and the previous mix of sales (mix 2). (As discussed earlier, R&D savings have been broken out separately since they are relatively insensitive to particular assumptions about the U.S. production base and the pace of U.S. procurement.) Under the current mix of sales, total savings would on the average be $560 million annually, while R&D savings would be $160 million per year. Tables 8 and 9 also contain estimates of the savings under a $4 billion sales program. It should be noted that the estimates are averages and in any one year the savings might be different from the estimates, depending on the mix and timing of rates.

Using Tables 8 and 9 it is possible to estimate the budgetary impact of a complete ban or a substantial reduction in the level of foreign military sales. Under the current mix of sales, a complete ban on foreign military sales would on the average result in the loss of savings of $560 million per year, which includes a $160 million loss in R&D recoupments. If the level of sales were to be reduced to $4 billion and the percentage of sales with the potential to generate savings were to remain at the current level of 50 percent, then the loss in savings would be $280 million per year, including an $80 million loss in R&D recoupments. However, if the mix of sales for a $4 billion program were assumed to be similar to the mix under $4 billion programs in previous years (70 percent of sales have the potential to generate savings), then the loss in savings would be $168 million per year, including $48 million in R&D recoupments.

TABLE 7

AVERAGE SAVINGS PER DOLLAR OF SALES FOR
FOREIGN MILITARY SALES PROGRAM
(dollars)

	Total Savings	R&D Savings	Other Categories
Mix 1	.07	.02	.05
Mix 2	.10	.03	.07

TABLE 8

TOTAL SAVINGS
(Millions of dollars)

	$8 Billion Sales Program	$4 Billion Sales Program
Mix 1	560	280
Mix 2	784	392

TABLE 9

R&D SAVINGS
(Millions of dollars)

	$8 Billion Sales Program	$4 Billion Sales Program
Mix 1	160	80
Mix 2	224	112

TECHNICAL APPENDIX A

The purpose of this appendix is to discuss the estimation of the average savings per dollar of sales for sales which generate savings. The following discussion focuses on three alternative estimators: the mean, the weighted mean, and an estimator based on a logarithmic model. The logarithmic model was the one used for the estimates presented in the main body of the report. Following the discussion of the three alternative estimators, a comparison is made of the alternative estimates for the data on sales and savings for the 35 weapon systems.

The Sample Mean

One estimator of the average savings-sales ratio is the sample mean savings-sales ratio:

$$\beta = \sum_{i=1}^{n} \frac{\frac{Y_i}{X_i}}{n}$$

Where Y_i is the savings for system i

Where X_i is the sales for system i

n is the number of systems in the sample

3 is the sample mean ratio.

This estimator is the least squares estimator for a model of sales and savings of the following form:

$$\frac{Y_i}{X_i} = \beta + u_i,$$

where u_i is a random variable with expected value of zero and a variance of σ^2.

Weighted Mean

A second estimator for the dollar value of savings per dollar of sales, B, is a weighted average of the sample savings-sale ratios;

$$\beta = \frac{\Sigma Y_i}{\Sigma X_i}$$

The above estimator is a weighted one since

$$\beta = \sum_{i=1}^{n} \frac{Y_i}{X_i} \cdot \frac{X_i}{\Sigma X_k}$$

In contrast to the unweighted mean which gives equal weight to each observation, this estimator gives a weight to system i which is proportional to the magnitude of sales for that system as a percentage of total sales for all systems in the data base. This estimator is a least squares estimator for the following model:

$$\frac{Y_i}{X_i} = \beta + u_i \sqrt{\frac{\Sigma X_k}{X_i}}$$

where u_i is a random variable with an expected value of zero and a variance of $_{CT}2$.

While the estimator for the variance of the sample mean is straight forward, being equal to

$$\sum_{i=1}^{n} \frac{\left(\frac{Y_i}{X_i} - \beta\right)^2}{n(n-1)}$$

the estimator for the variance of the weighted mean is not quite so straightforward. It equals

$$\sum_{i=1}^{n} \frac{\left(\frac{Y_i}{X_i} - \beta\right)^2 \frac{X_i}{X_k}}{(n-1)}$$

Logarithmic Model

The two previous estimates are maximum likelihood estimators for a savings-sale ratio which is normally distributed. However, the normal distribution is a symmetric distribition with infinitely long tails. Since the savings-sales ratios are by definition nonnegative the normality assumption is clearly an approximation. The distortion in estimating B, the average sales-savings ratio, which may result from this approximation is especially troublesome if B is small. An alternative estimator is one based on the assumption that the savings-sales ratio is lognormally distributed. The lognormal distribution is a nonnegative distribution which provides a better estimate if B is small. The underlying mail is:

$$\frac{Y_i}{X_i} = \beta u_i,$$

where u_i is lognormally distributed. Note that this model is linear in the logarithms so that

$$\ln\left(\frac{Y_i}{X_i}\right) = \ln \beta + \ln u_i,$$

where $\ln u_i$ is a normally distributed random variable with an expected value of zero and a variance of σ^2.

The estimator used for B is the so-called "jackknife" estimator, as discussed by Miller.[1] Estimation of the variance of the jackknife estimator is also discussed in the same reference. The logarithmic model was the one used to estimate the average savings-sales ratio in the main body of the report.

Comparison of Results

Table A contains the results of estimation of the savings-sales ratio using the three alternative estimators. The unweighted and weighted means give similar results. As one would expect both estimates are higher than the results using the logarithmic model.

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1. Rupert L. Miller, "A Trustworthy Jackknife," Annals of Mathematical Statistics. Vol. 35 (1964), pp 1684 - 1695.

Table A

ALTERNATIVE ESTIMATES OF AVERAGE SAVINGS-SALES RATIO

	Total Savings		
	Sample Mean	Weighted Mean	Logarithmic Model
Average Ratio	.21	.16	.14
Standard Error	.03	.02	.02
	R&D Savings		
Average Ratio	.04	.05	.04
Standard Error	.01	.01	.01