THE MEASUREMENT OF THE TIMING OF THE ECONOMIC IMPACT OF DEFENSE PROCUREMENT ACTIVITY: AN ANALYSIS OF THE VIETNAM BUILDUP

A DISSERTATION

SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL

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FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN ECONOMICS

BY

KENNETH LEE LAY

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ABSTRACT

This dissertation attempts to provide more precise knowledge about the timing of the impact of defense procurement activity on the output of the private sector of the United States economy. The performance patterns of 51 large defense procurement contracts which were administered between 1964 and 1969 are analyzed as a case study. Based on this analysis, a theoretical and statistical model is developed to estimate changes in economic output resulting from changes in the demand for defense procurement items. The model is used to estimate the rate of production on the total population of defense procurement contracts for the 1964-1969 period.

The theoretical and statistical model is based on the hypothesis that defense firms attempt to maintain their production at some optimum ratio to the level of unfulfilled demand for defense procurement items. It is further assumed that as the level of unfulfilled demand changes, the rate of production will also change, but not instantaneously. Instead, there will be an adjustment period during which the rate of production will either be above or below the optimum ratio to unfulfilled demand and moving toward the optimum ratio. Therefore, the actual rate of production on defense procurement contracts is determined by the level of unfulfilled demand and changes in this level over time.

The measurement of unfulfilled demand used is the level of unpaid obligations outstanding for procurement. The model is formulated to estimate the rate of production in the current month as a function of the amount of unpaid obligations outstanding in the current month and changes in this amount for the current month and the three previous months. The parameters of the model are estimated using the Almon distribution lag technique. The model provides a sensitive estimator of changes in the rate of production on the 51 sample contracts.

The rate of production on the total population of defense procurement contracts for the Vietnam buildup period is estimated. These estimates are used to evaluate the accuracy of various Government data series in the measurement of the timing of the economic impact of the Vietnam buildup and to validate some of the earlier analyses of Murray L. Weidenbaum and Harvey Galper. It is concluded that Government data did not accurately measure the timing of the economic effects of the Vietnam buildup, that the earlier analyses of Weidenbaum and Galper are generally correct, and that the model will improve future measurements of the timing of the economic impact of defense procurement activity.

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CHAPTER I

INTRODUCTION

OBJECTIVES OF STUDY

The purpose of this study is to suggest a method which will provide more precise knowledge about the timing of the impact of defense procurement activity on the output of the private sector of the United States economy. The years 1964 through 1969, which include periods before, during and after the sharpest phase of the Vietnam buildup, are used as a case study. A theoretical model is developed which estimates changes in economic output resulting from changes in the demand for defense procurement items. The parameters for this model are estimated from a sample of Defense Department procurement contracts.

The accurate measurement of the timing of theimpact of defense procurement activity on economic output is of interest because of the importance of this relationship in the formulation of national stabilization policies. One of the objectives of stabilization policies is the attainment

of an approximate balance between aggregate demand and potential supply in the economy. Because of the magnitude and volatility of Department of Defense procurement activity, satisfaction of this stabilization policy objective requires accurate information about the amount of economic output being created because of defense procurement contracts at each point in time.

This requirement for the accurate measurement of the production associated with defense procurement activity becomes particularly essential during a period of sharply changing defense activity, such as during the Vietnam buildup. As the level of production required to support defense activity increases, fewer private resources are available for civilian uses. Depending on the proximity of the private economy to a condition of full utilization, any significant shift of resources from civilian production to defense production, or the reverse, requires compensatory adjustments in the Nation's stabilization policies. These adjustments cannot be made adequately unless relatively precise and accurate information is available on the size and timing of the economic impact of changes in defense procurement activity.

It is the purpose of this dissertation to demonstrate that sufficiently accurate information about the timing of the impact on economic output of defense procurement

activity did not exist during the Vietnam buildup. As a result, national stabilization policies were inadequately restrictive to compensate for the increases in defense production and, hence, contributed to the unstable economic conditions of the late 1960's. The model which is developed in this dissertation would have provided more accurate information about the timing of this impact and would have improved national stabilization policies.

BEHAVIOR OF THE ECONOMY AND THE POLICIES DURING THE 1960's

The U.S. Economy in the Early 1960's

Between the first quarter of 1961 and the second quarter of 1965, the United States enjoyed strong and uninterrupted economic expansion. Over this period, the Nation's total output of goods and services increased $172.1 billion, representing an annual growth rate of 7.1 percent (Table 1). Employment increased by 5.8 million and the Nation's unemployment rate was reduced from 6.9 percent of the labor force in the first quarter of 1961 to 4.9 percent in the second quarter of 1965. Overall, the "gap" between the Nation's potential and actual output as measured by the Council of Economic Advisors was reduced from $50 billion at the start of the upturn in 1961 to

TABLE 1

CHANGES IN GROSS NATIONAL PRODUCT, EMPLOYMENT AND PRICES BETWEEN 1961 I AND 1965 II

	1	2	3
	1961 I[1]	1965 II	Percent Change Per Year
Gross National Product (Billions of Dollars)	503.6[a]	675.7[b]	7.1
Civilian Labor Force			
Employment (Millions of People)	66.6[c]	72.4[d]	2.1
Unemployment (Millions of People)	4.9[e]	3.7[f]	-5.7
Consumer Price Index (1957-59 = 100)			
All items	103.9[g]	109.6[h]	1.0
Wholesale Price Index (1957-59 = 100)			
All Commodities	101.0[i]	102.2[j]	.2
GNP Implicit Price Deflator (1957-59 = 100)	104.3[k]	110.7[l]	1.1

[1] In this table and all subsequent tables "I" denotes first quarter, "II" denotes second quarter, "III" denotes third quarter and "IV" denotes fourth quarter.

Sources: Given on next page.

SOURCES TO TABLE 1

a: The National Income and Product Accounts of the United States, 1929-1965 (a supplement to the Survey of Current Business) August, 1966, table 1.1, p. 3.

b: Survey of Current Business, July, 1969, table 1.1, p. 17.

c: Economic Report of the President, January 1966, table 2, p. 36.

d: Economic Report of the President, January 1966, table C-20, p. 233.

e: Economic Report of the President, January 1966, table 2, p. 36.

f: Economic Report of the President, January 1966, table C-20, p. 233.

g: Economic Report of the President, January 1963, table C-44, p. 225.

h: Economic Report of the President, January 1966, table C-43, p. 261.

i: Economic Report of the President, January, 1963, table C-42, p. 259.

k: The National Income and Product Accounts of the United States (a supplement to the Survey of Current Business) August, 1966, table 8.2, p. 161.

l: Survey of Current Business, July 1969, table 8.2, p. 47.

Column 3: Computed by author.

approximately $10 billion in mid-1965.[1]

The most notable characteristic of the economic expansion of the early 1960's, however, was its stability and orderliness. In the second quarter of 1965, the consumer price index was at 109.6 percent of its 1957-59 base, only 5.7 percentage points higher than in the first quarter of 1961 (Table 1). This represented an annual increase in consumer prices of approximately 1.0 percent per year, compared with annual increases of 2.2 percent per year for the decade of the 1950's. Wholesale prices were even more stable, increasing 1.2 percentage points during the four and one half years from early 1961 to mid-1965. The GNP Implicit Price Deflator, which is more comprehensive than either the consumer or wholesale price indexes, advanced a modest 1.1 percent per year in the early 1960's. As was pointed out in the 1968 Economic Report of the President, during the first half of the decade of the 1960's "economic activity rose along a balanced and fairly steady path."[2]

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[1] U.S. President, 1963 (Johnson) Economic Report of the President, (Washington: Government Printing Office, 1966), p. 40. (Hereafter cited as 1966 Economic Report).

[2] U.S. President, 1963 (Johnson) Economic Report of the President, (Washington: Government Printing Office, 1968), p. 103. (Hereafter cited as 1968 Economic Report).

The U.S. Economy After the Mid-1960's

In the summer and fall of 1965, events took place which greatly altered the economy's balanced and orderly expansion. On June 8, 1965, U.S. commanders were authorized to send American troops into combat in Vietnam. On July 28, 1965 the President sent a message to Congress indicating that the American commitment in Southeast Asia was being increased and that supplemental defense funds would be needed. By the end of December 1965, 80,000 additional troops had been deployed to Vietnam and by the end of June 1966, the Vietnam troop strength had been increased three-fold.[1]

The U.S. economy responded immediately and significantly to the additional stimuli of the buildup in military activity. In the second half of 1965, the Nation's output of goods and services increased at an annual rate of 10.1 percent (Table 2). This compared with a growth rate of 7.1 percent between the first quarter of 1961 and the second quarter of 1965. Civilian employment increased by .5 million and the unemployment rate dropped from 4.9 percent of the labor force in the second quarter of 1965 to 3.7

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[1]U.S. Congress, House, Committee on Appropriations, Department of Defense Appropriations for 1967, Part 1 (Washington: Government Printing Office, 1967), p. 378.

TABLE 2

INCREASES IN GROSS NATIONAL PRODUCT, EMPLOYMENT AND PRICES BETWEEN 1965 II AND 1966 IV

		(Percentage Change at Annual Rates) 1965 II - 1965 IV	1965 IV - 1966 IV
(1)	Gross National Product	10.1	8.5
(2)	Consumer Price Index	1.8	3.5
(3)	Wholesale Price Index	2.5	2.3
(4)	GNP Implicit Price Deflator	1.4	3.5
(5)	Average Gross Hourly Earnings- Manufacturing	3.1	4.2

	Civilian Labor Force	(Actual Values in Millions) 1965 II	1966 IV	1966 IV
(6)	Employment	72.4	72.9	74.8
(7)	Unemployment	3.7	2.9	2.6

Sources:

Row 1: Computed from Survey of Current Business, July 1969, table 1.1, p. 17.

Row 2: Computed from Economic Report of the President, January 1967, table B-42, p. 262.

Row 3: Computed from Economic Report of the President, January 1967, table B-44, p. 264.

Row 4: Computed from Survey of Current Business, July 1969, table 8.4, p. 48.

Row 5: Computed from Economic Report of the President, January 1967, table B-27, p. 245.

Row 6 and 7: Economic Report of the President, January 1967, table B-20, pp. 236, 237.

percent in the first quarter of 1966. This strong advance continued throughout 1966.

In a less favorable manner, however, the additional stimuli of the Vietnam buildup also had a direct and almost immediate impact on prices and wages. Between the second quarter of 1965 and the fourth quarter of 1965, consumer prices rose at an annual rate of 1.8 percent and wholesale prices rose at an annual rate of 2.5 percent (Table 2). The rate of increase in consumer prices doubled in 1966, rising 3.5 percent. The GNP price deflator rose at an annual rate of 1.4 percent in the second half of 1965 and 3.5 percent between the fourth quarter of 1965 and the fourth quarter of 1966. Finally, the annual rate of change in hourly earnings for manufacturing workers increased from 3.1 percent in the second half of 1965 to 4.2 percent in 1966.

National Stabilization Policies in the Mid-1960's

The economic plan which the Administration sent to Congress in January 1966 called for holding nondefense Federal expenditures to a minimum, reinstating some of the earlier excise tax reductions and beginning a system of graduated increases in the withholding schedule for individual income taxes. These measures were expected to achieve an approximate balance in national income accounts

budget. This was considered sufficient restraint to insure stable economic growth through 1966 and into 1967. As the 1966 Economic Report of the President asserted, "current policy represents a coordinated and consistent effort to promote balance of overall supply and aggregate demand - to sustain steady balanced growth at high employment levels with essential price stability."[1]

The economic record of 1966 and beyond strongly indicates that these objectives were not achieved. Instead, particularly during the early months of the buildup, demand was exceeding supply and inflationary pressures were building. the 1967 Economic Report of the President summarized by saying "all in all the economy exceeded reasonable speed limits in the period for mid-1965 through the first quarter of 1966."[2] Senator William Proxmire expressed somewhat the same conclusion in more poignant terms in April 1967 when he said:

> ". . . all of us in Congress are troubled as I am sure the Administration is, at errors that we made economically in 1966. The New York Times properly called it 'the year of the economic goof' because of the fact that we were unprepared for this

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[1] 1966 Economic Report, op cit., p. 180.

[2] U.S. President, 1963 (Johnson) Economic Report of the President (Washington: Government Printing Office, 1967), p. 47. (Hereafter cited as 1967 Economic Report.)

> escalation in military cost and as a result we had these high interest rates, unacceptable inflation, serious problems that we could have avoided with wiser policies, if we had had the information and acted on it."[1]

In retrospect, it is apparent that through most of the second half of 1965 and early 1966, key Federal economic policy makers, and others, failed to realize the full impact on the economy of the defense buildup in Southeast Asia. As one scholar of defense spending observed, despite the rapid expansion in defense contracts and the accelerating rate of inflation during this period of time . . . "the Nation, and particularly the Administration's economists, were still congratulating themselves on the 1964 tax cut and little need was felt, at least officially, for greater fiscal restraint."[2]

Perhaps the most tangible evidence of the apparent misjudgment concerning the economic consequences of the Vietnam buildup is the economic forecast issued by the Council of Economic Advisors for calendar year 1966. In

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[1]U.S. Congress, House, Senate, Joint Economic Committee, Economic Effect of Vietnam Spending, Hearings, Vol. I, 90th Congress, 1st Session, April 24, 25, 26, 27 (Washington: Government Printing Office, 1967), p. 192. (Hereafter cited as Joint Economic Committee, Vol. I.)

[2]Murray L. Weidenbaum, Economic Impact of the Vietnam War (Washington: The Center for Strategic Studies, 1967), pp. 33-34.

January 1966, after the buildup had been underway for a number of months, the Council forecast that the Nation's total output of goods and services would increase $48.5 billion in 1966. Instead, it increased $62.7 billion, about 29 percent more than expected. This underestimation of total demand was responsible in a substantial way for the inadequately restrictive fiscal policies which were recommended for 1966 and the subsequent sharp increases in prices, wages and interest rates.

OFFICIAL GOVERNMENT PREDICTIONS OF WAR COSTS

Many factors contributed to the underestimation of the economic consequences of the Vietnam buildup. One significant element was the poor quality of official projections of the expected costs of the Vietnam buildup. When the President made his July 28, 1965 speech indicating additional funds would be required for Vietnam, the fiscal year 1966 defense appropriation bill was before Congress. This bill requested $48.5 billion in new obligational authority and continued the downward trend in the defense budget evidenced since fiscal year 1964. In August 1965, Secretary McNamara submitted to Congress a request for an additional $1.7 billion in fiscal year 1966 for Vietnam related activities. In statements before the Subcommittee on Department of Defense Appropriations of the Senate

Committee on Appropriations, he indicated this amount might be sufficient to meet the additional requirements of Vietnam for fiscal year 1966. He closed his testimony by repeating that part of the President's July 28, 1965 statement which said:

> "I have asked the Commanding General, General Westmoreland, what he needs to meet this mounting aggression. He has told me. We will meet his needs."[1]

Secretary McNamara added:

> "The program I have outlined here today and the $1.7 billion amendment to the fiscal year 1966 Defense appropriation bill now before the committee will, in the collective judgment of my principal military and civilian advisors and myself provide the men, material, and facilities required to fulfill this pledge while at the same time maintaining the forces required to meet commitments elsewhere in the world."[2]

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[1] U.S. Congress, House, Senate, Joint Economic Committee, Economic Effect of Vietnam Spending, Hearings, Vol. II, 90th Congress, 1st Session, A compendium of Statements, Articles, and Papers compiled as background material (Washington: Government Printing Office, 1967), p. 377. (Hereafter cited as Joint Economic Committee, Vol. II.)

[2] Ibid., p. 377.

The $1.7 billion requested in August was not sufficient. In January 1966, Secretary McNamara returned to Congress and requested another $12.7 billion. This was raised by another $.9 billion in May 1966 to cover additional Army requirements. The $48.5 billion defense budget which was under consideration by Congress in July 1965 had increased to $63.5 billion by the time the fiscal year ended in June 1966.

The same cycle of low defense budget estimates early in the fiscal year being raised significantly as the year progressed was repeated in fiscal year 1967. The defense budget submitted to Congress in January 1966 requested $59.9 billion in new obligational authority for fiscal year 1967.[1] This was approximately $3.5 billion less than the total for fiscal year 1966. As was explained by Senator John Stennis, Chairman, Senate Armed Forces Committee, "fiscal planning at the time, as the Secretary of Defense frankly stated, was based on the arbitrary assumption that the War would end by July 1, 1967."[2] Total new obligational authority granted the Department of Defense for fiscal year 1967 was $72.8 billion, some 22 percent more than initially requested.

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[1] Joint Economic Committee, Vol. I, op.cit., p. 71.

[2] Joint Economic Committee, Vol. II, op.cit., p. 393.

SUMMARY

It has been indicated that the increase in defense activity caused by the Vietnam War was a significant factor in transforming the orderly and non-inflationary economic expansion of the early 1960's into the unstable and inflationary conditions of the late 1960's. Further, the severity of the inflationary and unstable economic conditions of the late 1960's was attributable in a large part to the miscalculations of the size and timing of the economic consequences of the military buildup and, in turn, the inadequate stabilization policies at the time of the buildup.

One of the reasons for the miscalculations of the impact on the economy of the Vietnam buildup was the poor quality of official estimates of the future resource requirements for the Vietnam War. In the next Chapter, the official budget data reported at the time of the buildup is evaluated. The way these data may also have contributed to underestimating the effects on the economy of the Vietnam War is shown.

CHAPTER II

MEASURING THE IMPACT OF DEPARTMENT OF DEFENSE ACTIVITY

INTRODUCTION

The official budget data reported at the time of the Vietnam buildup is evaluated in this chapter. Specifically, the data in the consolidated cash budget and those in the Federal sector of the national income and product accounts are examined. The time points when defense procurement activity is recorded in these budgets and how this timing affects the accuracy of these data as indicators of the impact on output of defense procurement actions is of particular interest. Finally, the method by which this study improves upon previous efforts to measure the timing of defense economic impact is discussed.

OFFICIAL MEASUREMENTS OF THE ECONOMIC IMPACT OF THE VIETNAM BUILDUP

Budget Data for Period of Vietnam Buildup

At the time of the Vietnam buildup, the data most widely used to measure the economic impact of defense activity were the cash payments data reported monthly by

the Department of Defense and the Department of Treasury and the Federal expenditures data reported quarterly by the Department of Commerce. The cash payments for defense activities are combined with all other Government disbursements and receipts in the consolidated cash budget and the Federal expenditures for defense activities are combined with all other expenditures and receipts in the Federal sector of the national income and product accounts.

The consolidated cash budget records activity on defense procurement contracts at the time of payment to defense contractors.[1] The composite receipts and payments as recorded in the cash budget are shown in Table 3. For fiscal year 1966 (during the sharpest phase of the Vietnam buildup), the cash budget recorded receipts of $134.5 billion, payments of $137.8 billion and a deficit of $3.3 billion.

The Federal sector of the national income and

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[1] Monthly data on payments for defense procurement items are published in the Treasury Department's Monthly Treasury Statement, the Defense Department's "Status of Funds" report and the Commerce Department's Defense Indicators publication. It should be noted that the new unified budget also records activity on defense procurement contracts at the time of payment to defense contractors. The only distinction between the two budgets is that a payment is considered to have occurred when the check is issued for purposes of the unified budget while a payment is not considered to have occurred until the check clears the banking system for purposes of the consolidated cash budget.

product accounts records expenditures for defense procurement items at the time of delivery. Expenditures are estimated statistically by beginning with Government checks issued, adding the change in Government accounts payable (as measured in surveys of businesses by the Securities and Exchange Commission) and subtracting the change in Government receivables for prepayments and advances. Stephen Taylor of the Federal Reserve Board has pointed out that this results in reporting expenditures when a procurement item is physically delivered to the Government and in reporting economic activity on these items prior to delivery as a change in private business inventories.[1] In fiscal year 1966, the Federal sector of the national income and product accounts recorded receipts of $133.0 billion, expenditures of $131.9 billion, and a surplus of approximately $1.0 billion (Table 3).

Reliance on National Income and Product Accounts Data

The numbers in the Federal sector of the national income and product accounts were given the greatest weight by policy makers at the time of the Vietnam buildup. The economic plans in both the 1966 and 1967 Economic Report

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[1] President's Commission on Budget Concepts, Staff Papers and Other Materials Reviewed by the President's Commission, (Washington: Government Printing Office, 1967) p. 202.

TABLE 3

SELECTED DATA FROM THE CONSOLIDATED CASH BUDGET AND THE FEDERAL SECTOR OF THE NATIONAL INCOME AND PRODUCT ACCOUNTS FOR FISCAL YEARS 1947 - 1969

	Consolidated Cash Budget			Federal Sector of National Income & Product Accounts		
Fiscal Year	Cash Receipts	Cash Payments	Surplus or Deficit	Total Receipts	Total Exp.	Surplus or Deficit
1947	43,531	36,931	6,600	42.7	29.5	13.2
1948	45,357	36,493	8,864	43.6	30.9	12.7
1949	41,576	40,570	1,006	40.0	39.6	.4
1950	40,940	43,147	-2,207	42.0	42.4	-.5
1951	53,390	45,797	7,593	60.8	44.6	16.2
1952	68,011	67,962	49	65.1	66.0	-1.0
1953	71,495	76,769	-5,274	69.3	75.8	-6.5
1954	71,626	71,858	-232	65.8	74.2	-8.5
1955	67,836	79,537	-2,702	67.2	67.3	-.1
1956	77,087	72,546	4,542	75.8	69.8	6.0
1957	82,105	80,006	2,099	80.7	76.0	4.7
1958	81,892	83,472	-1,580	77.9	83.1	-5.1
1959	81,660	94,752	-13,092	85.4	90.9	-5.5
1960	95,078	94,328	750	94.8	91.3	3.5
1961	97,242	99,542	-2,300	95.3	98.0	-2.7
1962	101,865	107,662	-5,797	104.2	106.4	-2.1
1963	109,739	113,751	-4,012	110.2	111.4	-1.2
1964	115,530	120,332	-4,802	115.5	116.9	-1.4
1965	119,699	122,395	-2,696	120.5	118.5	2.0
1966	134,479	137,818	-3,337	133.0	131.9	1.0
1967	153,596	155,142	-1,546	147.7	154.4	-6.7
1968[1]	158,823	175,981	-17,157	161.1	172.4	-11.3
1969[1]	181,146	188,725	-7,579	190.0	187.3	2.7

[1]Estimates

Sources: 1968 Economic Report of the President, tables B-62 and B-63, pp 283, 284. Data for Federal sector of National Income and Product Accounts for years 1965 - 1969 were revised on basis of Survey of Current Business, July, 1969, table 32.

of the President highlighted these data. As was stated in a speech delivered in October 1966 by Dr. Arthur Okun, at the time a member of the Council of Economic Advisors, the Federal budget on the national income accounts basis is ". . . our best measure of the economic impact of fiscal policy. . ."[1] This was expanded somewhat in the 1967 Economic Report of the President where it was pointed out that the economic situation would be discussed in terms of ". . . the national income accounts budget, considered to be the most complete and reliable measure of the Federal Government's activities and their impact."[2]

The quarterly performance of the national income and product accounts budget during the Vietnam buildup is shown in Table 4. The difference between receipts and expenditures moved from a surplus of $4.4 billion and $4.7 billion in the first and second quarters of 1965 respectively to a deficit of $3.1 billion in the third quarter of 1965. From the third quarter of 1965 to the second quarter of 1966, the national income and product

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[1] Arthur M. Okun, "National Defense and Prosperity" (unpublished remarks before the American Ordnance Association, Fort Lesley J. McNair, Washington, D.C., October 12, 1966), p. 6.

[2] 1967 Economic Report, op. cit., p. 63.

TABLE 4

RECEIPTS AND EXPENDITURES OF THE FEDERAL SECTOR OF NATIONAL INCOME AND PRODUCT ACCOUNTS DURING VIETNAM BUILDUP
(Seasonally Adjusted Annual Rates in Billions of Dollars)

Calendar Year and Quarter	Total Receipts	Total Expenditures	Surplus or Deficit
1965 I	123.2	118.8	4.4
1965 II	124.8	120.2	4.7
1965 III	123.4	126.5	-3.1
1965 IV	127.4	128.5	-1.1
1966 I	136.4	135.0	1.4
1966 II	141.4	138.4	3.0
1966 III	145.3	146.5	-1.2
1966 IV	147.0	151.1	-4.1
1967 I	147.5	159.5	-12.0
1967 II	148.3	161.4	-13.2
1967 III	152.0	165.3	-13.4
1967 IV	156.4	168.8	-12.3
1968 I	165.7	174.1	-8.4
1968 II	170.8	180.3	-9.5
1968 III	181.4	184.2	-2.8
1968 IV	187.3	187.4	-.1

Source: Survey of Current Business, July 1969, table 3.2, p. 30.

accounts budget indicates progressive movement toward a more restrictive position. The $3.1 billion deficit of the third quarter of 1965 was reduced to a $1.1 billion deficit in the fourth quarter and became a $1.4 billion and $3.0 billion surplus in the first and second quarters of 1966 respectively. The Federal sector again returned to a deficit position in the second half of 1966, but for the full calendar year of 1966 it was in approximate balance, as it had also been for the full fiscal year of 1966.

The performance of the national income and product accounts budget suggested that Government fiscal policy was somewhat restrictive in the first and second quarters of 1965, slightly stimulative in the third quarter of 1965 and neutral to slightly restrictive between the fourth quarter of 1965 and the fourth quarter of 1966. The Nation's economic policy makers apparently accepted these numbers as evidence that fiscal policy was not an expansionary influence during the buildup. It was in fact considered that fiscal policy was appropriately restrictive for the economic conditions. The 1967 Economic Report of the President summarizes the apparent success of economic policy in 1966 as follows:

> "By the closing months of 1966, it was clear that the brakes had worked. The economy had shouldered the burden of early active

> hostilities without the inefficient controls and without losing its basic health and stability. It was shown that policy could work both ways; it could restrain the economy, much as it had provided stimulus in the preceeding 5 years."[1]

EVALUATING OFFICIAL MEASUREMENTS OF THE ECONOMIC IMPACT OF THE VIETNAM BUILDUP

Inconsistency Between Budget Data and Subsequent Economic Record

The performance of the U.S. economy in the period of 1967 through 1969 indicates that stabilization policies during the buildup may not have been as appropriate and successful as was concluded in the 1967 Economic Report of the President. During this period of time, wages and prices began to escalate at the fastest rates experienced since the Korean War period. This was accompanied by interest rates which were, in many instances, the highest in the Nation's history. There were many signs which suggested that the economy had not been sufficiently restrained during the Vietnam buildup.

The inconsistency between the apparently neutral fiscal policy of 1965 and 1966 and the unstable and inflationary conditions of the late 1960's is largely

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[1] 1967 Economic Report, op.cit., p. 38.

attributable to the inaccurate government data used to measure the economic impact of the Vietnam buildup. As indicated previously, the accounting practices of the Federal Government result in defense activity being recorded either at the time when payments are made by the Defense Department or at the time when deliveries are received by the Defense Department. The economic impact of defense procurement activity, however, generally occurs before either the payments or deliveries related to this impact. This timing discrepancy between the actual impact of defense procurement activity and the measurement of this impact in the Federal accounts makes the widely used Government data inaccurate indicators of economic production on defense contracts, particularly during a period of sharply changing defense requirements.

Analysis by Murray Weidenbaum

The scholar credited with first pointing out in a definitive manner the deficiencies of Government data for the measurement of defense economic activity is Dr. Murray L. Weidenbaum. Dr. Weidenbaum's earliest work concerning the economic impact of defense spending was an analysis conducted in the late 1950's and early 1960's of the Korean buildup. Based on this analysis, Dr. Weidenbaum concluded that the largest gains in the gross national product and the sharpest

rises in prices during the Korean buildup period did not take place concurrently with the largest increases in defense expenditures as reported in the Federal Government budget and other official documents. Instead, he pointed out that ". . . the main expansive effect of this new program of purchases of privately produced goods and services occurred at the early stages of the spending process rather than at the terminal stages when the government disbursements were made."[1]

Professor Weidenbaum's analysis further indicated that program authorizations, appropriations, obligations or contract awards were better indicators of defense economic impact than budget expenditures. He concluded that this results largely from the willingness of defense contractors to spend their own money in anticipation of getting a contract or in the early stages of performing the contract once it is received. As Dr. Weidenbaum points out, on the basis of military obligations, contractors ". . . go out and hire people, they make commitments on machinery, they buy materials, they go through this kind

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[1] Murray L. Weidenbaum, "The Economic Impact of the Government Spending Process", University of Houston Business Review, Vol. 8 (Spring 1961), p. 40.

of action which expands the economy."[1]

Based on the findings from his analysis of the Korean buildup, Dr. Weidenbaum made adjustments to the budget numbers reported during the Vietnam buildup so as to more accurately measure the economic impact of the buildup. He attempted to take account of the lag between the time the Government obligates money to a contract and the time when expenditures are made on the basis of these obligations. His results are shown in Table 5.

The first column in Table 5 gives the deficit as it was recorded in the national income and product accounts in 1966.[2] The Series A data in column 2 is the excess of military obligations over expenditures during the period. The Series B data in column 3 is one half the excess of obligations over expenditures or roughly the results of an arithmetic average of military obligations and expenditures for each quarter. The Series A data in column 4 is the result of adding column 2 to the official national income and product accounts budget surplus or deficit as given in column 1. Column 5 is the result of adding column 3 to column 1.

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[1] Joint Economic Committee, Vol. I, op. cit., p. 184.

[2] The numbers in Table 5 are based on the national income and product accounts data as reported in November 1966.

TABLE 5

SOME VARIATIONS ON THE FEDERAL SURPLUS OR DEFICIT IN THE NATIONAL INCOME ACCOUNTS BUDGET

(Billions of Dollars at Annual Rates)

Calendar Year	Federal Surplus (+) or Deficit (-), Official Basis	Adjustments for Defense Obligations		Federal Surplus (+) or Deficit (-), Adjusted Basis	
		A	B	A	B
(Columns)	(1)	(2)	(3)	(4)	(5)
1964:					
1st Half	-4.3	-0.1	-0.1	-4.4	-4.4
2nd Half	-1.8	-4.4	-2.2	-6.2	-4.0
1965:					
1st Half	+4.4	-2.0	-1.0	+2.4	+3.4
2nd Half	-1.4	-5.2	-2.6	-6.6	-4.0
1966 Estimated:					
1st Half	+3.1	-8.4	-4.2	-5.3	-1.1
2nd Half	-2.1	-5.2	-2.6	-7.2	-4.6

Source: Murray L. Weidenbaum, "Economic Impact of the Vietnam War (Washington: Center for Strategic Studies, 1967) table 6, p. 36.

A comparison betweel column 1, which is the official national income and product accounts surplus or deficit, and columns 4 and 5, which are Dr. Weidenbaum's adjusted surplus or deficit, indicate that the impact on the economy of the Vietnam buildup in the second half of 1965 and the first half of 1966 may have been more expansionary than was suggested by the most widely used Government data. Based on his analysis in a paper published in late 1966, Dr. Weidenbaum concluded ". . . that the Federal Government appears to have been following a non-inflationary economic policy in 1966 when actually it has been a major source of inflationary pressure in the American economy in the past year."[1]

Analysis by Harvey Galper

Another scholar who has conducted extensive research on the problem of measuring defense economic impact is Dr. Harvey Galper. Dr. Galper agrees with Dr. Weidenbaum's conclusion that the payments data in the consolidated cash budget and the deliveries data in the national income and product accounts are generally lagging indicators of defense economic impact. He further agrees with Dr. Weidenbaum that obligations and contract awards

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[1] Ibid., p. 548.

are generally leading indicators of defense economic impact. In a paper presented before a 1967 Brookings Institution conference, Dr. Galper stated that the major direct impacts of a defense procurement action occurs ". . . in the stage of the expenditures process between contract award and final delivery."[1]

Dr. Galper points out, however, that the national income and product accounts do not fail to measure defense generated economic activity when it occurs. Rather the problem is that this economic activity is improperly allocated. Between the time a contract is awarded and the time when delivery under this contract takes place, the defense related production is recorded in the national income and product accounts as a change in private business inventories. The problem, then, becomes one of distinguishing between that change in business inventories which is primarily a result of civilian activity and that portion which is primarily a result of defense activity.

Dr. Galper attacks the problem of identifying the portion of private business inventories attributable to defense work in two steps. First, defense purchases of goods and services are estimated using a distributed lag function of current and past military prime contract awards to U.S. business. The lag is varied according to

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[1] Harvey Galper, "The Timing of Federal Expenditure Impacts," Budget Concepts for Economics Analysis, ed. Wilfred Lewis (Washington: Brookings Institution, 1968), p. 96.

the level of capacity utilization in the economy, the urgency of military demands, and the mix between soft goods and hard goods procurement items. Secondly, based on the derived estimates from the distributed lag equations of the rate at which defense contract awards are converted into deliveries and an assumed rectangular or inverted V production function, an estimate of the change in inventories attributable to defense production is developed.

The results of applying the Galper estimating techniques to the data for 1964, 1965 and 1966 are shown in Table 6. These numbers show defense goods-in-process inventories shifting from a disinvestment of approximately one billion dollars in the first quarter of 1965 to an investment of approximately four billion dollars in the fourth quarter of 1966. An accurate measurement of defense production, therefore, would add the disinvestment or investment in defense related business inventories to the defense purchases series of the national income and product accounts.

EVALUATION OF WEIDENBAUM AND GALPER RESULTS

The adjustments to the data in the national income and product accounts suggested by Weidenbaum and Galper are intuitively attractive. The adjustments indicate that these

TABLE 6

DEFENSE GOODS-IN-PROCESS INVENTORY INVESTMENT COMPARED WITH TOTAL INVENTORY INVESTMENT BY QUARTERS FOR 1964 - 1966

Year And Quarter	Defense Goods-in-Process Inventory Investment: Rectangular Production Assumption	Defense Goods-in-Process Inventory Investment: Inverted V Production Assumption	Total Inventory Investment	Ratio: Col. 1/ Col. 3
	(1)	(2)	(3)	(4)
1964:				
I	-.75	-.70	4.8	-.150
II	-.42	-.54	6.1	-.069
III	.07	-.04	4.8	.015
IV	-.47	-.27	7.7	-.061
1965:				
I	-1.29	-1.16	10.6	-.122
II	-.25	-.59	8.8	-.028
III	1.30	1.03	9.4	.138
IV	2.14	2.07	9.9	.216
1966:				
I	2.37	2.45	9.9	.239
II	3.29	3.15	14.0	.235
III	4.21	4.11	11.4	.369
IV	3.93	4.12	18.5	.212

Source: Harvey Galper, "The Timing of Federal Expenditure Impacts," Budget Concepts for Economic Analysis, ed. Wilfred Lewis (Washington: Brookings Institution, 1968) table 3, p. 103.

data underestimated the impact on the economy of the Vietnam buildup by significant amounts.

A serious deficiency with both Weidenbaum's and Galper's work does exist. Both scholars have been unable to adequately validate their results through the use of direct measurements or direct estimates of defense production. There is, in fact, no definitive way of knowing if the adjustments suggested by Dr. Weidenbaum and Dr. Galper lead to an improved measure of defense economic impact or if these adjustments only make bad data even worse. As was stated by Professor Warren L. Smith in reviewing one of Galper's articles, ". . . there is no really satisfactory independent check on his estimates of production and the derived series on inventory investment."[1]

This study provides an independent check on the analytical results obtained by both Weidenbaum and Galper. On the basis of empirical data about the actual production on defense procurement contracts, a statistical model is developed which yields direct estimates of defense

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[1] Warren L. Smith, Comments at a conference sponsored jointly by the President's Commission on Budget Concepts and the Brookings Institution, Washington, July 31 - August 1, 1967; published in Staff Papers op., cit., p. 454.

production. These estimates of production are used to test the validity of the Weidenbaum and Galper analyses. More importantly, these estimates help determine more precisely the timing of economic production on defense procurement contracts during the Vietnam buildup.

SUMMARY

The official budget data recorded during the Vietnam buildup inaccurately measured the timing of the economic impact of the buildup. This underestimation resulted in a large part from the accounting practices employed by the Government in measuring and classifying the economic activity associated with defense procurement contracts. Although the most significant economic consequences of a defense procurement action occur at the time production takes place, this production is not measured in the Federal accounts until the time of payment or delivery.

Weidenbaum and Galper have suggested methods of improving the quality of Government data for measuring the economic impact of defense activity. Although both methods have improved our understanding of the timing of the impact of defense spending, each lacks the precision and validation necessary for widespread use. This study provides the required precision and validation.

CHAPTER III

DESCRIPTION OF THE SAMPLE DATA AND THE BEHAVIOR PATTERN OF AGGREGATED SAMPLE DATA

The data which are analyzed in order to determine the timing of the economic impact of defense procurement activity are discussed in this chapter. In addition to briefly discussing the procedures for selecting the sample and the methods for collecting the data, the key variables used in the anlysis are defined and the behavior pattern of the aggregated sample data is analyzed. The latter concentrates on the aggregated monthly production of the sample contracts and a comparison of this production with the associated Government data used to measure it.

SAMPLE SELECTION AND DATA COLLECTION

Previously nonexistant data on the aggregated performance of 51 defense procurement contracts begun before, during and after the Vietnam buildup have been tabulated. The complete performance on these 51 contracts was initially reconstructed under the direct supervision of the author in connection with a special Defense Department study of the conversion to an accrual accounting system in the Department

of Defense.[1] The sample was selected from Air Force and Navy contracts for major hard goods procurement items. All of the contracts selected were one million dollars or larger, were administered by one of the 50 largest defense contractors and were at least 80 percent complete as of August 1969.

The sample selection procedures and an enumeration of the final sample are presented in Appendix A. The final sample represented defense procurement activity valued in excess of $2.8 billion. Table 7 summarizes the sample contracts according to military service, procurement program, pricing provision, contract size and the period when the first activity occurred on the contract.

It should be noted that a scientific sample design was not feasible because of the small number of contracts which satisfied all of the sampling criteria and because of the necessity of receiving the full cooperation of a number of defense firms. In most instances, the contracts which were included in the sample were selected in an arbitrary manner. Despite this caveat, the analysis did not appear to indicate any particular bias in the sample data.

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[1]See U.S., Department of Defense, unpublished paper entitled "A Final Report on the Proceedings of the DOD Special Study Group on Defense Contractor Constructive Delivery (Accrual Accounting Implementation)," Washington, August, 1970.

TABLE 7

SUMMARIZATION OF SAMPLE CONTRACTS

Contract Characteristics	Number of Contracts
Military Service	
Air Force	16
Navy	35
Procurement Program	
Aircraft	23
Missile	15
Electronics	11
Other	2
Pricing Provision	
Fixed Price	43
Cost Plus	8
Size	
Over $200 million	2
$100 - 200 million	8
$ 50 - 100 million	12
$ 25 - 50 million	8
$ 5 - 25 million	9
$ 1 - 5 million	12
First Activity on Contract	
Before April 1965	20
April 1965 - March 1966	16
After April 1966	15

Source: Appendix A, table 22.

The data collected on each of the 51 sample contracts is discussed in Appendices B and C. Data elements have been reconstructed from the documents and records of the appropriate Department of Defense accounting and disbursing offices. Nine different Defense Department accounting and disbursing activities were visited in order to complete this part of the data collection. Data elements also have been reconstructed from the internal records and documents of the selected defense firms. Twelve different prime contractors and 15 different plants were visited in order to complete this part of the data collection. Data collection took place between August, 1969 and January, 1970.

The most serious limitation of the data collection is the absence of production data for subcontractors and vendors on the sample contracts. The data on contractor performance analyzed in this study came from the records of the prime contractors for each of the 51 contracts. Prime contractors record the production of subcontractors or vendors at the time that they receive a shipment billing or physical shipment. In most cases the production by the subcontractors and vendors has taken place prior to these events. Therefore, it is not possible from the data collected to determine the exact timing of subcontractor and vendor production on the sample contracts.

DEFINITIONS OF KEY VARIABLES

Obligations

Obligations represent the official value of the contract and are time phased according to the month of entry into the records of the Defense Department accounting and disbursing office. Obligations include the basic amount of the letter contract or definitized contract, plus or minus all changes in these values as a result of amendments and modifications based on various obligating documents.

The obligations amount for each contract represents the total commitment by the Defense Department for private goods and services. Obligations initiate production in the private sector and the amount of obligations at a given point in time can be interpreted as representing the total amount of economic activity or production which will be caused by that contract during its lifetime. In fact, however, the amount of obligations, particularly during the early months of the contract's life, may represent only a small portion of the total stream of economic output that will be caused as a result of that procurement action.

Table 8 indicates the amounts by which the obligations for the 51 sample contracts increased from the time the contracts were begun until they were completed.

TABLE 8

CHANGE OF CONTRACT VALUES OVER TIME

Contract	Year & Month of Letter Contract Award	Year & Month of Definitized Contract Award	Value at Time of Letter Contract Award	Value at Time of Definitized Contract Award	Final Contract Value	Final Value as Percent of Definitized Value
N23	6509	6903	31621	102837	102837	100.0
AF13	6508	6607	695	59188	73700	124.5
AF14	6609	6704	5278	26764	82233	307.2
AF15	6411	6505	1000	18000	59116	328.4
AF16	6409	6501	600	5709	71931	1259.9
AF17	6508	6606	0	41249	48330	117.1
AF21	6610	6802	2000	6436	8241	128.0
N20	-	6603	-	34550	44975	130.1
N30	-	6509	-	2413	2417	102.4
N3	-	6503	-	8827	17466	197.6
N13	-	6411	-	105814	130348	123.1
N18	6602	6708	0	18845	53144	282.0
AF2	6408	6502	20000	38271	236118	643.0
N19	6608	6612	7154	10654	56829	533.4
AF12	6601	6707	0	18833	27291	144.9
AF11	6601	6703	12100	32998	98696	299.1
N31	-	6606	-	1471	2082	141.5
N25	6512	6612	2235	3546	11021	310.8
N45	6408	6503	0	43465	48414	113.3
AF9	6703	6707	2301	3201	9646	301.3
AF8	6606	6701	2309	10957	12208	111.4
AF10	6407	6409	0	1800	35822	1990.1
N24	-	6509	-	29358	166407	566.8
N29	-	6506	-	1235	1470	119.0
AF4	6702	6712	929	1516	1657	109.3
N17	6611	6705	0	13500	52950	392.2
N14	-	6601	-	83674	93809	112.1
AF3	6511	6606	500	1096	14373	1311.4

N33	-	6903	-	2043	2043	100.0
N10	-	6411	-	156574	220819	141.0
N47	6309	6312	0	30863	37646	121.9
N46	6606	6701	113173	133260	160973	120.7
AF7	6504	6607	5000	31379	57085	181.9
AF6	-	6508	-	6150	19108	310.6
N32	6612	6706	914	1938	1945	100.3
N11	-	6410	-	29432	29317	99.6
N9	-	6403	-	4392	4852	110.4
N4	-	6509	-	491	1483	304.0
N6	6611	6807	32000	172890	184013	106.4
N16	-	6706	-	80147	104998	131.0
N26	6706	6810	0	9647	10369	107.4
N34	-	6403	-	75323	107293	142.4
N22	-	6504	-	22358	28816	128.8
N21	6403	6503	0	79635	81988	102.9
N27	6610	6806	0	80943	134836	166.5
N36	-	6609	-	1945	2492	128.1
N41	6501	6611	815	9298	11951	144.0
N42	-	6408	-	53500	55215	103.2
N43	-	6412	-	1104	1104	100.0
N44	6601	6606	2930	2930	3165	108.0
N1	-	6310	-	-	1070	-

Source: Sample data discussed in Appendix A, table 22.

The final obligations amount of the sample contracts range from 99.6 to 1990.1 percent of the obligations amount at the time the contracts were definitively negotiated. On the average, the final obligations amount is 263.9 percent of the definitized contract value with a standard deviation of 351.8 percent. These findings suggest that the initial obligations amount is not a good indicator of the ultimate impact of a procurement contract on the economy. These findings also indicate that any statistical model developed to estimate the stream of economic output resulting from a group of defense procurement contracts must take into account the changes in obligations during the life of a contract.

Production

Production in this study is defined as the monthly costs incurred by the prime contractor in the process of completing the contract plus or minus the actual profit realized on the contract during that month. Profits on the sample contracts are defined as the difference between the costs incurred by the contractor and the total payments received by the contractor from the Department of Defense. Profits are distributed at the time of delivery and at a constant rate per dollar of delivery. Distributing profits on the basis of deliveries is consistent with the accounting practices

of most defense contractors, the payment procedures of the Department of Defense, and the accounting conventions used in the Department of Commerce national income and product accounts.[1]

The cumulative production on a contract as of a specific month is given below:

$$Q_{it} = C_{it} + \frac{(\Pi_{if})}{(D_{if})} \times (D_{it})$$

where

Q_{it} = Cumulative production on contract i as of month t

C_{it} = Cumulative costs incurred on contract i as of month t

Π_{if} = Final profit (or loss) on contract i

D_{if} = Final value of deliveries made on contract i

D_{it} = Value of deliveries made on contract i as of month t.

Aggregating all the sample contracts, production during any month equals the difference between the cumulative level of production in the current month and that level in the previous month, hence,

$$Q_t - Q_{t-1} = (C_t - C_{t-1}) + \frac{(\Pi_f)}{(D_f)} \times (D_t - D_{t-1})$$

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[1] Leonard Tashman, "Measuring the Economic Impact of the Defense Activity: An Evaluation of the Available Data," Defense Indicators, Series FS4, No. 69-2 (February, 1969) pp. 27-36.

or

$$\Delta Q_t = \Delta C_t + \frac{(\Pi_f)}{(D_f)} \quad X \quad (\Delta D_t)$$

where

ΔQ_t = Value of production on all sample contracts during month t

ΔD_t = Value of deliveries made on all sample contracts during month t

ΔC_t = Costs incurred on all sample contracts during month t

Π_f/D_f = Average rate of profit on all sample contracts expressed as a percent of deliveries.

Theoretically, the economic impact of a defense procurement contract occurs at the time of production. It is at the time of production that economic resources are consumed and that the contractor contributes "value added" to the gross national product. The empirical measurement of production, however, may not coincide exactly with economic impact. Although production is an economic concept, it can be measured objectively only by using accounting data. In this study, for example, production is equated with the costs incurred by the prime contractor and the actual profits realized on the contract. Costs and profits are both defined according to the accounting conventions of the participating defense firms. The use of accounting data compromises some of the economic qualities of the series on production for the sample contracts.

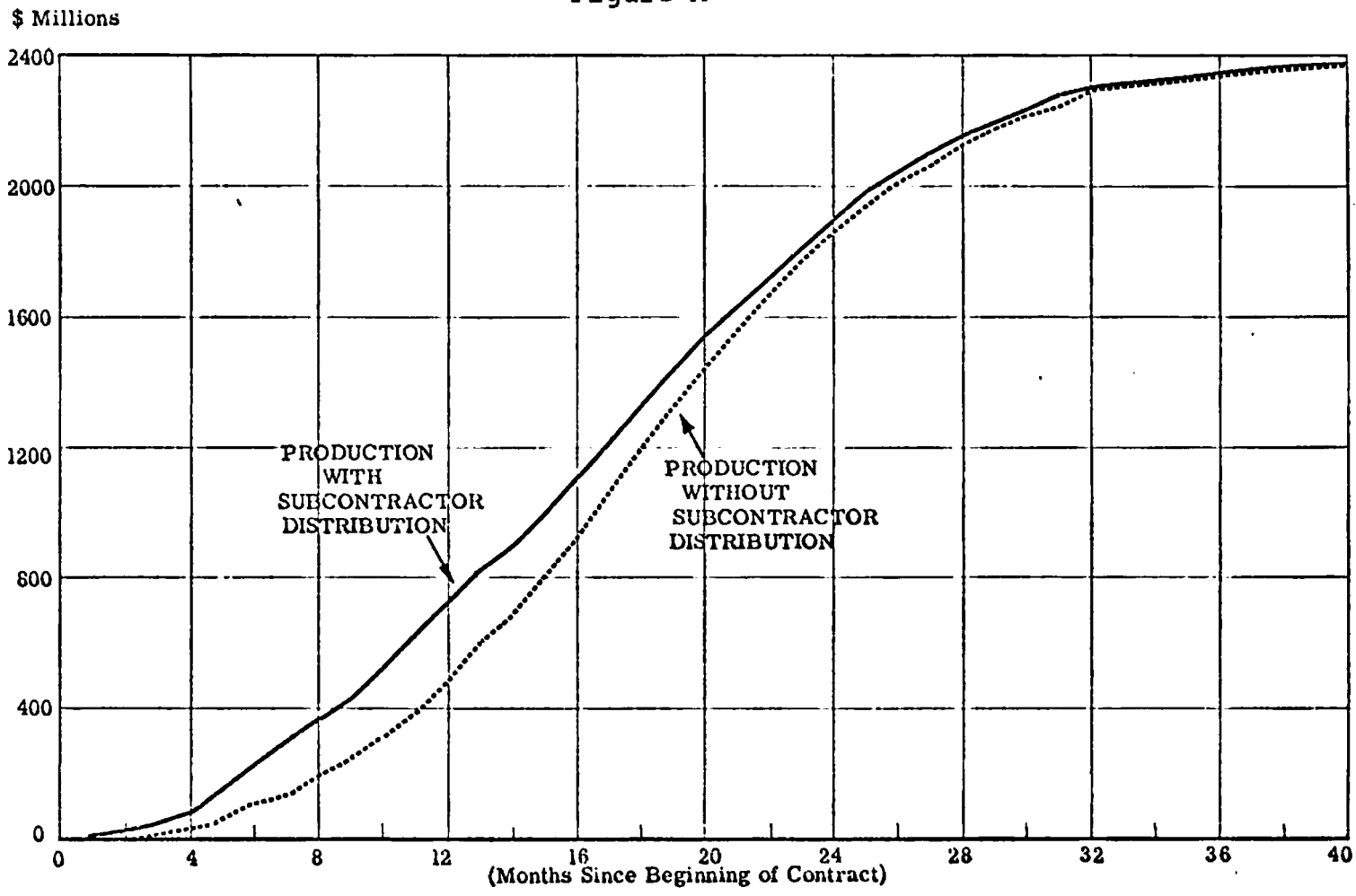
There is a further reservation which needs to be made about the theoretical definition of production and the empirical measurements of production. One of the objectives of the analysis is to determine the exact timing of the production, or economic impact, of defense procurement contracts. This is done by estimating production on the basis of cost and profit data extracted from the prime contractor's financial records. As previously discussed, prime contractors record the activity of their subcontractors and vendors at the time when these subcontractors and vendors submit billing documents or make physical shipments to the prime contractor. Generally, this accounting procedure results in the prime contractor recording the production of his subcontractors and vendors at some time after the production has occurred.

Figure A indicates the possible significance of the discrepancy between the theoretical ideal of measuring all contractor performance at the time of production and the empirical results from measuring production on the basis of the data from the prime contractor's accounting system. For purposes of constructing the "Production with Subcontractor Distribution" curve, it is assumed that subcontractor production, on the average, occurs midway between the time when the prime contractor issues an order to a subcontractor or vendor and the time when the subcontractor or vendor delivers the finished item to the prime contractor. If this assumption is valid,

COMPARISON OF PRODUCTION WITH AND WITHOUT DISTRIBUTION OF SUBCONTRACTOR EARNINGS,

DATA ON 46 CONTRACTS

Figure A



Source: Sample data.

the results in Figure A indicate that the maximum lag between the production series constructed from the prime contractor's records, which is analyzed in this study, and the actual production in the private economy occurs in about the 12th month after the contract's are begun and is approximately two months in length. From the 12th month until completion, the two series on production converge.

Payments

A third key data element in the analysis is the monthly payments on the sample contracts. Payments are defined as the checks issued by the responsible Defense Department disbursing office and are time phased according to the month of issue. This definition is comparable to, but not identical with, the one used in the consolidated cash budget during the time of the Vietnam buildup. The definition of payments used in this study differs from the definition used in the cash budget in that the latter makes adjustments to the checks issued data to reflect when these checks clear the banking system.[1] The discrepancy between checks issued and checks cleared is small, however, and should not compromise the quality of the analysis.

Both theoretically and empirically, payments represent remuneration to the contractor for completed

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[1] Samuel M. Cohn, "The Consolidated Cash Statement of Federal Financial Transactions - Some Issues," The Review of Economics and Statistics, Vol. XLV, No. 2 (May 1963), p. 121.

production. This completed production could be of three distinct types. It could be production on a cost reimbursement contract where the contractor is paid up to 100 percent of the costs he has incurred plus some fixed fee. It could be for production on a fixed price contract with progress payments where the contractor is paid up to 80 percent of the costs he has incurred in performing the contract. Finally, it could be for deliveries on either a fixed price or a cost reimbursement contract where the contractor is paid the difference between the value of the deliveries being made and the previous partial payments he has received.

Deliveries

A fourth data element which is critical to the analysis is monthly deliveries on each procurement contract. Monthly deliveries represent completed work by the prime contractors and are time phased according to the month when the responsible accounting and disbursing office recorded payments on the basis of shipping invoices. This definition is comparable to, but not identical with, the one used in the national income and product accounts to record defense purchases of procurement items.[1] The measurement of deliveries used in this study is not identical to the one used in the national income and product accounts because deliveries are estimated statistically

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[1] U.S. Congress. House. Senate. Joint Economic Committee The Federal Budget As An Economic Document, prepared by Dr. Roy E. Moor. (Washington: U.S. Government Printing Office, 1962), p. 123.

in the latter while they are actual observations in the present study.

Theoretically, deliveries on defense procurement contracts represent the physical shipments by defense firms of finished procurement items. This would indicate that the delivery is the terminal step in the production of defense procurement items.

There are, however, some exceptions to this interpretation of deliveries. In both the national income and product accounts and in this study some deliveries are recorded at intermediate steps in the production process. This situation occurs on cost reimbursement contracts which allow partial payments on the basis of costs incurred rather than procurement items completed. On these contracts, the Department of Defense legally takes possession of the item being produced as partial payments are made. Hence, on these contracts, both the national income and product accounts and this study will record as deliveries the payments made on cost reimbursement contracts for partially completed procurement items.[1]

Unpaid Obligations Outstanding

A final data element which is critical to the analysis is unpaid obligations outstanding. Unpaid

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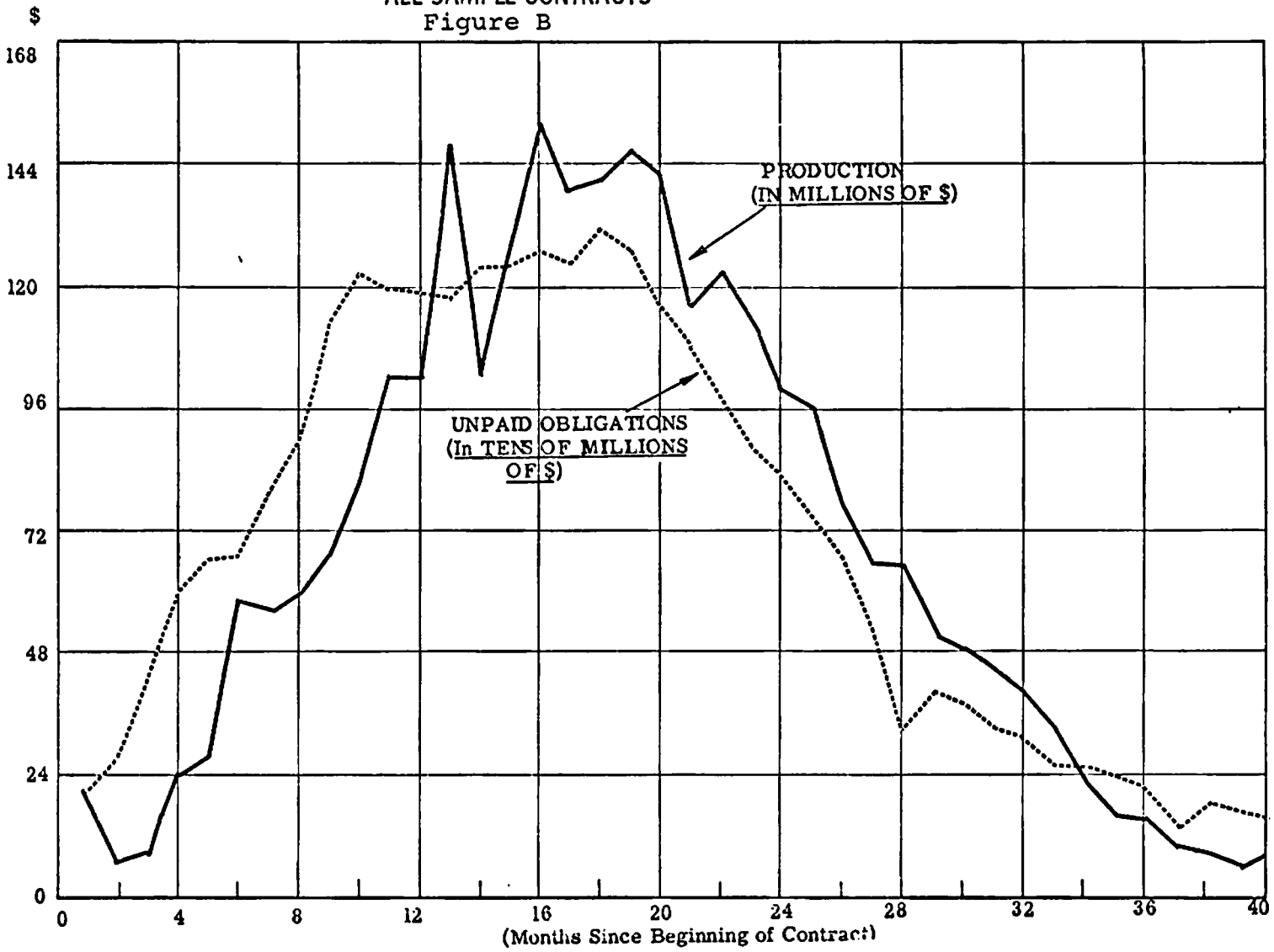
[1] Although partial payments are made on fixed price contracts, deliveries do not legally occur until the item is physically completed and shipped. Both this study and the national income and product accounts record the deliveries on fixed price contracts at the time that the item is physically shipped.

obligations outstanding is defined as total obligations on the contract minus total payments. The obligations amount is the official value of the contracts. The payments amount represents the completed production for which defense firms have received reimbursement. Therefore, unpaid obligations outstanding is the official value of the contract which has not been produced and payed for by the Government.

Theoretically, unpaid obligations outstanding are funds committed to the purchase of procurement items as they are produced. To defense contractors, the stock of unpaid obligations outstanding represent unfilled orders. To the Department of Defense, the stock of unpaid obligations outstanding represent unfulfilled demand. It is assumed in this study that defense contractors produce in order to fill unfilled orders and to satisfy unfulfilled demand.

The relationship between the stock of unpaid obligations outstanding for the sample contracts and the flow of monthly production on these contracts is shown in Figure B . During approximately the first 12 months of activity on these contracts, changes in unpaid obligations preceed changes in production by about three months. Between the 12th and 18th month, movements in these two variables are approximately coincidental. From the 18th month to the 28th month of contract activity, changes in unpaid obligations outstanding again lead changes in production by approximately three months. Finally, from the 28th to 40th month the relationship between these two variables becomes mixed.

COMPARISON BETWEEN MONTHLY PRODUCTION AND UNPAID OBLIGATIONS OUTSTANDING:
ALL SAMPLE CONTRACTS
Figure B



Source: Appendix A, table 22.

The empirical measurement of unpaid obligations outstanding only slightly compromises the theoretical interpretation of these data. On contracts which allow progress payments, some production is not payed for until the procurement item is finished and delivered. Therefore, although the production has taken place, it has not resulted in payments from the Defense Department, and it has not reduced the stock of unpaid obligations outstanding. To the extent that the defense firm views this unpaid production as a reduction in unfilled orders and as having satisfied the demand of the Defense Department, the stock of unpaid obligations outstanding overstates unfilled orders and unfulfilled demand.

The second compromise to the theoretical interpretation of unpaid obligations outstanding results from the distinction between firm obligations on defense procurement contracts and potential obligations on these contracts. The amount of firm obligations on a contract when it is definitized may be significantly less than the amount of obligations which are ultimately placed on this contract.[1] As obligations affect the level of unpaid obligations outstanding, the latter may also be understated in the early months of a contract's life.[2]

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[1] See page 38.

[2] This phenomenon helps explain the bell shaped curve for unpaid obligations outstanding in Figure B. If the full amount of obligations were placed on the contracts at the time of definitization, unpaid obligations outstanding would be plotted as a downward slopping curve.

The potential disagreement between the firm level of unpaid obligations outstanding and the potential level of this variable raises the theoretical question of whether the contractor responds to changes in the firm level of unfilled orders or to changes in the potential level of unfilled orders. It will be assumed in this study that the contractor is most influenced by the level of firm orders. This assumption is conceptually attractive because it attributes the greatest weight to the known amount of orders or obligations, and the least weight to the unknown amount of orders. This assumption is empirically attractive because efforts to forecast potential changes in orders and the value of defense procurement contracts have been singularly unsuccessful.

BEHAVIOR PATTERN OF AGGREGATED SAMPLE DATA

The previous chapter indicated that the existing Government data series do not afford accurate measurements of the economic impact of defense procurement activity. It was further suggested that, in general, obligations by the Government preceed production on defense procurement contracts while payments and deliveries succeed production. It was stated, however, that previous efforts, most notably those of Weidenbaum and Galper, had not been able to determine the exact relationships between these variables because of the absence of objective data on the production of defense procurement contracts. One of the points of departure in this study is the construction of production data for a sample of 51 contracts.

The general relationships among the aggregate values for obligations, production, payments and deliveries on the sample contracts are shown graphically in Figure C. All of these values are time phased according to the actual year and month of observation. As a rough measure, obligations lead production by about six months while payments and deliveries lag production by about two months and six months respectively.

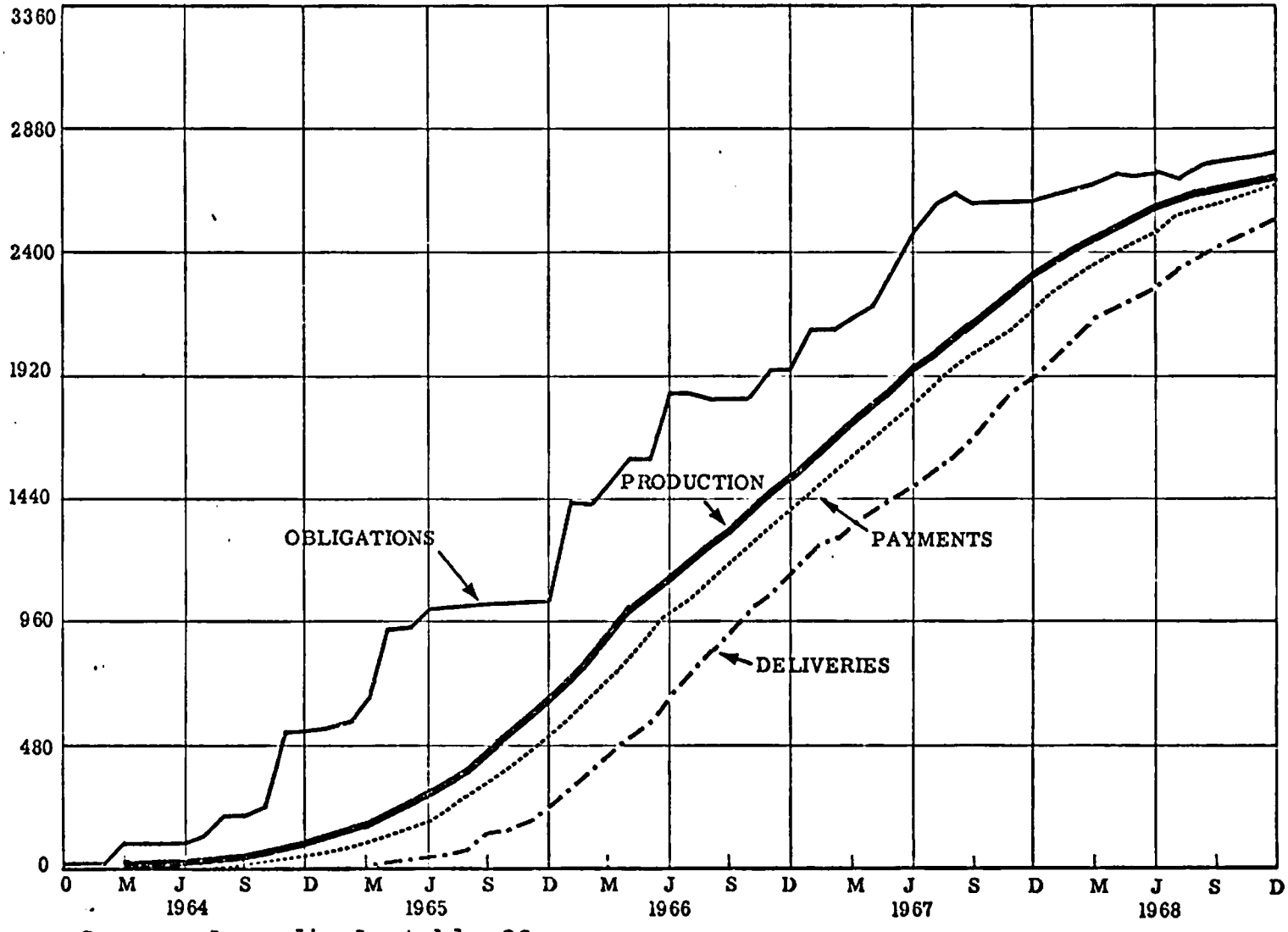
A more meaningful measure of the adequacy of Government payments and deliveries data for the measurement of the defense production or economic impact of the sample contracts is to compute the cumulative difference between production and payments or deliveries. Production minus payments could be labeled "unpaid production." Similarly, production minus deliveries could be labeled "undelivered production."

The values for unpaid and undelivered production indicate the amount of production which has occurred in the private economy but which has not yet been recorded in the Government's data series for payments and deliveries. These values further indicate the amounts by which the economic impact of new procurement contracts was understated in the consolidated cash budget and the national income and product accounts budget during the early months of the Vietnam buildup.

The cumulative difference between production and payments (unpaid production) and between production and

COMPARISON OF OBLIGATIONS, PRODUCTION, PAYMENTS AND DELIVERIES FOR ALL SAMPLE CONTRACTS BETWEEN 1964 AND 1968

Figure C



Source: Appendix A, table 22.

deliveries (undelivered production) over the full lives of the sample contracts is shown in Figure D. All of the contracts are begun at a hypothetical month zero and continued for 40 consecutive months.[1]

In general, Figure D indicates that production exceeds both payments and deliveries for the first 20 months of the contracts' lives and payments and deliveries exceed production over the remaining 20 months. At the end of 20 months of activity on the sample contracts, cumulative production on the sample contracts exceeds cumulative payments by about $335 million or 11 percent of total obligations for the sample and exceeds cumulative deliveries by approximately $950 million or 34 percent of total obligations.

The above results indicate that at the end of the 20th month after the sample contracts began, about one half of the final value of the contracts had been produced. At the same point in time, however, only about three-eighthsof the final value had been reflected in the Government's data series on payments (consolidated cash budget) and only about one-sixth had been reflected in the Government's data series on deliveries (Federal sector of national income and product accounts).

A more precise presentation of the relationship between the age of the contracts in the sample and the

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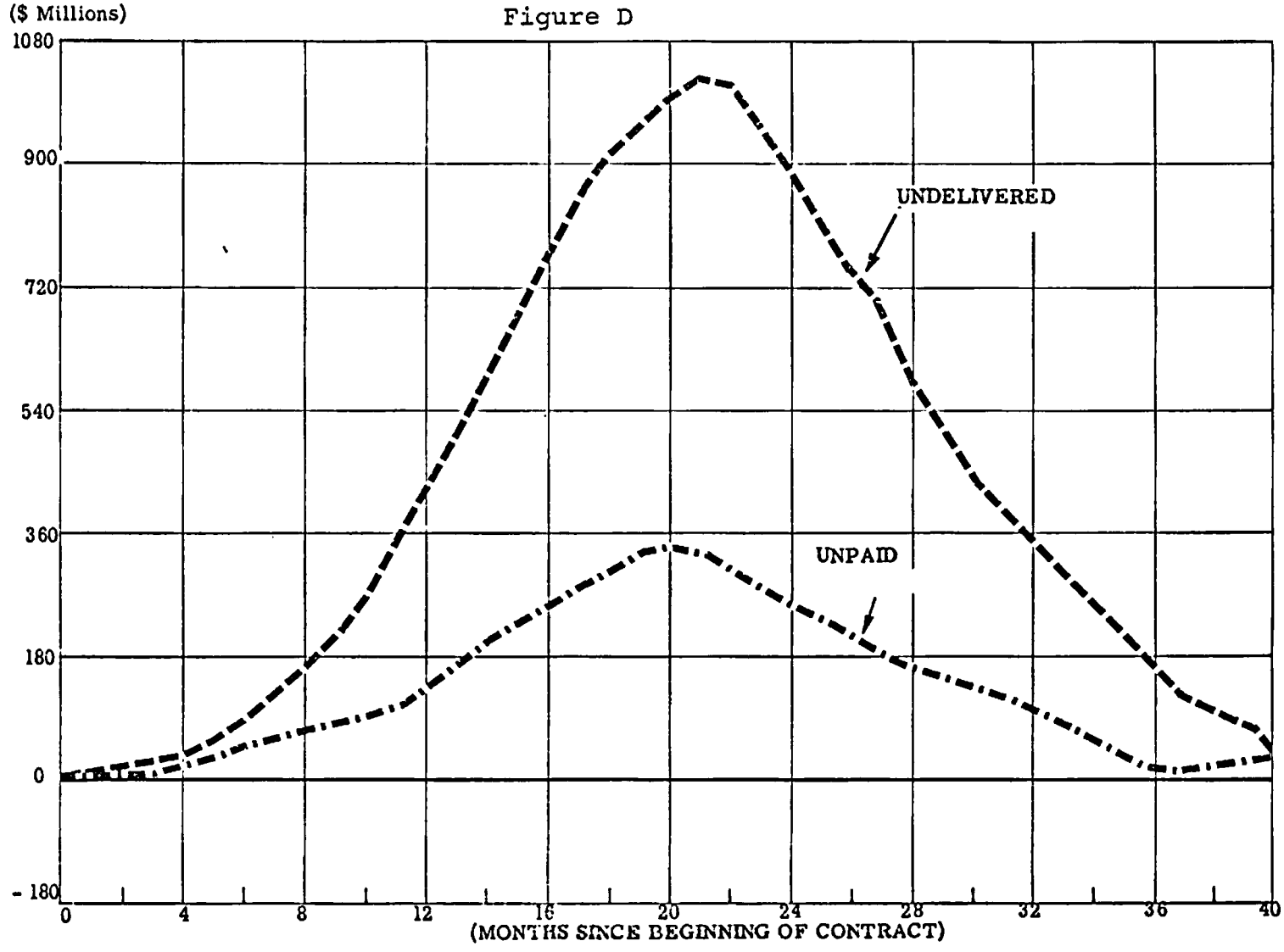
[1]It was found that, on the average, contracts in the sample were 100 percent complete in 40.4 months after they began.

COMPARISON OF CUMULATIVE DOLLAR VALUES FOR UNBILLED, UNPAID AND UNDELIVERED PRODUCTION: ALL SAMPLE CONTRACTS (3-MONTH MOVING AVERAGE)

Figure D



Source: Appendix A, table 22.

levels of unpaid and undelivered production is shown in Table 9. This table indicates that by the end of the first year of activity on a contract, on the average, about eight percent of the final contract value is produced but not paid for (or recorded in the Government's payment series) and approximately 19 percent is produced but not delivered (or recorded in the national income and product accounts).

Similarly, by the end of the second year after a contract begins, on the average, about 12 percent of the total contract is produced but not paid for and about 32 percent is produced but not delivered. From the end of the second year until completion of the contract, the levels of unpaid and undelivered production decline toward zero.

SUMMARY

The comparisons made in this chapter between production, payments and deliveries on the sample contracts confirms the thesis that the current Government data do not measure accurately the economic impact of defense procurement activity. This situation is particularly true during a period when the level of defense procurement activity is changing. During a defense buildup, the prevalent characteristic would be the letting of many "new" contracts while in a defense slowdown the prevalent characteristic would be the phasing out of many "old" contracts.

TABLE 9

RELATIONSHIP BETWEEN AGE OF CONTRACTS IN THE SAMPLE AND CUMULATIVE VALUES FOR UNPAID AND UNDELIVERED PRODUCTION

Age of Contracts (Months)	Cumulative Unpaid Production (% of Final Obligations)		Cumulative Undelivered Production (% of Final Obligations)	
Mean	Mean	Std.Dev.	Mean	Std.Dev.
3.51	0.003	0.006	0.005	0.007
6.81	0.026	0.019	0.041	0.019
8.48	0.047	0.033	0.088	0.032
9.25	0.064	0.051	0.130	0.046
10.51	0.071	0.047	0.172	0.061
11.96	0.080	0.052	0.190	0.092
13.49	0.084	0.047	0.229	0.110
14.23	0.094	0.041	0.271	0.121
15.06	0.106	0.064	0.299	0.142
15.96	0.118	0.063	0.309	0.166
17.00	0.126	0.087	0.309	0.179
19.43	0.113	0.061	0.327	0.185
19.86	0.112	0.100	0.338	0.217
21.68	0.106	0.091	0.349	0.228
22.07	0.126	0.104	0.345	0.225
23.50	0.116	0.125	0.319	0.259
25.12	0.096	0.102	0.313	0.253
30.23	0.067	0.097	0.212	0.231
31.24	0.058	0.092	0.173	0.223
33.57	0.034	0.084	0.089	0.159
40.40	0.012	0.030	0.024	0.060

Source: Computed by author from data collected on 51 sample contracts.

In a defense buildup, the findings in this chapter indicate that defense payments and deliveries underestimate defense production for up to 20 months after the "new" contracts are awarded. This would suggest that the economic impact of the large increase in defense contracts in mid-1965 was underestimated by the Government data until sometime in the first half of 1967.

In a defense slowdown, the findings indicate that defense payments and deliveries overestimate defense production for a comparable period of time. These findings would further suggest that a sharp decline in defense procurement contracts in the first half of 1969 will result in the Government data overestimating defense economic impact until sometime early in 1971.

CHAPTER IV

ANALYSIS OF CONTRACTOR BEHAVIOR

INTRODUCTION

In this chapter, the behavior of defense contractors is analyzed in order to develop a statistical model to estimate changes in production which result from changes in demand for defense procurement items. The model which is developed attempts to describe the aggregate response of defense contractors to fluctuations in the level of demand for their output. The value to be estimated is the production on defense procurement contracts. The measure of production has been previously defined (in Chapter III) as being equal to all costs incurred in the process of production plus the profits on the contracts distributed at the time of delivery.

The demand which is considered to influence the rate of production on procurement contracts is the "effective demand" for procurement items. Effective demand is usually defined as demand for output backed by the ability to pay for that output. For this study, demand is measured by the stock of public funds committed by the Department of Defense to the purchase of procurement items

at a point in time. No attempt is made to explain how the stock of funds, or level of demand for defense procurement items, is determined. The purpose of this chapter is to develop a theoretical explanation of how changes in the level of demand affects the rate of production.

PREMISES OF MODEL

The Role of Effective Demand

The first premise of the model is that the rate of production related to defense procurement activity is determined largely by the level of demand for defense procurement items and changes in this level over some specific period of time. It is further assumed that the relationship between production and demand is stable over time. Finally, it is assumed that production decisions are based upon a given level or rate of demand similar to the situation in a perfectly competitive market.

Effective demand for defense procurement items can be measured best by the level of "unpaid obligations outstanding" for procurement. Unpaid obligations outstanding is a stock of funds committed to the purchase of defense procurement items upon their production. This stock is increased when new obligations are incurred, and is decreased when payments are made from these funds. As discussed in Chapter III, unpaid obligations outstanding may be thought of as the unfulfilled demand of the Department of Defense. The production of defense contractors takes place in order to satisfy this unfulfilled demand.

Contractor Behavior

The second premise of the model is that defense contractors, in the aggregate, attempt to maintain their production at some optimum ratio to unfulfilled demand, or unpaid obligations outstanding.[1] That is to say, contractors attempt to produce in any month some optimum percentage of the amount of unfulfilled demand in that month. It is suggested that this optimum ratio between current production and existing demand is determined primarily by technological and managerial considerations on the part of the defense contractors. The consideration and decisions which go into the determination of the optimum production rate are exogeneous to the model and may be assumed in the short run to be constant.[2]

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[1]The ratio to be maintained between production and unfulfilled demand is optimum in that it maximizes the profits of defense firms by smoothing out, over the long term, the level of production in defense industries and by minimizing, over the long term, fluctuations in the labor requirements of the defense industries.

[2]It is recognized that the optimum rate may not be constant over a long period of time. For example, a shift in the objective function of Defense Department managers which places greater emphasis on less expensive weapons and less emphasis on rapid delivery would be expected to reduce the optimum production rate. It is assumed, however, that the assumption of a constant optimum production rate over a relatively short period of time is not sufficiently unrealistic to distort the analysis.

IDEALIZED BEHAVIOR OF INDIVIDUAL DEFENSE FIRM

Theoretical Analysis

The formulation of a statistical model to explain the aggregate response of defense firms to changes in unfulfilled demand begins by analyzing the "idealized" or "normal" behavior of a single defense firm. This analysis is undertaken in order to enhance understanding of the aggregate model. It should be noted that although many of the assumptions required for the analysis in this section are necessarily restrictive, the results and conclusions presented are not considered unrealistic.

The analysis begins by assuming that the firm has no outstanding defense contracts, i.e. its production on defense contracts is zero. In month "1", the firm receives a single defense contract award.[1] The contract award is for a given amount of procurement items which are to be produced and delivered to the Department of Defense within a specified period of time.

It is now assumed that based upon previous experience, the contractor knows that its profits will be maximized by producing on the contract at a specified,

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[1]A contract award to a defense contractor is synonomous with new obligations to the DOD.

but not necessarily constant, rate during each month of the life of the contract. That is to say that when the contractor receives a contract award, a specified percentage of the contract is produced in the first month, another percentage in the second month, and so on until the total amount of the contract has been produced.

Given the above assumptions, the idealized production path of the single defense firm on a new contract award can be presented as follows:

(a) $q_1 = A_1 CA$

$q_2 = A_2 CA$

$q_3 = A_3 CA$

.

.

.

$q_n = A_n CA$

where

q_1 = Production by the defense firm in the month of the contract award. (q_2, q_3, etc. equal production by the defense firm in each successive month after the contract award)

A_1 = Percentage of the contract award produced in the month of the award. (A_2, A_3, etc. equal percentage of the contract award produced in each successive month after the contract award)

CA = Value of the contract award.

n = Number of months required to produce all of the contract award.

A constraint to the above set of equations is required. Since the total production at the end of n months must equal the amount of the contract award, then the sum of the percentages of the contract produced in each of the n months must equal 100 percent of the contract award. That is to say

$$\text{(b)} \qquad \sum_{i=1}^{n} A_i = 1$$

It is now assumed that the defense firm produces on all contract awards at the same, but not necessarily constant, monthly rates. That is to say that when the firm receives a contract award, he always produces a specific percentage of the contract in the first month, another percentage in the second month and so on until the contract is completely produced in the n month after it was received. For purposes of simplification, it is further assumed that these percentages are independent of such factors as the size or type of contract or whether the contract award is a new contract or a modification to an existing one.

It is next assumed that the firm has no outstanding defense contracts, receives a contract award in month 1 and receives a new contract award of the same size in each subsequent month after month 1. These assumptions suggest that the monthly production of the firm on these contract awards in month 1 and subsequent months can be presented as follows:

(c) $q_1 = A_1\ CA$

$q_2 = A_2\ CA + A_1\ CA$

$q_3 = A_3\ CA + A_2\ CA + A_1\ CA$

.

.

.

.

$q_n = A_n\ CA + A_{n-1}\ CA + A_{n-2}\ CA + \ldots + A_1\ CA$

The last equation can be reduced to

(d) $q_n = \sum_{i=1}^{n} A_i\ CA$

As it has been previously specified that $\sum_{i=1}^{n} A_i = 1$, then in month n and each subsequent month the rate of production by the defense firm in each month equals the amount of the contract award for that month. This relationship further indicates that in month n and each subsequent month, the amount of unproduced contract awards, i.e., $\sum_{i=1}^{n} CA_i - \sum_{i=1}^{n} q_i$, is constant and hence the ratio between the rate of production and the level of unproduced contract awards, i.e., $\frac{q_n}{\sum_{i=1}^{n} (CA_i - q_i)}$, is constant. These relationships are maintained as long as the rate of contract awards does not change.

It is further hypothesized that when the defense firm's rate of production equals the rate of contract awards and is a constant ratio of unproduced contract awards, the firm is in equilibrium. It is also assumed that the ratio between production and unproduced contract

awards when the firm is in equilibrium equals the "optimum" rate of production. Finally, it is assumed that the Department of Defense reimburses the firm on the basis of production and, therefore, unproduced contract awards, $\sum_{i=1}^{n} (CA_i - q_i)$, equals unpaid obligations outstanding for the defense work of this firm and will be designated as upo_i. That is to say

$$(e) \qquad upo_i = \sum_{i=1}^{n} (CA_i - q_i)$$

where

upo_i = Unpaid obligations outstanding on the aggregated defense contracts of the individual defense firm in month i.

Illustrative Analysis

In this section the idealized response of a defense firm to changes in the rate and level of demand for his output is analyzed in terms of some simple examples. The analysis begins by assuming that the defense firm produces the total amount of all contract awards in ten months (n = 10) and that the contractor follows a "uniform" production path[1] on each contract. These assumptions suggest that the production rate of the single defense firm for any given month could be specified for illustrative purposes as follows:

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[1]The production path is uniform in that equal percentages of the contract are produced in the months equidistant from the mid-point of the total production life of the contract.

$$(f) \quad q_i = 0.03\ CA_i + 0.06\ CA_{i-1} + 0.10\ CA_{i-2} + 0.14\ CA_{i-3} + 0.17\ CA_{i-4} + 0.17\ CA_{i-5} + 0.14\ CA_{i-6} + 0.10\ CA_{i-7} + 0.06\ CA_{i-8} + 0.03\ CA_{i-9}$$

The above equation is synonomous with saying that the firm produces three percent of a contract award in the first month, six percent in the second month and so on until the contract is fully produced at the end of ten months.

It is now assumed that the defense firm has no outstanding defense contracts and receives a $100 contract award. The production pattern achieved by using equation (f) is shown in Table 10.

TABLE 10

ILLUSTRATIVE PRODUCTION PATH ON SINGLE CONTRACT AWARD

Month (i)	q_i	CA_i	upo_i
1	3	100	97
2	6	0	91
3	10	0	81
4	14	0	67
5	17	0	50
6	17	0	33
7	14	0	19
8	10	0	9
9	6	0	3
10	3	0	0

Table 10 indicates that the monthly production of the individual defense firm on a single contract builds up to a peak in the fourth and fifth months and then declines until the contract award is fully produced in the tenth month.[1] As only a single contract award is received, the ratio between monthly production, q_i, and unpaid obligations outstanding, upo_i, declines to zero after the tenth month. At the end of the tenth month, total production equals the amount of the initial contract award and production ceases.

Now it is assumed that the contractor has no outstanding defense contracts and receives a continuous monthly stream of $100 contract awards. The production pattern achieved by using equation (f) is shown in Table 11.

In the ten months after receipt of the first contract award, the rate of production and the ratio between monthly production and the level of unpaid obligations outstanding increases. Beginning with the tenth month, monthly production equals monthly contract awards and the ratio between monthly production and the level of unpaid obligations outstanding is constant.

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[1]The same general pattern of production was observed on the 51 sample contracts. In the aggregate, the rate of production on these contracts increased for the first 16 months of contract activity, stayed near the peak for the next four months, and then declined toward zero for the final 16 months.

TABLE 11

ILLUSTRATIVE PRODUCTION PATH WHEN RATE OF CONTRACT AWARDS IS CONSTANT

Month (i)	q_i	CA_i	upo_i	q_i/upo_i
1	3	100	97	0.0309
2	9	100	188	0.0479
3	19	100	269	0.0706
4	33	100	336	0.0982
5	50	100	386	0.1295
6	67	100	419	0.1599
7	81	100	438	0.1849
8	91	100	447	0.2036
9	97	100	450	0.2156
10	100	100	450	0.2222
11	100	100	450	0.2222
12	100	100	450	0.2222

It has been previously stated that when these conditions are satisfied, i.e., $q_i = CA_i$ and $\frac{q_i}{upo_i} = k$, the defense firm is in equilibrium.

When the defense firm is in equilibrium, monthly production can be estimated by the following equation:

(g) $\dot{q}_i = a^* upo_i$

where

q_i = Production by the defense firm in month i

upo_i = Unpaid obligations outstanding in month i, or $\sum_{i=1}^{n} (CA_i - q_i)$

a* = Ratio of production to unpaid obligations outstanding when the defense firm is in equilibrium.

In the example above, a* equals 0.2222.

It has been shown that if the firm produces on each contract at a specified proportion in each month of the life of the contract and if the firm receives a constant rate of contract awards, the firm's production rate will stabilize at a fixed and optimum ratio to the level of unpaid obligations outstanding. When this condition is achieved, the firm is in equilibrium.

The analysis now considers the behavior of the firm when the rate of contract awards is changed and the firm is temporarily in disequilibrium. It is assumed that after receiving a continuous stream of monthly contract awards of equal size for 20 months, the rate of monthly contract awards is doubled in the 21st month. The expected production pattern from this change is shown in Table 12.

The results in Table 12 indicate that in the first ten months after the doubling in the rate of contract awards, the rate of production increases until it is twice the previous equilibrium level and once again equals the rate of contract awards. The level of unpaid obligations outstanding also increases for ten months until it is

TABLE 12

ILLUSTRATIVE PRODUCTION PATH WHEN RATE OF CONTRACT AWARDS IS DOUBLED

Month (i)	q_i	CA_i	upo_i	q_i/upo_i
10-20	100	100	450	0.2222
21	103	200	547	0.1883
22	109	200	638	0.1708
23	119	200	719	0.1655
24	133	200	786	0.1692
25	150	200	836	0.1794
26	167	200	869	0.1922
27	181	200	888	0.2038
28	191	200	897	0.2129
29	197	200	900	0.2189
20	200	200	900	0.2222
31-40	200	200	900	0.2222

twice the previous equilibrium level. As a result of different rates of change in the increases in production and in the level of unpaid obligations outstanding, the ratio between these two values at first declines and then increases. However, as both the rate of production and the level of unpaid obligations outstanding doubled at the end of ten months, the optimum ratio between these two values is once again obtained.

The specific example shown in Table 12 suggests the more general case where production increases when the level of unpaid obligations outstanding increases, but at a somewhat slower rate, and where production decreases

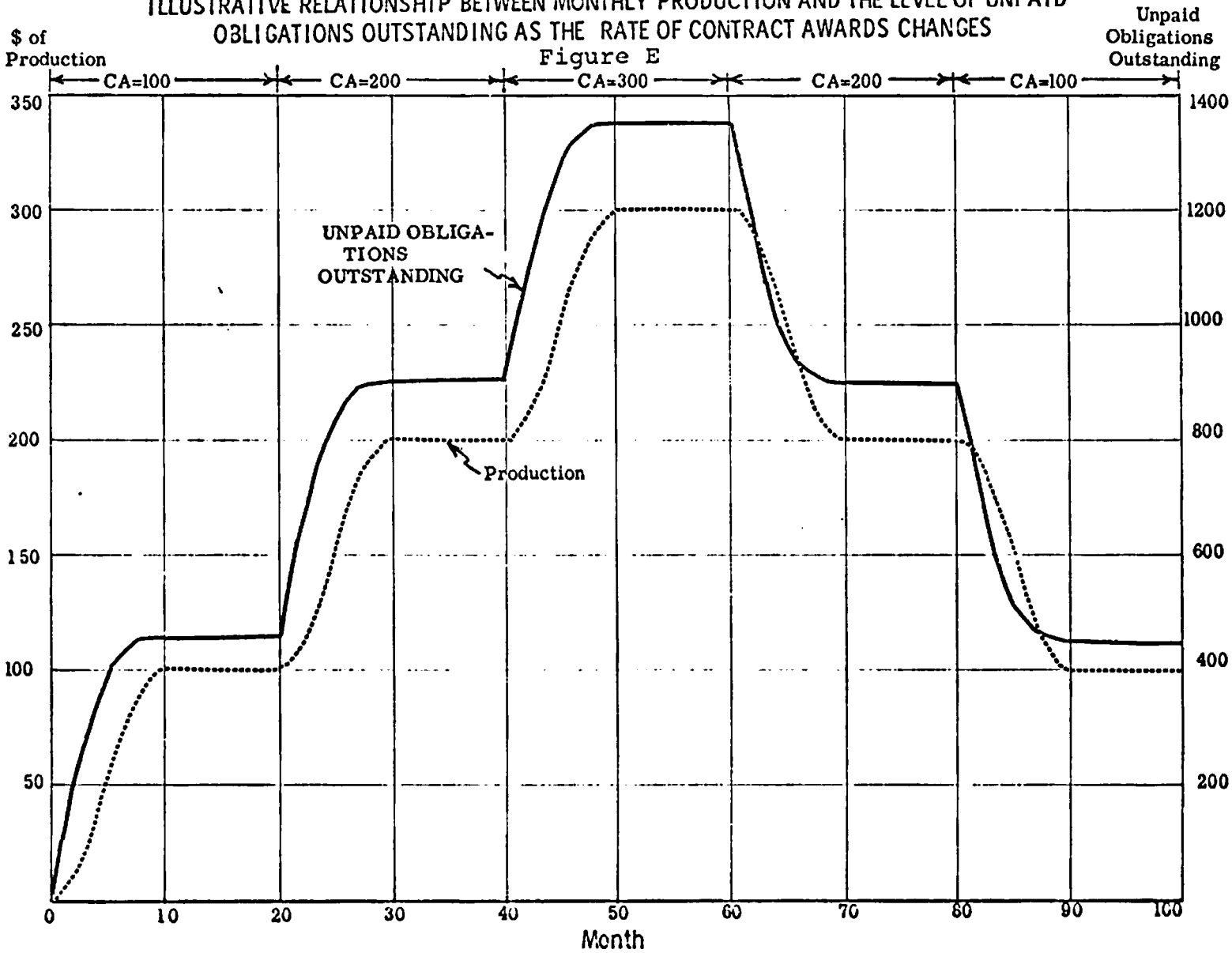
when the level of unpaid obligations outstanding decreases, but again at a somewhat slower rate. The more general relationship between the rate of production and the level of unpaid obligations outstanding during increases and decreases in the rate of contract awards is shown in Figure E. It should be noted that the scale for monthly production in Figure E is one fourth the scale for unproduced contract awards, or unpaid obligations outstanding.

The relationships shown in Figure E further suggest specific response patterns for the ratios between q_i and upo_i when the rate of contract awards is altered. These response patterns are shown in Figure F. Figure F indicates that when the rate of contract awards is increased, the ratio between the rate of production and the level of unpaid obligations outstanding at first declines and then rises until the previous optimum ratio is reestablished. Conversely if the rate of contract awards declines, this ratio at first rises and then declines until the previous optimum ratio is reestablished.

Figure F also indicates that the response patterns of the ratio between monthly production and the level of unpaid obligations outstanding is influenced by the rate at which contract awards is changed. This ratio, for example, drops more sharply when contract awards is doubled from 100 to 200 (month 20) than when contract awards is increased by one-half from 200 to 300 (month 40). Similarly, the ratio between monthly production and the level of

ILLUSTRATIVE RELATIONSHIP BETWEEN MONTHLY PRODUCTION AND THE LEVEL OF UNPAID OBLIGATIONS OUTSTANDING AS THE RATE OF CONTRACT AWARDS CHANGES

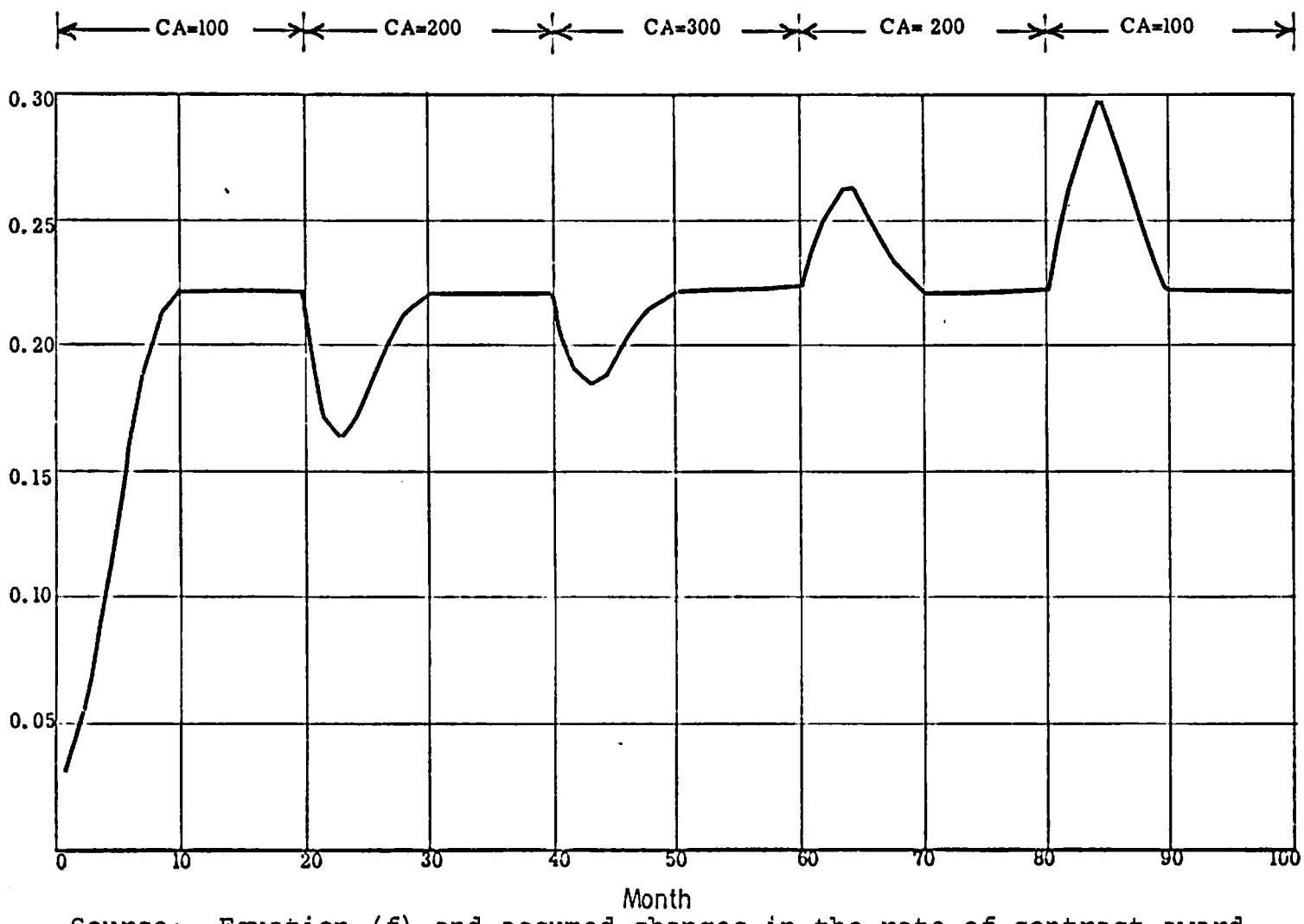
Figure E



Source: Equation (f) and assumed changes in the rate of contract awards.

RESPONSE PATTERN OF RATIO OF MONTHLY PRODUCTION TO LEVEL OF UNPAID OBLIGATIONS OUTSTANDING AS THE RATE OF CONTRACT AWARDS CHANGES

Figure F



Source: Equation (f) and assumed changes in the rate of contract award.

unpaid obligations outstanding rises more sharply when contract awards is halved from 200 to 100 (month 80) than when contract awards are reduced by one-third from 300 to 200 (month 60).

The rate of change in contract awards affects the response pattern of the ratio between production and unpaid obligations outstanding by affecting changes in the level of unpaid obligations outstanding. Therefore, it can be said that the difference between the equilibrium ratio of q_i to upo_i and the actual ratio during the ten month adjustment period after a change in the rate of contract awards is some function of the changes in unpaid obligations outstanding. This analysis would indicate a function for the rate of production when the rate of contract awards is changing of the following nature:

(h) $$q_i = a^* upo_i + a_1 \Delta upo_i + a_2 \Delta upo_{i-1} + \cdots + a_{10} \Delta upo_{i-9}$$

Equation (h) indicates that the current rate of production is equal to the equilibrium ratio of the current level of unpaid obligations outstanding plus or minus certain adjustments resulting from changes in the level of unpaid obligations outstanding during the previous ten months. The examples shown in Figure F indicate that when the level of unpaid obligations outstanding is increasing, the actual ratio between q_i and upo_i will be below the optimum ratio and when the level of unpaid obligations outstanding is decreasing, the actual ratio of

q_i to upo_i will be above the optimum ratio. These relationships would further indicate that the signs of the adjustment coefficients in equation (h) will be negative.

The actual values for the adjustment or reaction coefficients, a_1, a_2, etc., can be estimated for the example shown in Table 12 where the rate of contract awards is doubled in the 21st month.

These values are computed, for example, by taking the values in the 21st month for production (103), for the level of unpaid obligations outstanding (547) and for the change in unpaid obligations outstanding (97) and estimating equation (h). As the changes in unpaid obligations outstanding for all months other than the current month equal zero, equation (h) would be specified as follows:

(i) $$103 = 0.2222\ (547) + a_1(97) + a_2\ (0) + a_3\ (0) + \ldots + a_{10}\ (0)$$

The same procedure used in estimating a_1 is used for the 22nd through 30th months consecutively to obtain estimates for a_2 through a_{10}. The results from this estimation procedure are shown in Figure G. This figure indicates that a change in the level of unpaid obligations outstanding has its greatest affects on the rate of production in the month of the change and the subsequent three or four months. After the fourth month, the adjustment in production as a result of the change is largely completed and the subsequent affects approximate zero.

ESTIMATES OF REACTION COEFFICIENTS
FOR UNIFORM PRODUCTION PATH

Figure G

Source: Equation (h) and data in table 12.

One final illustrative example should prove useful in understanding the model which is to be developed to estimate aggregate changes in production by many defense firms. Thus far all of the illustrations have assumed a uniform production path. There are two logical deviations from the uniform production path. First, the contractor could build up to his peak production very quickly and then slowly reduce the rate back toward zero as the contract is being completed. This type of response by the contractor could be labeled a "skewed to the right" production path. Second, the contractor could build up to his peak production rate ery slowly and then let his production rate fall sharply as the contract nears completion. This type of response by the contractor could be labeled a "skewed to the left" production path.

A skewed to the right production path would result from the equation

(j) $$q_i = 0.05\ CA_i + 0.08\ CA_{i-1} + 0.13\ CA_{i-2} + 0.17\ CA_{i-3} + 0.20\ CA_{i-4} + 0.15\ CA_{i-5} + 0.10\ CA_{i-6} + 0.07\ CA_{i-7} + 0.04\ CA_{i-8} + 0.01\ CA_{i-9}$$

and a skewed to the left production path would result from the equation

(k) $$q_i = 0.01\ CA_i + 0.04\ CA_{i-1} + 0.07\ CA_{i-2} + 0.10\ CA_{i-3} + 0.015\ CA_{i-4} + 0.20\ CA_{i-5} + 0.17\ CA_{i-6} + 0.13\ CA_{i-7} + 0.08\ CA_{i-8} + 0.05\ CA_{i-9}$$

These two equations were used to estimate the equilibrium ratio between production and unpaid obligations outstanding and to estimate the reaction coefficients for changes in upo_i for a skewed to the right and a skewed to the left production path. The results of these derivations are compared with the earlier values for the uniform production path in Table 13.

TABLE 13

ESTIMATES OF EQUILIBRIUM PRODUCTION RATIO AND REACTION COEFFICIENTS IN EQUATION (h) FOR ILLUSTRATIVE UNIFORM, SKEWED TO THE RIGHT AND SKEWED TO THE LEFT PRODUCTION PATHS

Equilibrium Production Ratio and Reaction Coefficients	Uniform Production Path	Skewed to the Right Production Path	Skewed to the Left Production Path
α^*	0.2222	0.2564	0.1961
α_1	-0.1921	-0.1995	-0.1861
α_2	-0.1573	-0.1716	-0.1552
α_3	-0.1131	-0.1047	-0.1230
α_4	-0.0599	-0.0428	-0.0883
α_5	-0.0109	+0.0200	-0.0306
α_6	+0.0175	+0.0083	+0.0370
α_7	+0.0152	-0.0002	+0.0286
α_8	+0.0098		+0.0170
α_9	-0.0009		-0.0002

The results shown in Table 13 indicate that the skewed to the right production path has a higher equilibrium ratio of production to the level of unpaid obligations outstanding than does the skewed to the left production path. These computations also indicate that the skewed to the right production path results in a more rapid reaction to changes in the rate of contract awards and in the level of unpaid obligations outstanding than does the skewed to the left production path. In all cases, the most significant reaction of production to changes in the level of unpaid obligations outstanding takes place within the first three to four months and the reaction becomes very small by the seventh month for the skewed to the right production path and by the ninth month for the uniform and skewed to the left production path.

AGGREGATE BEHAVIOR OF DEFENSE FIRMS

In order to develop a statistical model which will explain the aggregate response of defense firms to fluctuations in the level of demand for their output, it is now necessary to generalize the analysis in the previous section. This is done by hypothesizing that the idealized behavior observed in the previous section represents a central tendency of behavior for all defense firms. It is further

hypothesized that deviations from this idealized behavior are caused by a sufficiently large number of factors that a normal distribution is generated around the mean of behavior with the sum of deviations from this mean equal to zero.

The above hypotheses will be valid if the behavioral results observed on the aggregate of contract awards of the individual firm are similar to the results observed on an aggregate of awards selected from many firms. The single firm has a continuous stream of awards and adjusts his production rate to some optimum ratio to the level of unpaid obligations outstanding on those awards. Similarly the selection of contract awards from many firms over different periods would also represent a stream of awards and it would be expected that, if the sample is sufficiently large and sufficiently random, an optimum relationship between the rate of production and the level of unpaid obligations on these awards would also be observed. This conclusion only indicates that when an aggregate of contracts from many firms is averaged into a "typical contract," the pattern of behavior which would be observed would be expected to fit the idealized pattern of behavior developed in the previous section.

This indicates that the profit maximizing behavior for the individual firm would be expected to prevail for aggregates of defense firms. In the aggregate, these firms adjust their production in response to changing levels of demand in order to retain their labor forces, optimize on their use of capital and other resources, and smooth out their production over the long run. These considerations would be expected to cause defense firms in the aggregate to tend to keep their aggregate rate of production at some optimum ratio to the level of aggregate unpaid obligations outstanding. Based upon this expectation, a model is developed in the next section which explains the aggregate response of defense firms to changes in the level of aggregate demand for their output.

Formulation of Equations to Explain Aggregate Behavior

Using the symbol Q_t for aggregate production in month t, and UPO_t for aggregate unpaid obligations outstanding, or unfulfilled demand, on defense contracts in month t, it is hypothesized that:

(1) $$Q_t = \alpha^* UPO_t$$

where α^* is the optimum rate at which defense contractors produce to satisfy demand and is a constant. This equation is similar to equation (g), $q_i = a^* upo_i$, for the idealized behavior of the individual firm.

If UPO_t did not change from month to month, i.e., if obligations incurred equaled payments made during each month, it is expected that this naive model would explain

the rate of aggregate production on defense procurement items. If the level of demand were stable, it would be expected that defense contractors would maintain a rate of production which is a constant and an optimum percentage of that demand, with only random and offsetting disturbances from all other factors. A condition where: (1) effective demand, or UPO, is stable; and, (2) production is at the optimum ratio to demand represents a condition of equilibrium in the model.

A change in the level of UPO, or unfulfilled demand, temporarily creates a condition of disequilibrium. If the level of demand is increased, the existing rate of production is temporarily below the optimum rate. If effective demand is decreased, the existing rate of production is temporarily above the optimum rate.

It is assumed that contractors respond to a change in effective demand by adjusting their production toward the new optimum level. This adjustment, however, is not instantaneous but takes time. The delay in obtaining the optimum rate results from the managerial and administrative difficulties in changing the size of the labor force, the stocks of various inventories and the amounts of other factors of production.

An important question is how swiftly aggregate production responds to the new level of aggregate demand and regains its optimum position. If UPO increases during t+1, it is hypothesized that Q also increases in month t+1, but not enough to reachieve the new optimum relationship.

Instead, production in month t+1, and perhaps for several months thereafter, continues to be below the optimum rate. Conversly, a decrease in demand results in a decrease in production; but for the month of the adjustment and some months thereafter production is above the optimum rate.

If the model is to explain the rate of production during periods of changing defense activity, it clearly must be able to explain the rate of change in production in response to a change in effective demand. That is to say, it must be able to explain the path to a new equilibrium condition after a change in effective demand creates a condition of disequilibrium. The equilibrium condition specified in

(l) $Q_t = \alpha^* UPO_t$

can now be modified so that the actual rate of production is expressed by

(m) $Q_t = \alpha_o UPO_t$

where α_o is the actual ratio of production to demand for month t.

The actual ratio of production to demand, α_o, does not equal the optimum ratio, α^*, when a condition of disequilibrium exists. A condition of disequilibrium exists because the level of unfulfilled demand is changing. It is assumed that if the level of UPO, or unfulfilled demand, is changing modestly, the actual ratio of production to demand will differ only slightly from the optimum ratio. Conversely, it is assumed that if the level of UPO

is changing greatly, the difference between α_o and α^* will be great. These assumptions are supported by the analysis of the idealized behavior of the single firm in the previous section.

The above analysis further suggests that the difference between α^* and α_o is determined by changes in the level of demand. As α_o and α^* are both related to the current level of demand, it can be further suggested that the difference between α_o and α^* is determined by changes in demand as a percent of the current level of demand.

This leads to the following formulation

$$\alpha_o - \alpha^* = f\left[\frac{(\Delta UPO_t)}{(UPO_t)}, \frac{(\Delta UPO_{t-1})}{(UPO_t)}, \ldots \frac{(\Delta UPO_{t-n})}{(UPO_t)}\right]$$

where ΔUPO_t equals the change in unpaid obligations for month t and where the length of the adjustment process is not specified, that is to say where the number of months required to reachieve equilibrium is not specified.

Adding α^* to both sides of the above equation gives

$$(n) \qquad \alpha_o = \alpha^* + f\left[\frac{(\Delta UPO_t)}{(UPO_t)}, \frac{(\Delta UPO_{t-1})}{(UPO_t)}, \ldots \frac{(\Delta UPO_{t-n})}{(UPO_t)}\right]$$

By assuming that the adjustment function is linear, one obtains

$$(o) \qquad \alpha_o = \alpha^* + \alpha_1 \frac{\Delta UPO_t}{UPO_t} + \alpha_2 \frac{\Delta UPO_{t-1}}{UPO_t} + \ldots + \alpha_{n+1} \frac{\Delta UPO_{t-n}}{UPO_t}$$

where the coefficients $\alpha_1, \alpha_2, \ldots \alpha_{n+1}$ are the adjustment, or reaction, coefficients which coordinate the lag between changes in the level of demand and the return of production to its equilibrium position. It is expected that the coefficients $\alpha_1, \alpha_2, \ldots \alpha_{n+1}$ will have negative signs and will deteriorate in value (approaching zero) as the lag becomes greater. It should be pointed out that when the level of effective demand is constant, where $\Delta UPO_t = \Delta UPO_{t-1} = \ldots \Delta UPO_{t-n} = 0$, the original model (equation (1)) and the model just formulated are equal, for then $\alpha_o = \alpha^*$.

As was suggested earlier, it is expected that during the transition period of a defense buildup, the rate of production will be a smaller proportion of demand than the optimum proportion ($\alpha_o < \alpha^*$), but will be moving toward the optimum; and, in a defense phasedown the reverse process will exist.

Since α_o cannot be observed directly in the data, and since the objective is to estimate the rate of production and not the ratio, the formulation of α_o in (o) is substituted for α_o in (m) to give

$$(p) \qquad Q_t = \left[\alpha^* + \alpha_1 \frac{\Delta UPO_t}{UPO_t} + \alpha_2 \frac{\Delta UPO_{t-1}}{UPO_t} + \ldots \alpha_{n+1} \frac{\Delta UPO_{t-n}}{UPO_t}\right] UPO_t$$

After multiplication of terms, (p) yields

$$(q) \qquad Q_t = \alpha^* UPO_t + \alpha_1 \Delta UPO_t + \alpha_2 \Delta UPO_{t-1} + \ldots \alpha_{n+1} \Delta UPO_{t-n}$$

Equation (q) is to be estimated by regression analysis of the aggregated data from the sample of 51 contracts. The parameter estimates α^*, α_1, α_2, . . . α_{n+1} which result from that regression are the same as the ones obtained from equation (o).

SUMMARY

This chapter began by presenting illustrative examples which analyzed the idealized response of a single contractor to changes in the demand for his output. It was shown that if the contractor produces each contract at a given percentage in each month of the contract's life, and if the stream of contract awards is invariant, the contractor's monthly production stabilizes at a constant ratio to unpaid obligations outstanding. Further, it was shown that if the rate of contract awards and level of unpaid obligations outstanding changes, production will temporarily be above or below its optimum rate but will gradually adjust back toward the optimum rate.

Based upon the analysis of the idealized response of a single firm to changes in the level of demand for his output and certain assumptions concerning aggregation, a model was developed for estimating production on procurement contracts by defense firms in the aggregate. The model explains production as a function of the level of demand and changes in this level of demand over time. The demand for defense procurement items is defined as unpaid

obligations outstanding for procurement. The equation formulated to estimate production using this definition of demand is

$$Q = \alpha^{*}UPO_{t} + \alpha_{1}\Delta UPO_{t} + \alpha_{2}\Delta UPO_{t-1} + \ldots + \alpha_{6}\Delta UPO_{t-5}$$

The next chapter estimates this equation for the sample of 51 defense procurement contracts.

CHAPTER V

STATISTICAL RESULTS

The previous chapter analyzed the behavior of defense firms in response to changes in the level of demand for their output. It was shown that defense contractors attempt to keep their rate of production at some optimum ratio to the level of unfulfilled demand, or unpaid obligations outstanding, on their defense procurement contracts. It was further shown that the actual rate of production on these contracts differs from the optimum rate because of changes in the level of unfulfilled demand over time.

Based upon the analysis of contractor behavior in the previous chapter, an equation was developed which attempts to explain the current rate of production on defense procurement contracts as a function of the level of unpaid obligations outstanding in the current month and changes in this level during the current month and each of the previous five months. In this chapter, this equation is estimated for the total sample of 51 contracts, and the subsamples of Navy, Air Force, aircraft, missile and electronics contracts. The basic data for the total sample and the subsamples which were used in the estimation procedure are given in Appendix A.

Methodology

The data on production and unpaid obligations outstanding from the 51 contracts were aggregated on a monthly basis, beginning with the first month of reported activity for each contract. From these data, equation (q) is estimated using "ordinary least squares" (OLS) regression techniques for the first 36 months of contract performance. The arbitrary cut-off of 36 months was chosen with the following considerations in mind:

(a) The average length of the 51 contracts is 40.4 months;

(b) During the first 36 months of activity, the 51 contracts achieve, as a unit, 95 percent of their final production. To include the final 5 percent of total production would require extending the regression over nearly twice the period;

(c) By setting the cut-off point at the 36th month (exactly three years) as opposed to say, 40 months, the possibility of an unevaluated seasonal bias which could result from having more observations in some months than others is avoided.

Presentation of Statistical Results

All sample contracts. The OLS estimation of equation (q) for the aggregated sample data gives the following parameter estimates:

		t-ratios	
$Q_t =$	$(\alpha^*)0.0996\ UPO_t$	46.35	(.995)
	$(\alpha_1)-0.1042\Delta UPO_t$	-3.02	(.995)
	$(\alpha_2)-0.0811\Delta UPO_{t-1}$	-2.29	(.975)
	$(\alpha_3)-0.0050\Delta UPO_{t-2}$	-0.14	
	$(\alpha_4)-0.0516\Delta UPO_{t-3}$	-1.53	
	$(\alpha_5)-0.0243\Delta UPO_{t-4}$	-0.85	
	$(\alpha_6)-0.0003\Delta UPO_{t-5}$	-0.06	

$R^2 = 0.956$

Durbin Watson Statistic = 0.88

Standard Error[1] = 0.121

From the analysis in the previous chapter, the estimate of α^*, 0.0996, indicates that the optimum monthly production rate is approximately ten percent of unpaid obligations outstanding, or unfulfilled demand. In a constant state, where new obligations equal payments, defense contractors would maintain monthly production at the optimum rate. The actual production rate deviates from the optimum production rate only when the level of UPO is changing.

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[1]The term standard error as used in this paper refers to a percent of the mean of the dependent variable. This presentation deviates from the generally accepted practice in that the value of the standard error is divided by the mean of the dependent variable rather than presented in its original form.

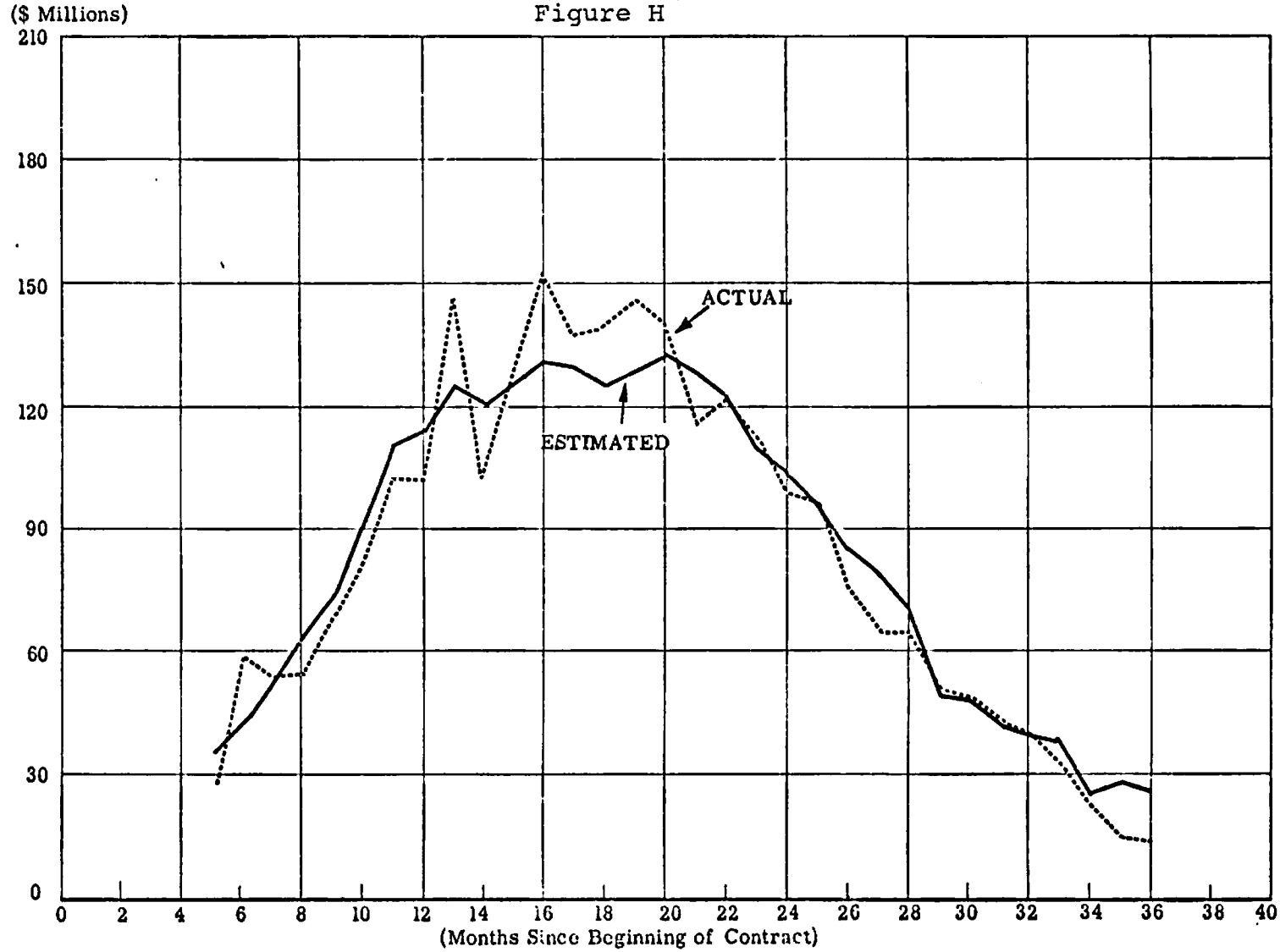
In general, the coefficients of the changes in UPO behave as was expected from the theoretical model. It was hypothesized that after UPO increases, the contractor will be operating below his optimum rate. Conversely, after UPO decreases, the reverse situation was expected. The negative values for the coefficients of the lagged variables supports this hypothesis. In other words, the negative coefficients lead to subtractions from the optimum rate when UPO is increasing and to additions to the optimum rate when UPO is decreasing.

It was also hypothesized that the impact on the actual production rate of changes in UPO prior to month t would decline as the number of months from month t increases. The general deterioration toward zero of the coefficients for the changes in UPO and the decline in the t-ratios as the time from month t increases supports this hypothesis. The hypothesis is further validated by use of the Spearman rank correlation test. Using this test and a one tailed test of significance, the hypothesis that the values of $\alpha_1, \ldots \alpha_6$ deteriorate sequentially is not rejected at the 95 percent confidence level.

As indicated by an R^2 of 0.956 and as illustrated in Figure H, the equation does a good job of tracking the production of the sample contracts. The standard error of the estimate of this equation is 12.1 percent of the mean value of the dependent variable, indicating reasonably

ACTUAL AND ESTIMATED MONTHLY PRODUCTION FOR ALL SAMPLE CONTRACTS

Figure H



Source: Equation (q) and Appendix A, Table 22.

small variance in the estimates considering the smallness and diverseness of the sample. The t-ratios for the estimates of α^*, α_1, and α_2 are significant at the 95 percent level of confidence. The fact that the remaining parameters, α_3 through α_6, are not significant at the 95 percent level of confidence indicates that changes in UPO that occured more than two months before the current month may not be important in explaining production in the current month.

Finally the Durbin Watson Statistic of 0.88 indicates that significant autocorrelation of the error terms exists. The existence of this autocorrelation is confirmed in Figure H which shows that the equation overestimates production during the early and late months of the contracts and underestimates it during the middle months. However, the Durbin Watson Statistic is not so critically low as to require respecification of the model.[1]

Subsample analysis. The analysis of the estimating equations for the subsamples must be interpreted with considerable caution. As stated earlier in this chapter, the model is formulated to explain the aggregate response of defense contractors to changes in effective demand.

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[1] The autocorrelation of this equation is analyzed later in this chapter.

Given this formulation, even the full sample of 51 contracts is relatively small. To subdivide the sample into smaller units further increases the risks of small sample bias and non random observations.

Despite this potentiality, the estimating equations generally behave according to expectations when fitted to the subsample data. The optimum production rates for the subsamples range between 9 and 12 percent of UPO. The coefficients of the lagged variables are generally negative and deteriorate toward zero. Finally the t-ratios for the lagged variables most distant from month t are generally insignificant, further indicating that changes in unpaid obligations in the months immediately preceeding month t have the greatest influence on the determination of the production rate for month t.

1. Navy Contracts

The OLS estimation of equation (q) for the Navy contracts is shown below.

		t-ratios	
$Q_{nt} =$	$(\alpha^*_n)\ 0.0956\ UPO_{n-t}$	25.8	(.995)
	$(\alpha_{n1})-0.1201\Delta UPO_{nt}$	-1.70	(.950)
	$(\alpha_{n2})-0.0447\Delta UPO_{nt-1}$	-0.83	
	$(\alpha_{n3})-0.0050\Delta UPO_{nt-2}$	-0.09	
	$(\alpha_{n4})-0.0760\Delta UPO_{nt-3}$	-1.27	
	$(\alpha_{n5})-0.0028\Delta UPO_{nt-4}$	-0.05	
	$(\alpha_{n6})-0.0033\Delta UPO_{nt-5}$	-0.07	

(Note: the subscript "n" denotes Navy)

$R^2 = 0.890$

Durbin Watson Statistic = 1.13

Standard Error = 0.208

The estimate of α^*, 0.0956, for the Navy subsample agrees with the total sample estimate of the optimum production rate being about ten percent of unfulfilled demand. But the lag structure does not maintain the rational order seen in the estimate for the total sample equation. Although all the coefficient estimates are negative, as expected, the estimates for α_{n2} and α_{n3} are smaller than the estimate for α_{n4}. The t-ratios further indicate that the estimates for α_{n3} , α_{n5} and α_{n6} are not significant at the 95 percent level of confidence. Finally, the Spearman rank correlation rejects the hypothesis that values of α_{n1}, $\alpha_{n2} \cdots \alpha_{n6}$ deteriorate sequentially at the 95 percent confidence level.

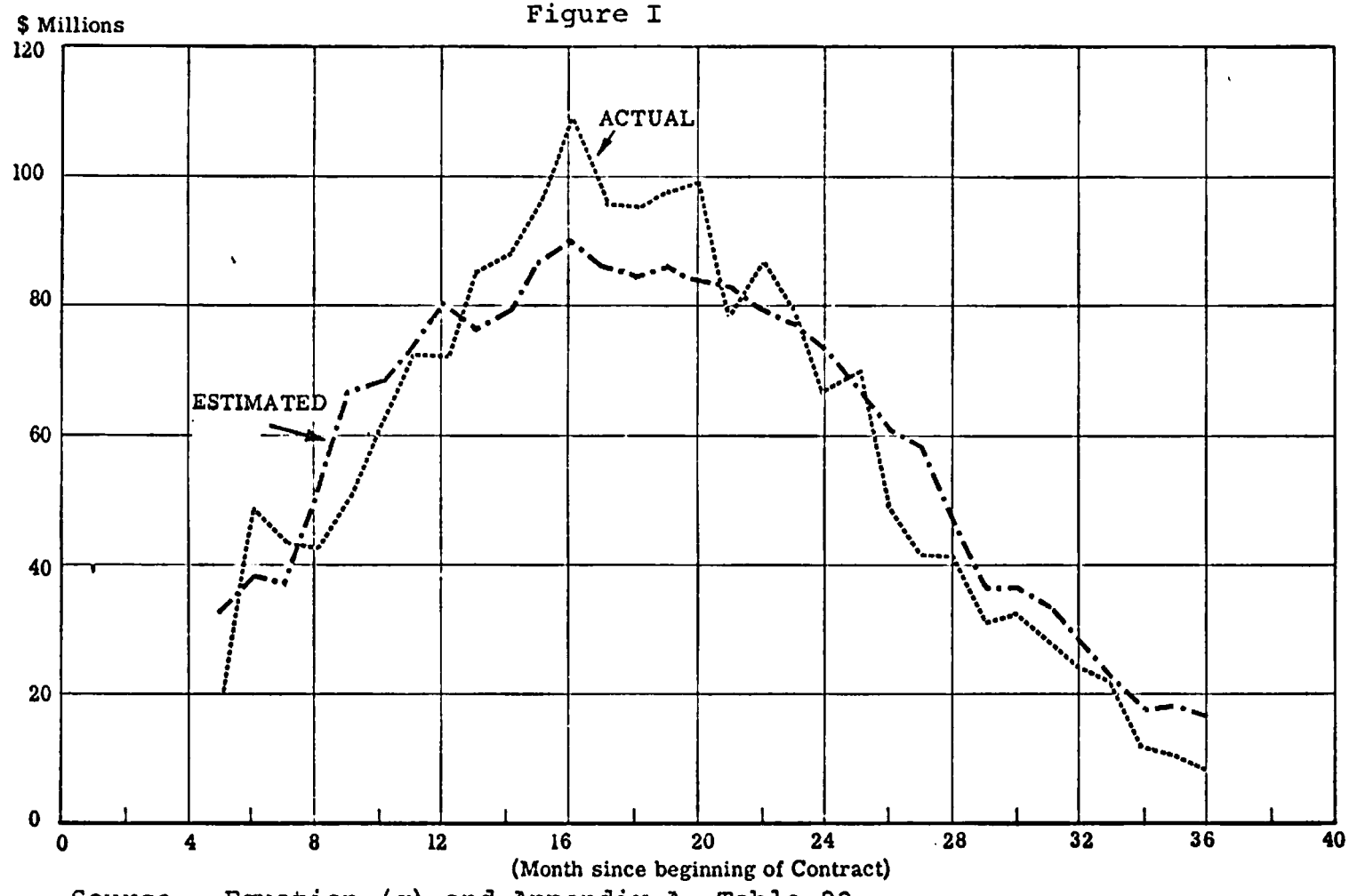
A comparison of actual and estimated production for the Navy contracts is shown in Figure I. As indicated by a somewhat lower R^2 and higher standard error, the estimates of production do not track the actuals as well for the Navy contracts as was observed in the estimates for the total sample. An explanation for this fact is that the Navy subsample is too small a sample by itself to insure randomness in the disturbances from the normal pattern of events.

2. Air Force Contracts

The small sample problem observed in the Navy equation is even more pronounced for the Air Force

ACTUAL AND ESTIMATED PRODUCTION FOR ALL NAVY CONTRACTS IN SAMPLE

Figure I



Source: Equation (q) and Appendix A, Table 22.

estimating equation. The model when applied to Air Force contracts yields the parameter estimates shown below.

		t-ratios	
$Q_{at} =$	$(\alpha^*_a)\ 0.1099\ UPO_{at}$	42.0	(.995)
	$(\alpha_{a1})-0.0735\Delta UPO_{at}$	-4.19	(.995)
	$(\alpha_{a2})-0.0490\Delta UPO_{at-1}$	-2.76	(.995)
	$(\alpha_{a3})-0.0380\Delta UPO_{at-2}$	-1.72	(.950)
	$(\alpha_{a4})-0.0218\Delta UPO_{at-3}$	-1.22	
	$(\alpha_{a5})+0.1059\Delta UPO_{at-4}$	5.94	(.995)
	$(\alpha_{a6})-0.1476\Delta UPO_{at-5}$	-8.36	(.995)

(Note: the subscript "a" denotes Air Force)

$R^2 = 0.946$

Durbin Watson Statistic = 1.74

Standard Error = 0.148

The estimate of α^*_a, 0.1099, is again consistent with the total sample estimate of the optimum production rate. The adjustment coefficients $\alpha_{a1}, \ldots \alpha_{a6}$ show agreement with the model's expectations up to a lag of four months activity (t-4). However, α_{a5} and α_{a6} are both substantially different than hypothesized. The explanation from the data is that production on the 16 Air Force contracts does not assume the normal distribution observed on the total sample. Specifically,

there is an abnormal jump in production in the 13th month (see Figure J) which results in part from normal growth and partially from a random coincidence of sub-contractor deliveries.

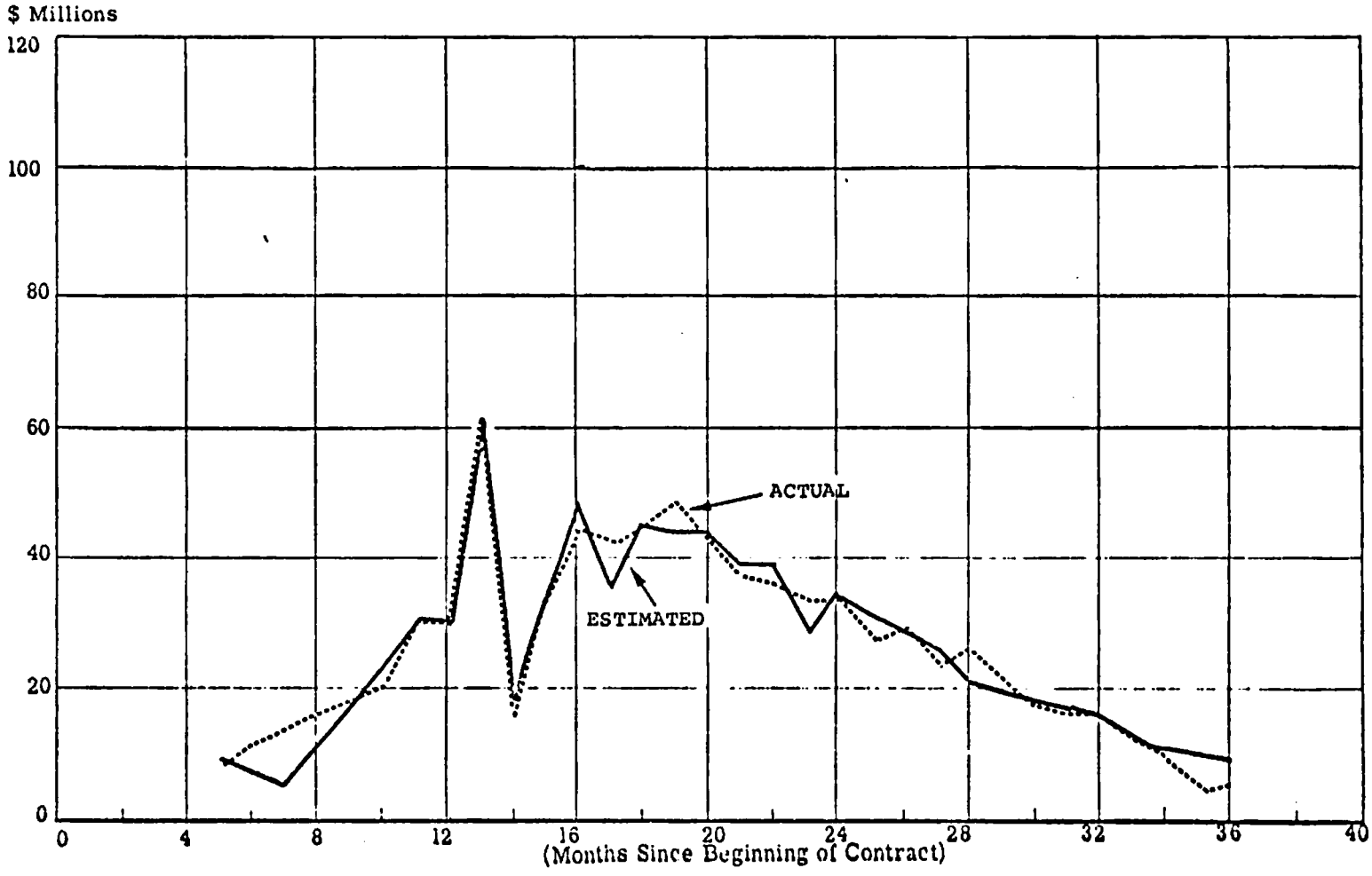
In order for the model to explain this abnormal jump, the coefficient for ΔUPO_{t-4} becomes positive, instead of negative, and the coefficient for ΔUPO_{t-5} becomes more negative than the coefficients for the lagged terms closer to month t. As seen in Figure J, and in an R^2 of 0.946 and in a standard error of about 0.150, these coefficients do a good job of explaining production on the 16 Air Force contracts comprising the sample even though the equation coefficients do not conform to expectations. This equation may not, however, be applicable to any other set of Air Force contracts.

3. Aircraft Contracts

The parameter estimates derived when the model is tested on the data for the aircraft contracts are shown below.

		t-ratios	
$Q_{pt} =$	$(\alpha^*_p)\ 0.0925\ UPO_{pt}$	23.1	(.995)
	$(\alpha_{p1})-0.1166\Delta UPO_{pt}$	-2.43	(.975)
	$(\alpha_{p2})-0.0489\Delta UPO_{pt-1}$	-1.08	
	$(\alpha_{p3})-0.0326\Delta UPO_{pt-2}$	-0.77	
	$(\alpha_{p4})-0.0488\Delta UPO_{pt-3}$	-1.15	
	$(\alpha_{p5})-0.0047\Delta UPO_{pt-4}$	-0.11	
	$(\alpha_{p6})-0.0071\Delta UPO_{pt-5}$	-1.17	

FIGURE J
ACTUAL AND ESTIMATED PRODUCTION FOR ALL
AIR FORCE CONTRACTS IN SAMPLE



Source: Equation (q) and Appendix A, Table 24.

(Note" the subscript "p" denotes aircraft)

$R^2 = 0.850$

Durbin Watson Statistic = 1.54

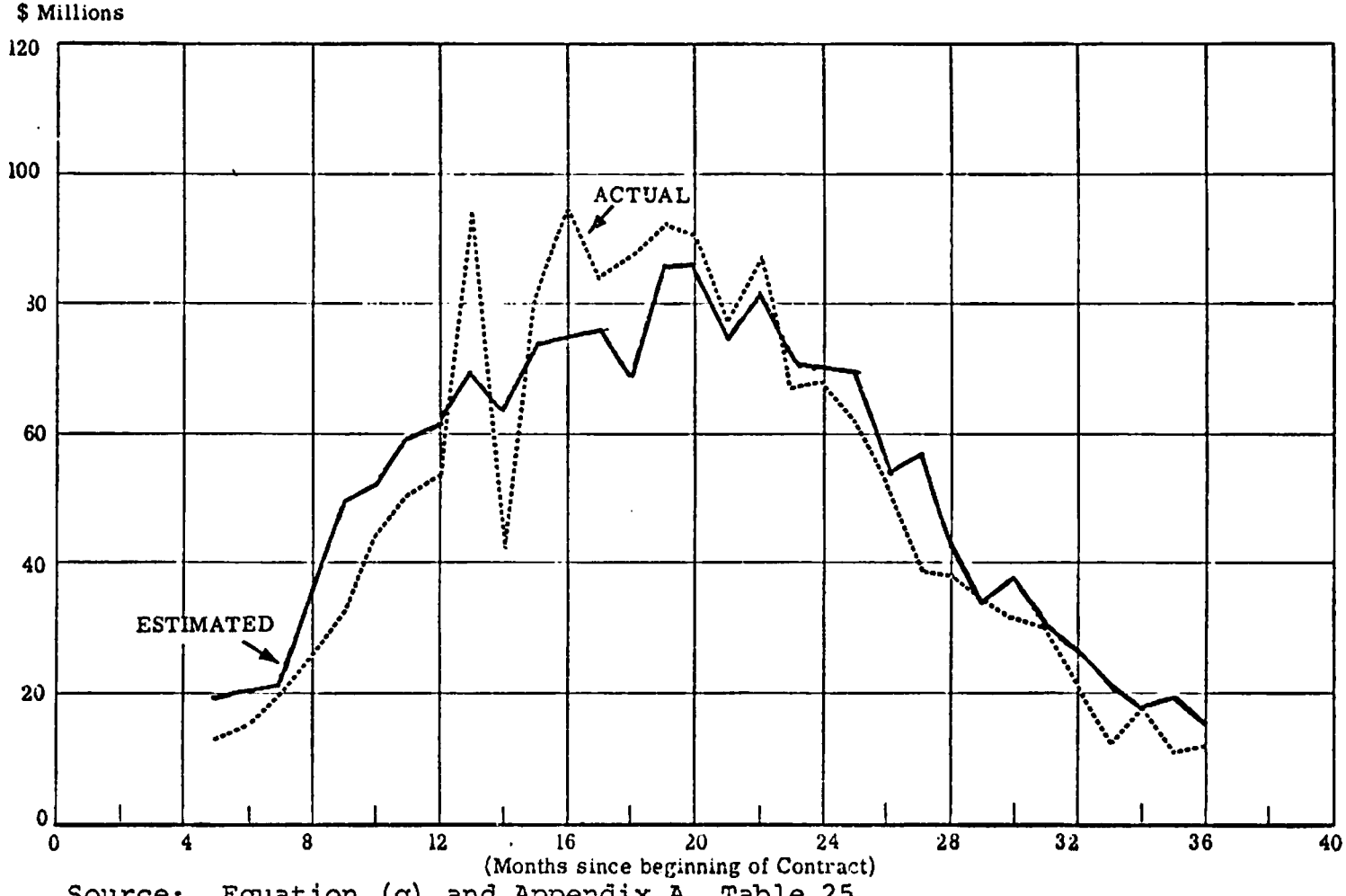
Standard Error = 0.254

Although the non-normal distribution of production on the Air Force contracts is also prevalent for the aircraft subsample (Figure K), its impact on the coefficient estimates was less significant. The optimum rate of production for the aircraft contracts is approximately nine percent of unfulfilled demand and the adjustment coefficients generally deteriorate toward zero. The Spearman rank correlation test shows that the hypothesis concerning deterioration of the six coefficients on the lagged changes in demand is accepted at the 95 percent level of confidence.

The estimator of aircraft production is the least efficient of the estimating equations developed. The R^2 of 0.850 and the standard error of 0.254 for this estimator indicates that the estimates of production do not track the actual values as accurately as was observed for the total sample and the other subsamples. In addition, the t-ratios indicate that only the level of unfulfilled demand (UPO) and changes in this level in the current month are significant at the 95 percent level of

ACTUAL AND ESTIMATED PRODUCTION FOR ALL AIRCRAFT CONTRACTS IN SAMPLE

Figure K



Source: Equation (q) and Appendix A, Table 25.

confidence in explaining the rate of production. Figure K compares the estimates of production, using the aircraft estimator, with the actual values.

4. Missile Contracts

The coefficient estimates for the subsample of missile contracts are shown below.

		t-ratios	
Q_{mt} =	(α^*_m) 0.1252 UPO_{mt}	30.6	(.995)
	(α_{m1})-0.0750ΔUPO_{mt}	-3.33	(.995)
	(α_{m2})-0.0606ΔUPO_{mt-1}	-2.69	(.990)
	(α_{m3})-0.0530ΔUPO_{mt-2}	-2.37	(.975)
	(α_{m4})-0.0300ΔUPO_{mt-3}	-1.38	
	(α_{m5})-0.0155ΔUPO_{mt-4}	-0.69	
	(α_{m6})-0.0023ΔUPO_{mt-5}	-0.11	

(Note: the subscript "m" denotes missiles

R^2 = 0.898

Durbin Watson Statistic = 1.64

Standard Error = 0.189

Of all subsamples tested, the missile contracts conform best to the model's expectations with regards to the coefficients on the lagged changes in demand. The estimates for α_{m1}, α_{m2}, . . ., α_{m6} are all negative and show a marked tendency to deteriorate toward zero as the lag becomes greater. The t-ratios for α^*_m, α_{m1}, α_{m2}, and α_{m3} are all significant at the 95 percent level of confidence. The fact that the t-ratios for the last two coefficients, α_{m5} and α_{m6}, are quite low reinforces the

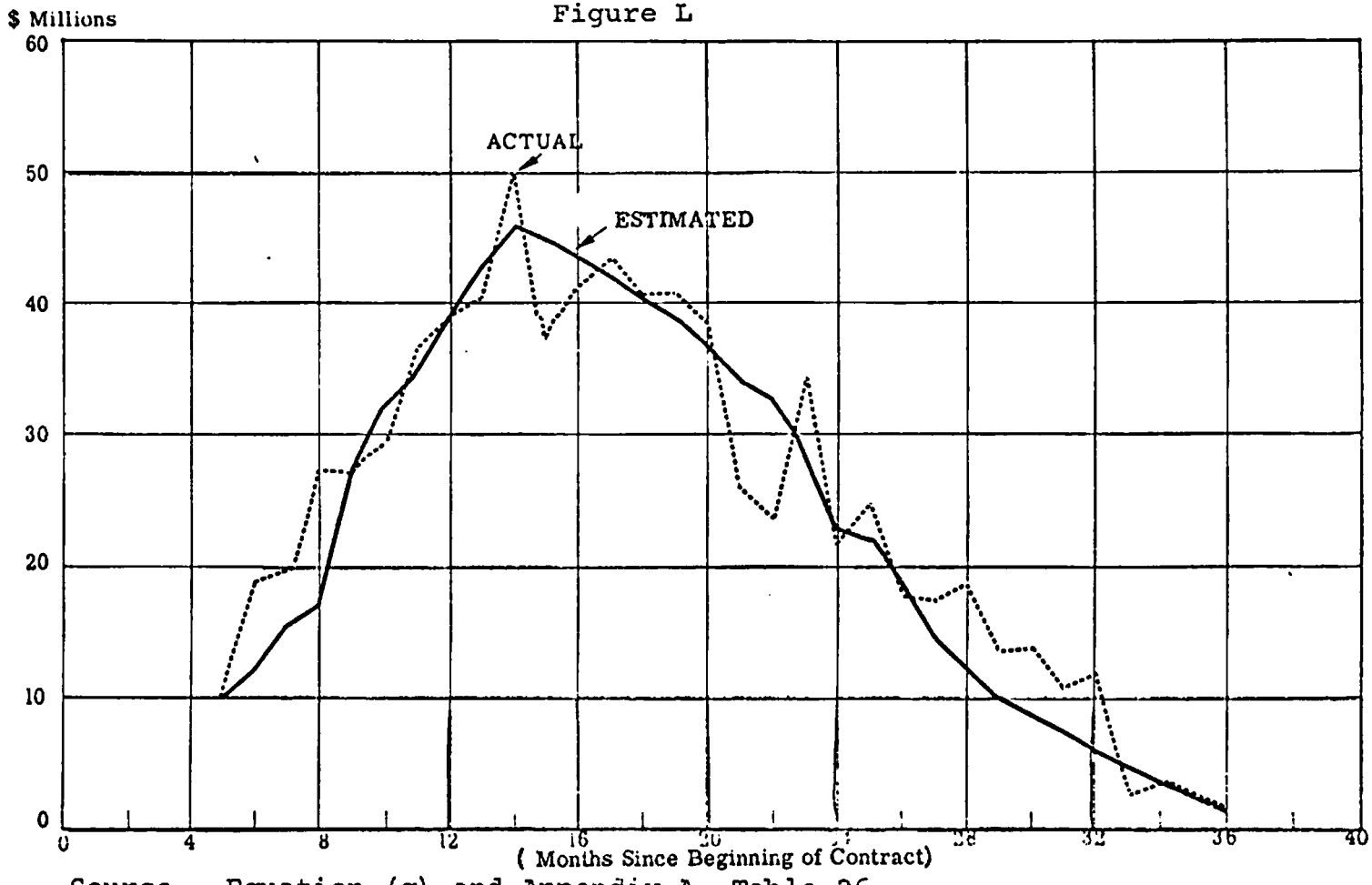
hypothesis that the coefficients will deteriorate toward zero and become insignificant at some number of months prior to the month being investigated, or month t.

The estimate of α^*_m, 0.1252, is significantly higher than the estimates of α^*, α^*_n, α^*_a, and α^*_p, indicating that the optimum rate of production on missile contracts may be higher than for the other types of contracts in the sample. This finding suggestsa quicker reaction of production to demand for missile contracts. Figure L also indicates that missile contracts proceed more quickly toward completion than other types of contracts. Whereas the total sample achieves peak production near the 13th month, and sustains that peak through the 20th month (production in the 20th month on the total sample of contracts equals 94 percent of the highest monthly production), missile production tails off more quickly from its peak, achieving only 70 percent of its peak production in the 20th month.

Considering that this is only a small subsample of the total, missile contracts perform well within the theory of the model. In addition to the good coefficient estimates, the R^2 is high (0.898), the standard error of the estimate is a low percentage of the mean estimate of monthly production (18.9 percent), and the Durbin Watson Statistic is reasonably large (1.64). It is expected, however, that the model would perform better on a large sample where deviations from the norm are more likely to be offsetting.

ACTUAL AND ESTIMATED MONTHLY PRODUCTION FOR ALL MISSILE CONTRACTS IN SAMPLE

Figure L



Source: Equation (q) and Appendix A, Table 26.

5. Electronics Contracts

The coefficient estimates for the subsample of electronic contracts are shown below.

		t-ratios	
Q_{et} =	(α^*_e) 0.0930 UPO_{et}	26.8	(.995)
	(α_{e1})-0.0133ΔUPO_{et}	-0.67	
	(α_{e2})-0.0739ΔUPO_{et-1}	-4.31	(.995)
	(α_{e3})-0.0518ΔUPO_{et-2}	-3.01	(.995)
	(α_{e4})-0.0450ΔUPO_{et-3}	-2.62	(.990)
	(α_{e5})-0.0434ΔUPO_{et-4}	-2.98	(.995)
	(α_{e6})-0.0355ΔUPO_{et-5}	-2.47	(.990)

(Note: the subscript "e" denotes electronics contracts)

R^2 = 0.857

Durbin Watson Statistic = 1.18

Standard Error = 0.233

The optimum production rate and the relative magnitude of the coefficients on the lagged variables again conform to expectations. The notable exception is the estimate of α_{e1} which is the smallest coefficient on the lagged variables. The t-ratio of -0.67 further indicates that this variable is not significant at the 95 percent level of confidence in explaining the current month's production. This finding may indicate that production on electronic contracts responds to changes in demand in the previous month and earlier months but not to changes in demand during the current month.

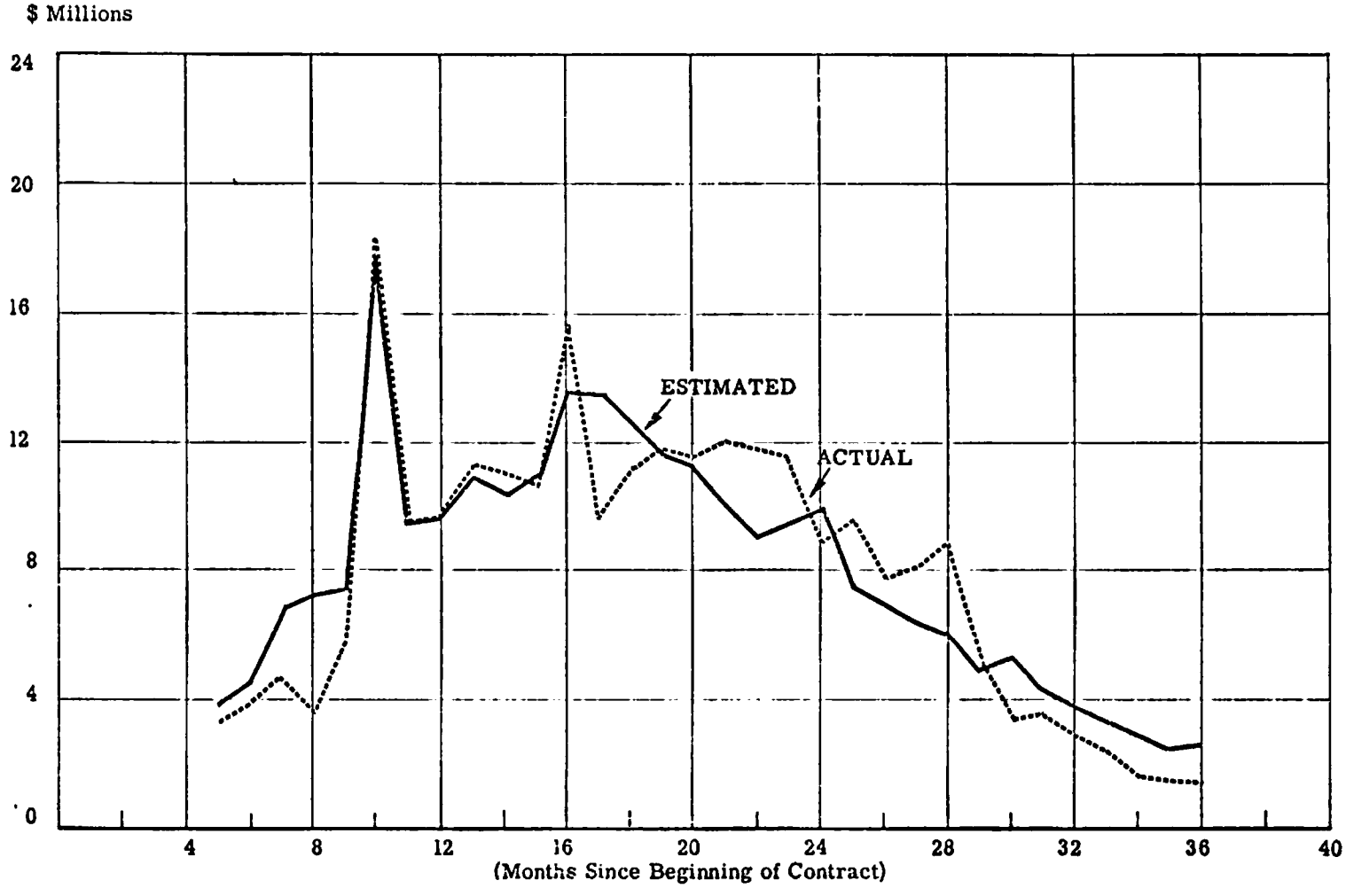
The remaining coefficients on the lagged changes in demand all conform to expectations and all have significant t-ratios at the 95 percent level of confidence. As shown by an R^2 of 0.857 and as illustrated in Figure M, the equation for the electronics subsample does a reasonably good job of tracking actual production. The Durbin Watson Statistic of 1.18 again indicates possible autocorrelation among the error terms and gives one explanation for the overestimation of production in the early and late months and underestimation in the middle months. The standard error of 23.3 percent of the mean of the estimates of production indicates significant variance in the estimates. All in all, however, the equation for the electronics contracts predicts actual production reasonably well considering the small number of contracts in the subsample.

ADDITIONAL INTERPRETATION OF STATISTICAL RESULTS

The equations as estimated in the previous section generally conform with the analysis and theory in Chapter IV. It was found that the rate of production by defense firms on procurement contracts can be estimated with reasonable reliability as a function of the level of unpaid obligations outstanding, or unfulfilled demand, on those contracts and changes in the level of unpaid obligations outstanding. It was further found that the affects of past changes in the level of unpaid obligations upon the current rate of production become less important as the length of the lag increases.

ACTUAL AND ESTIMATED MONTHLY PRODUCTION FOR ALL ELECTRONICS CONTRACTS IN SAMPLE

Figure M



Source: Equation (q) and Appendix A, Table 27.

The previous statistical tests, however, pointed out three potentially troublesome areas. First, some of the t-ratios for the coefficients on the lagged variables were not significant at the 95 percent level of confidence. Second, the coefficients on the lagged variables did not always deteriorate smoothly toward zero as had been hypothesized. Third, the Durbin Watson Statistic, particularly for the equation for the total sample, indicated that some autocorrelation among the error terms may exist.

These discrepancies between the theoretical model and the statistical estimates could be caused by either mis-specification of the model or mis-estimation of the model. The former refers to possible theoretical deficiencies of the model and are discussed in this section. The latter refer to possible statistical or data deficiencies in the model and are discussed in the next section.

The mis-specification could be caused by either using the wrong variables, i.e., UPO and changes in UPO, to explain the rate of production on procurement contracts or by omitting some variables, other than UPO, which affect the rate of production. Because of the goodness of fit achieved for all the equations, e.g., an R^2 of 0.956 on the equation for the total sample, it is more likely that the equations are mis-specified because of omissions of certain explanatory variables than because of using the wrong independent variables.

One possible omission of an explanatory variable exists in the use of UPO as the level of effective demand for defense procurement items. As indicated in Chapter III, the level of UPO on a defense procurement contract often underestimates the ultimate level of demand for procurement items on that contract. The possibility for significant underestimation is particularly great during the early months of a contract. It is possible that defense firms adjust their rate of production not only in response to actual changes in the level of UPO but also in response to expected changes in the level of UPO. But as it is not possible to estimate realiably future changes in UPO for either the sample or the population of defense procurement contracts, the model will not be respecified to consider potential changes in UPO.

Another possible explanatory variable which was omitted from the model is the urgency of the military requirements. During a military buildup, such as related to Vietnam, the Department of Defense offers incentives for fast production and early deliveries. It is likely that these incentives, particularly on certain contracts, cause the rate of production to increase. The possibility further suggests that for short periods of time the optimum ratio, α^*, between production and UPO may be

variable, rather than constant as was hypothesized, and may be dependent upon the urgency of military requirements.[1]

It is possible that the rate of production is also dependent upon general economic conditions and, in particular, such variables as capacity utilization rates and unemployment rates. When capacity utilization rates are low and unemployment is high, it is expected that defense firms would respond more quickly to changes in the level of demand for their output. Conversely, if capacity utilization rates are high and unemployment rates are low, they could not respond as quickly. These possibilities suggest that both the optimum rate of production, α^*, and the reaction coefficients, $\alpha_1 \ldots \alpha_6$, may be variable and dependent upon general economic conditions.

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[1]The results from the statistical tests in the previous section suggest that the variable α^* might be applicable to the sample contracts. The equations overestimated production in the early and late months of the contracts and underestimated in the middle months. This could indicate that the optimum rate of production is lower in the early and late months of the contracts than in the middle months. It is difficult, however, to develop a meaningful relationship which would explain this observation for the sample contracts and also be applicable to the total population of defense procurement contracts. Because of this difficulty, no attempt is made in this paper to incorporate a variable optimum ratio of production into the statistical model.

In general, although there are many variables, e.g., expected changes in UPO, urgency of military requirements, capacity utilization rates, and unemployment rates, which could help explain the rate of production on defense procurement contracts, all of them pose difficult problems of measurement on the sample contracts and even more difficult problems in being related to the total population of defense procurement contracts. Therefore, equation (q) will not be re-specified. Instead, an attempt is made in the next section to use statistical methods to overcome the potentially troublesome areas in the model as it was estimated in the previous section.

ADDITIONAL REFINEMENTS TO STATISTICAL MODEL

The three discrepancies between the theoretical model developed in Chapter IV and the statistical model estimated in this chapter have been identified as (1) insignificant t-ratios on some of the lagged variables, (2) a non-smooth deterioration in the coefficients on the lagged variables, and (3) a low Durbin Watson statistic on the equation for the total sample. This section discusses statistical methods of ameliorating these problem areas.

The first step is to shorten the lag structure in the model. In most of the equations (the exceptions were the Air Force and electronics equations) the t-ratios

for the last two lagged variables, ΔUPO_{t-4} and ΔUPO_{t-5} were insignificant at the 95 percent confidence level. Although this finding conformed with one of the theoretical hypotheses of the model, i.e., the longer the lag from month t the less influence will a change in unfulfilled demand have on the current rate of production, the inclusion of these two variables in the model adds very little to the explanation of changes in the rate of production and may in fact detract from the overall efficiency of the estimators. Therefore, the model is respecified to consider the level of unfulfilled demand, or UPO, in the current month and changes in that level in the current month and the previous three months only, or

(r) $$Q_t = \alpha^* UPO_t + \alpha_1 \Delta UPO_t + \alpha_2 \Delta UPO_{t-1} + \alpha_3 \Delta UPO_{t-2} + \alpha_4 \Delta UPO_{t-3}$$

The second step is to constrain the coefficients on the lagged variables so that they deteriorate smoothly toward zero. This can be done by using the distributed lag regression developed by Shirley Almon.[1] This technique requires that the nature of the distribution of the coefficients on the lagged variables, i.e., $\alpha_1 \ldots \alpha_4$, be specified and that the end values for the coefficients be specified. From the previous analysis, it is realistic to specify that the distribution of $\alpha_1 \ldots \alpha_4$ be quadratic and that the value for α_4 be equal to zero.

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[1]Shirley Almon, "The Distributed Lag Between Capital Appropriations and Expenditures," Econometrica, Vol. 33, No. 1 (January, 1965), pp. 178-196.

Given these constraints, the Almon distributed lag regression technique is used to estimate equation (r) for all the sample contracts. The estimates of the parameters are given below.

	t-ratios
$Q = (\alpha^*)\ 0.0989\ UPO_t$	52.3 (.995)
$(\alpha_1) -0.1173 \Delta UPO_t$	-4.13 (.995)
$(\alpha_2) -0.0824 \Delta UPO_{t-1}$	-6.79 (.995)
$(\alpha_3) -0.0433 \Delta UPO_{t-2}$	-2.31 (.975)
$(\alpha_4) -0.000\ \Delta UPO_{t-3}$	-1.41

$R^2 = 0.951$

Durbin Watson Statistic = 1.10

Standard Error = 0.118

The results achieved using the Almon lag technique have improved the quality of the estimator for all the sample contracts. The coefficients on the lagged variables deteriorate smoothly to zero, the t-ratios for α^*, α_1 and α_2 are significant at the 99.5 percent level of confidence, the t-ratio for α_3 is significant at the 97.5 percent level of confidence and the t-ratio for α_4 is significant at the 90.0 percent level of confidence. Finally, with 33 observations and a Durbin Watson statistic of 1.10, the hypothesis that significant autocorrelation of the error terms exists is not accepted at the 97.5 percent level of confidence.[1]

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[1] J. Durbin and G.S. Watson, "Testing for Serial Correlation in Least Squares Regressions, II", Biometrika, Vol. 38, (1951), p. 174.

SUMMARY

Although the estimation of the parameters for equation (q) generally conformed to expectations, potential problem areas were observed in the form of (1) low t-ratios on some of the explanatory variables, (2) a non-smooth deterioration in the coefficients on the lagged variables and (3) possibly low Durbin Watson statistics. All of these problem areas were improved by shortening the lag structure of the estimating equation and reestimating the parameters using the Almon distributed lag regression techniques.

The improvements in the statistical qualities of the model achieved by these techniques resulted in a small decrease in the R^2 for the total sample equation (0.951 versus 0.956) and a slight improvement in the standard error (0.118 versus 0.121). Additionally, the equation still conforms to the analysis and theory in Chapter IV and indicates that defense firms attempt to maintain their rate of production at about 10 percent of the level of unfulfilled demand, or UPO on their contracts.

The parameters as estimated above for equation (r) using the Almon techniques are used in the next chapter to estimate the production on all defense procurement contracts for the 1965 through 1969 period.

CHAPTER VI

THE RESULTS OF APPLYING THE STATISTICAL MODEL TO THE TOTAL AGGREGATE POPULATION DATA

In this Chapter, the statistical model as estimated for the total sample is applied to the total population of defense procurement contracts. This application yields quarterly estimates of production on all Department of Defense procurement contracts for the 1964 through 1969 period. These estimates of production are compared with the data on payments and deliveries on defense procurement contracts as reported by the Government for the same period of time and with the earlier results obtained by Weidenbaum and Galper.

The comparisons between the estimates of production and the actual data on deliveries and payments indicate the accuracy of Government data in measuring the economic impact of the Vietnam buildup and the portion of private inventory accumulation during the Vietnam buildup which is directly[1] attributable to production on defense procurement

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[1]No attempt is made here to investigate the indirect effects of the defense buildup on private inventories. The impact, for example, of the Vietnam buildup on subcontractor inventories and the inventories of the primary supply industries are not analyzed.

contracts. These comparisons also indicate how accurately the Federal budget reflected the fiscal impact of Government operations during the buildup. Finally these comparisons indicate the potential value of the statistical model developed in this study for estimating production on defense procurement contracts and for improving stabilization policy decisions during periods of changing defense activity.

METHODOLOGY

The first problem encountered is to construct a data series on "effective demand" for total defense procurement. The Department of Defense compiles a monthly series on "Gross Unpaid Obligations Outstanding for Procurement."[1] This series, however, is not identical to the definition of unpaid obligations outstanding (UPO) used in estimating the model. "Gross Unpaid Obligations Outstanding for Procurement" double counts obligations when one military service obligates funds to another service for the purpose of obtaining certain goods or services.

For example, if the Air Force wants to buy aircraft that are being produced on a Navy contract, the Air Force obligates funds to the Navy. The Navy in turn obligates an equal amount of funds to the defense firm building the aircraft.

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[1] U.S., Department of Commerce, Defense Indicators (Washington: Government Printing Office, June, 1970) pp. 19 and 33.

The Defense Department series on "Gross Unpaid Obligations Outstanding for Procurement" counts these obligations when the Air Force obligates the funds to the Navy and again when the Navy obligates the funds to the defense firm. Thus, the obligation is counted twice and as a result the level of obligations overstates the total commitments of the Defense Department to purchase aircraft from the private sector.

The double counted obligations are eventually netted out. When payments are made on these obligations they are double counted, e.g., in the above illustration the payments would be counted when the Navy pays the defense firm and again when the Air Force pays the Navy. At the completion of the contract the double counted obligations less the double payments equal zero. At any time prior to completion of the contract, however, "Gross Unpaid Obligations For Procurement" overstate the unfulfilled demand of the Defense Department because of the double counted obligations.

The extent to which "Gross Unpaid Obligations Outstanding for Procurement" overstate the true level of unfulfilled demand is not known. One estimate is obtained by comparing the figure for "Net Unpaid Obligations, Procurement", published annually in the Appendix to the budget,[1] with the Defense Department series on "Gross Unpaid

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[1]U. S., Bureau of the Budget, Appendix, The Budget of the United States, Fiscal Year 1971 (Washington: Government Printing Office, January 1970) pp.283-294.

Obligations Outstanding for Procurement." For the years 1964 through 1969 the ratio of net to gross (double counted) unpaid obligations outstanding for procurement ranged between 0.79 and 0.81 and averaged 0.80. This estimate suggests that the "gross" series may overstate unfulfilled demand for procurement items by as much as 25 percent.

In the absence of more definitive criteria, it is assumed that the true level of unfulfilled demand lies between 75 and 85 percent of "Gross Unpaid Obligations Outstanding for Procurement." Quarterly production for all procurement contracts is estimated for the 1964 through 1969 period by using equation(r) as estimated for all the sample contracts and by defining UPO_t to equal one of the following:

(1) UPO_t = 0.75 X "Gross Unpaid Obligations Outstanding for Procurement" for month t; and

(2) UPO_t = 0.80 X "Gross Unpaid Obligations Outstanding for Procurement" for month t; and

(3) UPO_t = 0.85 X "Gross Unpaid Obligations Outstanding for Procurement" for month t.

If the model as previously estimated performs well on the aggregated data for all defense procurement contracts, it is expected that the true levels of production during the 1964 through 1969 period are within the range of estimates obtained from the use of these three different measures of unfulfilled demand.

QUALIFICATIONS

Before proceeding to the estimates of production for all defense procurement contracts, it is well to make explicit some of the hazards involved in applying the coefficients and the model developed from the sample data to the much larger, and perhaps much different, total population of procurement contracts. First, the sample of 51 contracts used in estimating the parameters of the model is neither a random nor a representative sample of the total population of defense procurement contracts. The sample does not include any Army or Marine Corps contracts, any "softgoods" contracts or any ship construction contracts. The potential errors introduced by these omissions are indeterminable, since the production data analyzed in this paper exist, so far as known to the author, only for the contracts comprising the sample.

It is expected, however, that there is a systematic bias in the results when the model is generalized to the entire population of defense procurement contracts. The question becomes how biased are the results and are the biases constant over time. If the estimated production systematically overpredicts actual production by, say, 25 percent, the production estimates could be multiplied by 0.80 and unbiased estimates would be obtained.

If, however, this bias is not constant over time,[1]

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[1]Due, perhaps, to a change in the ratio of Army-Marine Corps to Navy-Air Force contracts or "softgoods" to "hardgoods" contracts.

the problem of adjusting the estimates of production is substantially complicated. The estimates may be biased in such a way, for example, as to overstate production by a percentage which varies from year to year. The bias could not be estimated unless fluctuations in the bias were dependent upon fluctuations in some known variable, e.g., the ratio of Army to Navy contracts. In the absence of production data for all types of defense contracts, it is impossible to determine if such a predictable relationship exists.

A further problem of potential bias stems from the fact that the definition of production used in this study includes the contractors' profits. The rate of profit on procurement contracts used in estimating the parameters of the model in Chapter V was the actual rate of profit observed on the sample of 51 contracts. Therefore, in using the model to estimate production on all defense procurement contracts, it is necessary to assume that the rates of profit observed on the sample are "typical" of profits on all defense procurement contracts for the same period. While the assumption that the sample generated "typical" rates of profit is reasonable it is unlikely that the profit rate on defense contracts is constant over time. Profits on defense contracts may reasonably be expected to fluctuate from year to year. Therefore, the assumption with regard to the rate of profits may obscure some of the actual fluctuations in production.

In summary, it is extremely hazardous to generalize the results obtained from the sample to the total procurement contract population. It is anticipated that a systematic bias in the estimates of production exists and that the amount of this bias is not constant, but there is no a priori assumption as to whether the bias produces over or under estimations.

ESTIMATING PRODUCTION ON ALL PROCUREMENT CONTRACTS

The estimates of production resulting from equation (r) and the three definitions of UPO_t are shown in Table 14. This table also includes Government data on payments and deliveries for all procurement contracts. The table shows how the three different definitions of unfulfilled demand yield different measurements of the magnitude, but not the timing, of the increase in production caused by the Vietnam buildup.

The estimates of production in Table 14 suggest the potential magnitude of the understatement in the Government data of the economic impact of the Vietnam buildup. These estimates indicate that production on defense procurement contracts increased approximately $7-8 billion between the last quarter of 1964 and the last quarter of 1966. For the same period, payments on defense procurement contracts increased $3.4 billion and deliveries increased $3.7 billion.

TABLE 14

ESTIMATES OF PRODUCTION AND ACTUAL PAYMENTS AND DELIVERIES ON DEFENSE PROCUREMENT CONTRACTS FOR 1965-1969

(Billions of Dollars at Annual Rates)

Year & Quarter	Production 75%	Production 80%	Production 85%	Payments	Deliveries
1964 IV	13.28	14.17	15.07	13.68	13.32
1965 I	13.25	14.12	15.01	11.48	12.29
1965 II	13.05	13.83	14.68	11.02	12.47
1965 III	14.00	14.93	15.84	13.37	12.92
1965 IV	14.85	15.84	16.84	13.84	13.56
1966 I	15.57	16.60	17.64	14.60	12.83
1966 II	16.06	17.12	18.19	15.54	13.95
1966 III	18.52	19.75	21.00	17.57	15.90
1966 IV	20.20	21.55	22.90	17.06	17.02
1967 I	20.68	22.05	23.43	20.30	18.89
1967 II	20.48	21.84	23.21	21.13	19.74
1967 III	22.07	23.54	25.01	24.24	20.12
1967 IV	22.35	23.84	25.33	22.40	20.40
1968 I	22.15	23.63	25.10	23.47	21.22
1968 II	21.51	22.98	24.41	23.03	21.70
1968 III	22.52	24.02	25.52	22.87	21.50
1968 IV	23.86	25.46	27.05	24.32	21.89
1969 I	23.88	25.47	27.07	24.79	22.15
1969 II	22.07	23.52	25.00	24.34	22.15
1969 III	20.37	21.73	23.09	22.01	22.74
1969 IV	19.22	20.50	21.77	22.36	22.44

Sources: Production: Equation (r) and adjusted "Gross Unpaid Obligations Outstanding for Procurement" data, Defense Indicators, June 1970, Table 2, p. 19 and Table 645, p. 33.
Payments: Defense Indicators, Table 3, p. 23 and Table 682, p. 36.
Deliveries: Mr. Charles Waite, Head, Federal Government, National Income and Product Accounts Division, Department of Commerce.

A more precise comparison between the estimates of production and the Government data used to measure this production is shown in Table 15. In this table unpaid production is the difference between the estimates of production on all defense procurement contracts and the payments recorded in the Government accounts on these contracts. Undelivered production is the difference between the estimates of production and Government data on deliveries. Positive values for unpaid or undelivered production indicate the amounts by which production exceeded payments or deliveries and negative values indicate the amounts by which payments or deliveries exceeded production.

Accepting the 80 percent adjustment to "Gross Unpaid Obligations Outstanding for Procurement" as being most reasonable, it is seen that Government data on payments and deliveries underestimated production on defense procurement contracts for most of the period being investigated. Both unpaid and undelivered production were positive and increasing through 1965 and 1966, reached peak levels in the last quarter of 1966, maintained large positive values through 1967 and 1968, and began dropping off sharply by the second quarter of 1969. By the last quarter of 1969, unpaid and undelivered production were negative for the first time during the 1965 through 1969 period.

These data indicate that production on defense procurement contracts has been greater than Government payments and deliveries for most of the last half of the

TABLE 15

ALTERNATIVE MEASUREMENTS OF UNPAID AND UNDELIVERED PRODUCTION FOR ALL PROCUREMENT CONTRACTS FOR 1965-1969

(Billions of Dollars at Annual Rates)

Year & Quarter	Unpaid Production			Undelivered Production		
	75%	80%	85%	75%	80%	85%
1964 IV	-0.40	+0.49	+1.39	-0.04	+0.85	+1.75
1965 I	+1.77	+2.64	+3.53	+0.96	+1.83	+2.72
1965 II	+2.03	+2.81	+3.66	+0.58	+1.36	+2.21
1965 III	+0.63	+1.56	+2.47	+1.08	+2.01	+2.92
1965 IV	+1.01	+2.00	+3.00	+1.29	+2.28	+3.28
1966 I	+0.97	+2.00	+3.04	+2.74	+3.77	+4.81
1966 II	+0.52	+1.68	+2.65	+2.11	+3.27	+4.24
1966 III	+0.95	+2.18	+3.43	+2.62	+3.85	+5.10
1966 IV	+3.14	+4.49	+5.84	+3.18	+4.53	+5.88
1967 I	+0.38	+1.75	+3.13	+1.79	+3.16	+4.54
1967 II	-0.65	+0.71	+2.08	+0.74	+2.10	+3.47
1967 III	-2.07	-0.70	+0.77	+2.05	+3.42	+4.89
1967 IV	-0.05	+1.44	+2.93	+1.95	+3.44	+4.93
1968 I	-1.32	+0.16	+1.63	+0.93	+2.41	+3.88
1968 II	-1.52	-0.05	+1.38	-0.19	+1.28	+2.71
1968 III	-0.35	+1.15	+2.65	+1.02	+2.52	+4.02
1968 IV	-0.46	+1.14	+2.73	+1.97	+3.57	+5.17
1969 I	-0.91	+0.68	+2.28	+1.73	+3.32	+4.92
1969 II	-2.27	-0.82	+0.66	-0.08	+1.37	+2.85
1969 III	-1.64	-0.28	+1.08	-2.37	-1.01	+0.35
1969 IV	-3.14	-1.86	-0.59	-3.22	-1.94	-0.67

Source: Table 14.

1960's. In total, production on defense procurement contracts during the 1965 through 1969 period has exceeded payments by about $6 billion and has exceeded deliveries by about $12 billion. The converse to this finding is that for some period of time in the early 1970's, payments and deliveries will exceed production by $6 billion and $12 billion respectively. This excess of payments and deliveries over production will occur, of course, only if the overall level of defense procurement activity either stabilizes or continues to decline.

The data in Table 15 also indicate the potential which existed for underestimating the economic consequences of the early part of the Vietnam buildup. Between the second quarter of 1965 and the last quarter of 1966, production on defense procurement contracts exceeded payments by $4.2 billion and production exceeded deliveries by $5.3 billion. In the last half of 1966 alone, production exceeded payments by $1.7 billion and production exceeded deliveries by $2.1 billion. In the absence of other economic intelligence, the defense payments and deliveries data would have misled the economic analysts and policy makers in late 1966 both as to the total amount of private resources which had been consumed in defense production since the start of the buildup, and as to the rate at which private resources were being consumed in defense production at that time.

ADJUSTMENTS TO THE NATIONAL INCOME AND PRODUCT ACCOUNTS

It has been previously established that the data in the national income and product accounts were most widely used to evaluate the economic impact of the Vietnam buildup. It has also been established that these accounts measure the economic output of defense procurement activity at the time of delivery. Prior to delivery, production on defense procurement contracts is included in the change in private business inventories. As a substantial amount of production often occurs on new contracts before deliveries are made, it is likely that the national income and product accounts did not reflect accurately the fiscal effects of the Vietnam buildup.

The potential errors which could have resulted from using the national income and product accounts to evaluate the economic impact of the Vietnam buildup are of at least three types. First, the series on defense purchases of goods and services, which measures defense procurement activity at the time of delivery, may have understated the direct fiscal impact of the buildup. Second, the series on private business inventories, which includes defense production until the time of delivery, may have overstated the accumulation of inventories directly attributable to civilian economic activity during the buildup. Finally, the surplus or deficit in the Federal sector of the national income and product accounts,

which includes defense purchases of goods and services on the expenditure side, may have understated the expansionary influence of the Federal government on the economy during the buildup.

The measurements of undelivered production derived in the previous section make it possible to adjust the national income and product accounts so that they may more accurately reflect the economic consequences of the Vietnam buildup. Positive values for undelivered production reflect production that has occurred in the private sector but which has not yet been delivered. Therefore, positive values for undelivered production should be added to the defense purchases series, subtracted from the change in inventories and subtracted from the surplus or deficit in the Federal sector of the national income and product accounts. These adjustments should make the national income and product accounts a more valid indicator of the economic consequences of the Vietnam buildup.

The suggested adjustments to the series on defense purchases of goods and services are shown in Table 16 . The estimates of undelivered production shown in this table are those resulting from the use of equation (r) and the 80 percent adjustment to "Gross Unpaid Obligations Outstanding for Procurement."

It is shown in Table 16 that between the second quarter of 1965 and the last quarter of 1966, when the sharpest phase of the Vietnam buildup took place, the change in the published series was greater than the change in

TABLE 16

ADJUSTED SERIES ON NIA DEFENSE PURCHASES OF GOODS AND SERVICES FOR 1965-1969

Year & Quarter	(1) Published Defense Purchases of Goods and Services	(2) Estimates of Undelivered Production Based on 80% Adjustment to Gross Obligations	(3) Adjusted Defense Purchases of Goods and Services	(4) Change in Published Defense Purchases	(5) Change in Adjusted Defense Purchases
1964 IV	48.5	0.9	49.4		
1965 I	48.2	1.8	50.0	-0.3	+0.6
1965 II	49.1	1.4	50.5	0.9	+0.5
1965 III	50.7	2.0	52.7	1.6	+2.2
1965 IV	52.5	2.3	54.8	1.8	+2.1
1966 I	55.3	3.8	59.1	2.8	+4.3
1966 II	58.6	3.3	61.9	3.3	+2.8
1966 III	63.0	3.9	66.9	4.4	+5.0
1966 IV	65.4	4.5	69.9	2.4	+3.0
1967 I	69.9	3.2	73.1	4.5	+3.2
1967 II	71.9	2.1	74.0	2.0	+0.9
1967 III	73.0	3.4	76.4	1.1	+2.4
1967 IV	74.6	3.4	78.0	1.6	+1.6
1968 I	76.1	2.4	78.5	1.5	+0.5
1968 II	77.9	1.3	79.2	1.8	+0.7
1968 III	78.8	2.5	81.3	1.1	+1.9
1968 IV	79.3	3.6	82.9	0.5	+1.6
1969 I	79.0	3.3	82.3	0.3	-0.6
1969 II	78.5	1.4	79.9	0.5	-1.4
1969 III	80.3	-1.0	79.3	1.8	-0.6
1969 IV	79.2	-1.9	77.3	-0.9	-2.0

Sources:

Column 1: 1964 IV - 1965 IV: National Income and Product Accounts of the United States, 1929-1965, August 1966, Table 1.1, p. 3.

1966 I - 1966 IV: Survey of Current Business, July 1968, Table 1.1, p. 19.

1967 I - 1968 IV: Survey of Current Business, July 1969, Table 1.1, p. 17.

1969 I - 1969 IV: 1970 Economic Report of the President, February, 1970, Table C-1, p. 177.

Column 2: Table 15.

adjusted series in only two quarters. For the full seven quarter period, the adjusted series increased, on the average, 15 percent more per quarter than the published series.

The suggested adjustments to the NIA series on the change in private business inventories are shown in Table 17. These adjustments indicate that the inclusion of undelivered defense production in the series on private business inventories obscures the change in inventories caused by civilian economic activity. Between the second quarter of 1965 and the last quarter of 1966, the published series overstates the changes in civilian inventories by between $1.4 billion and $4.5 billion. As a large increase in defense production is generally considered to be inflationary and a large overhang in civilian inventories is considered to be deflationary, failure to identify the magnitude of the accumulation of business inventories during the Vietnam buildup which was directly attributable to defense activity could have contributed to inappropriate stabilization policy decisions.

The final revisions suggested by the estimates of undelivered production are in the Federal sector of the national income and product accounts. Defense purchases of goods and services enter directly into the series on total expenditures of the Federal Government. Therefore, an increase in defense purchases causes a commensurate

TABLE 17

ADJUSTED SERIES ON NIA CHANGE IN PRIVATE BUSINESS INVENTORIES

(Billions of Dollars at Annual Rates)

Year & Quarter	(1) Change in Published Business Inventories	(2) Estimates of Undelivered Production Based on 80% Adjustment to Gross Obligations	(3) Change in Adjusted Business Inventories
1964 IV	7.4	0.9	6.5
1965 I	9.5	1.8	7.7
1965 II	7.6	1.4	6.2
1965 III	8.7	2.0	6.7
1965 IV	10.4	2.3	8.1
1966 I	10.9	3.8	7.1
1966 II	15.4	3.3	12.1
1966 III	12.8	3.9	8.9
1966 IV	19.8	4.5	15.3
1967 I	9.0	3.2	5.8
1967 II	3.4	2.1	1.3
1967 III	7.8	3.4	4.4
1967 IV	9.5	3.4	6.1
1968 I	1.6	2.4	-0.8
1968 II	9.9	1.3	8.6
1968 III	7.2	2.5	4.7
1968 IV	10.5	3.6	6.9
1969 I	6.6	3.3	3.3
1969 II	6.9	1.4	5.5
1969 III	10.7	-1.0	11.7
1969 IV	7.8	-1.9	9.7

Sources: Column 1: 1964 IV-1965 IV: The National Income and Product Accounts of The United States August, 1966, Table 1.1, p. 3.
1966I-1966 IV: Survey of Current Business, July 1968, Table 1.1, p. 19.
1967 I-1968 IV: Survey of Current Business, July 1969, Table 1.1, p. 17.
1969 I-1969 IV: 1970 Economic Report of the President, February 1970, Table C-1.

Column 2: Table 15.

reduction in the surplus or deficit in the national income and product accounts budget.

In Table 18, the surplus or deficit in the Federal sector of the national income accounts is revised to properly reflect the previous adjustments to the series on defense purchases. These adjustments indicate that Federal fiscal policy was significantly more expansionary during the Vietnam buildup than had previously been indicated. While the published data had indicated that the NIA Federal budget was approximately in balance between the second quarter of 1965 and the last quarter of 1966, the adjusted series indicates that the NIA budget was, on the average, $3.1 billion in deficit for each of the seven quarters and more than $8.0 billion in deficit in the last quarter of 1966.

Although any one of the adjusted series discussed in this section may not have caused the Nation's economic policy makers to adopt more restrictive fiscal policies during the Vietnam buildup, the existence of all three of the adjusted series might have had such an effect. It would in fact have been difficult not to subscribe to more restrictive policies if a 15 percent faster growth in the quarterly change in defense purchases, a 25 percent slower growth in the quarterly accumulation of private business inventories and a consistent deficit in the NIA budget were being monitored. Therefore, it is

TABLE 18

ADJUSTED SURPLUS OR DEFICIT IN FEDERAL SECTOR OF NATIONAL INCOME AND PRODUCT ACCOUNTS FOR 1965-1969

(Billions of Dollars at Annual Rates)

Year & Quarter	(1) Published Surplus or Deficit	(2) Estimates of Undelivered Production Based on 80% Adjustment to Gross Obligations	(3) Adjusted Surplus or Deficit
1965 I	4.4	1.8	2.6
1965 II	4.7	1.4	3.3
1965 III	-3.1	2.0	-5.1
1965 IV	-1.1	2.3	-3.4
1966 I	1.4	3.8	-2.4
1966 II	3.0	3.3	-0.3
1966 III	-1.2	3.9	-5.1
1966 IV	-4.1	4.5	-8.6
1967 I	-12.0	3.2	-15.2
1967 II	-13.2	2.1	-15.3
1967 III	-13.4	3.4	-16.8
1967 IV	-12.3	3.4	-15.7
1968 I	-8.4	2.4	-10.8
1968 II	-9.5	1.3	-10.8
1968 III	-2.8	2.5	-5.3
1968 IV	-.1	3.6	-3.7
1969 I	+10.1	3.3	+6.7
1969 II	+13.5	1.3	+12.2
1969 III	+7.7	-1.0	+8.7
1969 IV	+6.6	-1.9	+8.5

Sources: Column 1: 1965 I-1968 IV: Survey of Current Business, July 1969, Table 3.2, p. 30. 1969 I-1969 IV: 1970 Economic Report of the President, February 1970, Table C-64, p. 253.

Column 2: Table 15.

concluded that the model developed and tested in this dissertation would have been helpful to economic policy makers in evaluating the economic impact of the Vietnam buildup.

WEIDENBAUM'S, GALPER'S AND AUTHOR'S ADJUSTMENTS TO NATIONAL INCOME AND PRODUCT ACCOUNTS

In Chapter II, the analyses of defense economic impact by Murray Weidenbaum and Harvey Galper were discussed. Both scholars have previously indicated that the defense expenditures data, as recorded in the national income and product accounts, are not accurate indicators of defense economic impact, particularly during a defense buildup or slowdown. In an attempt to improve the quality of these data, Weidenbaum and Galper each proposed adjustments to the national income and product accounts for the period of the Vietnam buildup. Weidenbaum made his adjustments on the basis of the excess of defense obligations over defense expenditures during the Vietnam buildup. Galper made his adjustments on the basis of changes in defense contract awards and certain assumptions concerning the rate of production on these awards by defense firms.

As discussed in Chapter II, the major shortcoming of the Weidenbaum and Galper analyses has been the absence of a

definitive method of validation. Specifically there have been no direct estimates of defense production for the Vietnam buildup with which the Weidenbaum and Galper adjustments could be compared. This study provides the required direct estimates of production.

The adjustments proposed by Weidenbaum and Galper are identical in definition to what has been referred to in this study as undelivered production. The adjustments in all cases are the amounts by which the national income and product accounts understated the impact of defense activity during the Vietnam buildup. The adjustments recommended by Weidenbaum and Galper to compensate for this understatement are compared with the author's recommended adjustments in Table 19.

With the exception of Weidenbaum's series A adjustment, all of the results in Table 19 are in general agreement. For the second half of 1965 and the full year of 1966, Weidenbaum's series B adjustment indicates that, on the average, the national income and product accounts understated defense production, by $3.1 billion and Galper's adjustments indicate that the understatement was between $2.8 and 2.9 billion. The author's adjustments indicate that the magnitude of the understatement was between $2.2 billion and $4.4 billion with the most likely amount of the understatement being $3.3 billion. Therefore, Weidenbaum's series B adjustment and

Table 19

ADJUSTMENTS TO NATIONAL INCOME AND PRODUCT ACCOUNTS BY MURRAY WEIDENBAUM, HARVEY GALPER AND THE AUTHOR
(Billions of Dollars at Annual Rates)

	Weidenbaum's Adjustments for Defense Obligations		Galper's Adjustments For Goods-in-Process Inventory Investment		Author's Adjustments For Undelivered Production		
	A	B	Rectangular Production Assumption	Inverted Production Assumption	75% Adj. to Gross Oblig.	80% Adj. to Gross Oblig.	85% Adj. Gross Ob.
1965	1	2	3	4	5	6	7
1st half	2.0	1.0	-0.8	-0.9	.8	1.6	2.5
2nd half	5.2	2.6	1.7	1.6	1.2	2.2	3.1
1966							
1st half	8.4	4.2	2.9	2.8	2.4	3.6	4.5
2nd half	5.2	2.6	4.1	4.1	2.9	4.2	5.5

Sources:

Columns 1 and 2: Table 5
Columns 3 and 4: Table 6
Columns 5, 6, and 7: Table 15

both of Galper's adjustments are within the range of estimates by the author and are all within $.5 billion, at an annual rate, of the author's most likely estimate.

Weidenbaum's series A adjustments do not conform with the author's findings. In these adjustments, Weidenbaum indicates that, on the average, the national income and product accounts understated the rate of defense production by $6.3 billion between mid-1965 and the end of 1966. This adjustment is approximately 50 percent greater than the high end of the range of estimates derived by the author and approximately twice the author's most likely estimate of the amount by which the national income and product accounts data understated actual production on defense procurement contracts.

One final comparison among the recommended adjustments in Table 19 is worthwhile. The adjustments by Galper and the author show a general upward trend after mid-1965 and reach peak levels in the last half of 1966. By comparison, Weidenbaum's recommended adjustments achieve their highest levels in the first half of 1966 and decline in the last half of 1966. Although not a definitive test, the behavior of private business inventories between mid-1965 and the end of 1966 lend more support to the Galper/author adjustments than to the Weidenbaum adjustments.

Between mid-1965 and the end of 1966, accumulation was gradually increasing and increased $2.1 billion, at an annual rate, between the first and last half of 1966.[1] Weidenbaum's analysis would indicate that all of this increase plus an additional $1.6 to $3.2 billion[2] was attributable to investment in civilian business inventories. Galper's analysis would indicate that $1.2 to $1.3 billion of the increase, or approximately one half of the total increase in the rate of private business inventory accumulation, was directly attributable to increases in defense inventories. The author's adjustments would indicate that between $0.5 billion and $1.0 billion of the increase was directly attributable to increases in defense inventories. Given the increasing levels of defense obligations and contract awards throughout 1966, the results achieved by Galper and the author appear more reasonable.

For purposes of economic policy decision making, determining which of the recommended adjustments represent

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[1]U.S., Department of Commerce, 1969 Business Statistics (Washington: U.S. Government Printing Office, 1969) p. 2.

[2]The difference between Weidenbaum's adjustments for the first and second half of 1966.

the correct trend could be of critical importance. The Weidenbaum adjustments indicate that civilian inventories were increasing at an unsustainable rate in late 1966 and would need to be disinvested in 1967. Such disinvestment would be expected to act as a depressing influence on the economy during 1967 and would have discouraged the adoption of more restrictive stabilization policies in late 1966 and early 1967. The adjustments recommended by Galper and the author indicate less inventory disinvestment in civilian inventories in 1967 and would have been less likely to discourage more restrictive stabilization policies during this period. In retrospect, more restrictive stabilization policies should not have been discouraged in late 1966 and early 1967. Therefore, the adjustments to the national income and product accounts recommended by Harvey Galper and the author appear to be the more reasonable in light of the behavior of private business inventories in the last half of 1966 and in light of the economic record of the late 1960's.

CONCLUSION

On the basis of a small sample of defense procurement contracts, a statistical model for estimating the production or economic output defense procurement contracts has been

developed. The model has been applied to the population data reported during the Vietnam buildup. This application helped quantify the deficiencies of the Government payments and deliveries data in measuring the economic consequences of the Vietnam buildup and of the current slowdown.

It is concluded that the statistical model developed in this dissertation can assist economic analysts and policy makers in evaluating the economic effects of defense activity. First, the model permits a more accurate measurement of what portion of a change in private business inventories reflects defense activity and what portion reflects civilian activity. This should lead to better forecasts of both the total national output (GNP) and the composition of this output. Second, the model will permit a more precise measurement of the timing and magnitude of the economic impact of defense procurement activity. This should lead to a refined estimate of the government spending, or defense spending, multiplier used in the various macroeconomic models. Both of these improvements should enhance our knowledge of how and when defense activity impacts on the economy and improve our ability to formulate economic policies to counteract the potentially destabilizing influences of large swings in defense activity.

APPENDIX A

PROCEDURES FOR SELECTING SAMPLE AND DATA FROM THE SAMPLE

The contract universe for the sample of contracts analyzed in this dissertaion was constrained to Air Force and Navy contracts which were: (1) one million dollars or larger; (2) for aircraft, missile and space systems or electronics and communications equipment; (3) administered by one of the 50 largest defense contractors; and (4) begun between mid-1963 and mid-1967. The contract universe was further constrained to include only contracts which were at least 80 percent complete, i.e., unpaid obligations were less than 20 percent of total obligations, and which were still "open" as of August 1969. These constraints were imposed on the basis of what was considered practicable and what was considered the potentially most fruitful areas of investigation.

The constraints concerning Air Force and Navy contracts, the percentage of completion of the contracts, and contracts which were still "open" resulted from considerations of practicability. Only the Air Force and Navy were able to provide master contract lists identifying all of their contracts which satisfied the basic criteria of size of contract, type of commodity, name of contractor, date of contract award and current

percentage of completion. The percentage of completion constraint insured that time would not be wasted on contracts which showed only a brief period of performance. Finally, the requirement that the contract still be "open" as of August 1969 was imposed in order to assure the availability of the required accounting and financial records on the contract at both the Department of Defense accounting and disbursing offices and at the defense contractor's plant.

The constraints concerning the size of contract, the type of commodity, the size of contractor, and the date when the contract began resulted from considerations as to what were the potentially most fruitful areas of investigation. The deficiencies of payments and deliveries data in the measurement of defense production are most severe on large defense contracts for major hard goods procurement. It is in this category of defense activity that contracts are let for complex weapon systems which are produced over extended periods of time. Therefore, this category is where substantial production takes place early in the contracts which is not immediately reflected in either payments from the Defense Department or deliveries to it.

The constraints on the size of contract and type of procurement program as well as the size of the contractor further assured that attention would be focused on those contracts and contractors where the Defense Department

spends a large and concentrated portion of its procurement funds. In fiscal year 1968, two-thirds of the value of all Department of Defense contract awards was one million dollars or larger and about half was for aircraft, missiles and electronics.[1] Further, 56.9 percent of the value of Defense Department contracts was awarded to one of the 50 largest defense contractors (Table 20).

The constraints concerning when the contract was begun assured that the sample would include contracts begun before, during and after the sharpest phase of the Vietnam buildup. This was considered necessary in order to relate the analysis of the sample data to the much larger population data reported by the Government covering the same period. Based on all of the above constraints, master contract lists provided by the Air Force and Navy were screened to identify all eligible contracts as of July 1969. From this information, with guidance from Department of Defense officials, 15 contractors were chosen which were administering eligible contracts.

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[1]U.S., Department of Defense, Military Prime Contract Awards and Subcontract Payments or Committments, (Washington: Defense Printing Office, 1969), p. 20.

TABLE 20

PRIME CONTRACT AWARDS TO THE 50 LARGEST DEFENSE CONTRACTORS FOR FISCAL YEAR 1969

Rank	Companies	Thousands of Dollars	Percent of U.S. Total	Cumulative Percent of U.S. Total
	U.S. Total	$36,888,601	100.00	100.00
1.	Lockheed Aircraft Corp.	2,040,236	5.53	5.53
2.	General Electric Co.	1,620,775	4.39	9.92
3.	General Dynamics Corp.	1,243,055	3.37	13.29
4.	McDonnel Douglas Corp.	1,069,743	2.90	16.19
5.	United Aircraft Corp.	997,380	2.70	18.89
6.	American Tele & Tele Co.	914,579	2.48	21.37
7.	Ling Temco Vought Inc.	914,114	2.48	23.85
8.	North American Rockwell Corp.	674,175	1.83	25.68
9.	Boeing Co.	653,638	1.77	27.45
10.	General Motors Corp.	584,439	1.58	29.03
11.	Raytheon Co.	546,772	1.48	30.51
12.	Sperry Rand Corp.	467,861	1.27	31.78
13.	AVCO Corp.	456,054	1.24	33.02
14.	Hughes Aircraft Co.	439,016	1.19	34.21
15.	Westinghouse Electric Corp.	429,558	1.16	35.37
16.	Textron Inc.	428,290	1.16	36.53
17.	Grumman Air. Eng. Corp.	417,052	1.13	37.66
18.	Honeywell Inc.	405,575	1.10	38.76
19.	Ford Motor Co.	396,333	1.07	39.83
20.	Olin Matheieson Chemical Corp.	354,359	0.96	40.79
21.	Litton Industries, Inc.	317,102	0.86	41.65
22.	Teledyne Inc.	308,455	0.84	42.49
23.	RCA Corp.	298,992	0.81	43.30
24.	Standard Oil Co. (N.J.)	291,053	0.79	44.09
25.	Martin Marietta Corp.	264,279	0.72	44.81
26.	General Tire & Rubber Co.	263,501	0.71	45.52
27.	Int'l Business Machines Corp.	256,623	0.70	46.22
28.	Raymond Morrison Knudson (JV)	254,000	0.69	46.91
29.	Int'l Telephone & Tele Corp.	238,267	0.65	47.56
30.	Tenneco Inc.	236,679	0.64	48.20

TABLE 20 (Continued)

Rank	Companies	Thousands of Dollars	Percent of U.S. Total	Cumulative Percent of U.S. Total
31.	Dupont - I De Nemours & Co.	211,965	0.57	48.77
32.	FMC Corp	195,625	0.53	49.30
33.	Norris Industries	187,553	0.51	49.81
34.	Bendix Corp.	184,437	0.50	50.31
35.	Hercules Inc.	179,622	0.49	50.80
36.	Northrop Corp.	178.907	0.48	51.28
37.	Uniroyal Inc.	174,088	0.47	51.75
38.	TRW Inc.	170,379	0.46	52.21
39.	Pan American World Airways Inc.	167,437	0.45	52.66
40.	Asiatic Petroleum Corp.	155,583	0.42	53.08
41.	Mobil Oil Corp.	151,515	0.41	53.49
42.	Standard Oil Co. of Calif.	148,773	0.40	53.89
43.	Fairchild Hiller Corp.	148,586	0.40	54.29
44.	Collins Radio Co.	145,751	0.40	54.69
45.	Kaiser Industries Corp.	142,398	0.39	55.08
46.	General Telephone & Electn Corp.	140,476	0.38	55.46
47.	Day & Zimmerman Inc.	137,793	0.37	55.83
48.	Texas Instruments Inc.	132,483	0.36	56.19
49.	Federal Cartridge Corp.	131,901	0.36	56.55
50.	Magnavox Co.	130,282	0.35	56.90

Source: Department of Defense, 100 Companies and Their Subsidiary Corporations Listed According to Net Value of Military Prime Contract Awards, Fiscal Year 1969, October 1969, pp. 7-13.

The 15 contractors with eligible contracts were visited between August 1969 and January 1970. In each case, the contractor was asked to assist in reconstructing the monthly production and other performance parameters on a small number of eligible contracts. All contractors who were visited agreed to participate and provide as much of the requested information as possible.

The final determination of which of the eligible contracts would be reconstructed for complete analysis was made largely by the appropriate defense contractor. The contractor was, however, urged to reconstruct the performance of those contracts for which he had the most complete records. Additionally, he was urged to select contracts of different sizes, different pricing provisions, and different beginning dates to the maximum extent possible. Finally, no contractor was allowed to reconstruct the performance of more than six contracts. The final sample is enumerated in Table 21.

BASIC DATA FOR TOTAL SAMPLE AND SUBSAMPLE

The obligations, production, payments and deliveries data for the total sample and each of the five subsamples are given in Tables 22 - 28.

TABLE 21

ENUMERATION OF SAMPLE CONTRACTS AND THEIR BASIC CHARACTERISTICS

Contract[1]	Year & Month of First Activity	Year & Month of Letter Contract Award[2]	Year & Month of Definitized Contract Award	Procurement Program	Type of Contract[3]	Progress Payment Percentage[4]	Final Contract Value ($)[5]
N23	6509	6509	6903	Electronics	FFP	.80	102837
AF13	6501	6508	6607	Aircraft	FFPV	.70	73700
AF14	6603	6609	6704	Aircraft	FPIFV	.70	82233
AF15	6409	6411	6505	Aircraft	FFP	.70	59116
AF16	6408	6409	6501	Aircraft	FPIFV	.70	71931
AF17	6504	6508	6606	Aircraft	FPIFV	.70	48330
AF21	6610	6610	6802	Missiles	FFPV	.70	8241
N20	6601	-	6603	Missiles	FFP	.70	44975
N30	6509	-	6509	Electronics	FP	.70	2471
N3	6409	-	6503	Aircraft	FFP	.70	17466
N13	6408	-	6411	Aircraft	FFP	.70	130348
N18	6702	6602	6708	Missiles	FFP	.70	53144
AF2	6408	6408	6502	Missiles	FPIF	.70	246118
N19	6608	6408	6502	Missiles	CPIF	-	56829
AF12	6601	6601	6707	Missiles	FPIFV	.70	27291
AF11	6601	6601	6703	Missiles	CPIF	-	98696
N31	6607	-	6606	Electronics	FFP	.70	2082
N25	6512	6512	6612	Electronics	CPIF	-	11021
N45	6405	6408	6503	Aircraft	FFP	.70	48414
AF9	6612	6703	6707	Missiles	FPIFV	.70	9646
AF8	6606	6606	6701	Missiles	FFPV	.70	12208
AF10	6407	6407	6409	Missiles	CPIF	-	35822
N24	6409	-	6509	Aircraft	FFP	.70	166407
N29	6506	-	6506	Electronics	FPIF	.70	1407
AF4	6702	6702	6712	Other	CPIFV	-	1657
N17	6611	6611	6705	Missiles	FFP	.80	52950
N14	6507	-	6601	Aircraft	FFP	.70	93809

AF3	6511	6511	6606	Missiles	FPIFV	.70	14373
N33	6707	-	6706	Electronics	FFP	.70	2043
N10	6409	-	6411	Aircraft	FFP	.70	220819
N47	6309	6309	6312	Aircraft	FPIFV	.70	37646
N46	6501	6606	6701	Aircraft	FFP	.70	160973
AF7	6503	6504	6607	Aircraft	FPIFV	.70	57085
AF6	6508	-	6508	Missiles	FFP	.70	19108
N32	6612	6612	6706	Electronics	FFP	.70	1945
N11	6410	-	6410	Aircraft	FFP	.70	29317
N9	6403	-	6403	Aircraft	FP	.70	4852
N4	6509	-	6509	Aircraft	CPFF	-	1493
N6	6605	6611	6807	Aircraft	FFP	.80	184013
N16	6604	-	6706	Aircraft	FP	.70	104998
N26	6706	6706	6810	Aircraft	FFP	.80	10369
N34	6403	-	6810	Aircraft	FP	.70	107293
N22	6506	-	6504	Electronics	FPI	.70	28816
N21	6403	6403	6503	Missiles	FFP	.70	81988
N27	6610	6610	6806	Aircraft	FFP	.70	134836
N36	6609	-	6609	Other	FFP	.70	2492
N41	6501	6501	6611	Electronics	CPFF	-	11951
N42	6311	-	6408	Missiles	FPP	.70	55215
N43	6412	-	6412	Electronics	CPFF	-	1104
N44	6601	6601	6606	Electronics	FFP	.70	3165
N1	6310	-	6310	Aircraft	FFP	-	1070

[1]The letter N denotes a Navy contract and the letters AF denote an Air Force contract.

[2]The first two numbers indicate the calendar year and the last two letters indicate the month of the year. The letter and definitized contract award information was extracted from DOD accounting records.

[3]All types designated by the letter F are fixed price contracts and all types designated by the letter C are cost plus contracts.

[4]This column indicates the percent of total costs reported by the contractor for which he receives payment from the Defense Department prior to deliveries.

[5]This column indicates the final obligations on the contract.

TABLE 22

OBLIGATIONS, PRODUCTION, PAYMENTS AND DELIVERIES
DATA FOR ALL SAMPLE CONTRACTS
(MILLIONS OF DOLLARS)

Month	Obligations	Production	Payments	Deliveries
1	227.4	20.0	16.2	4.4
2	324.5	31.8	20.1	6.4
3	485.1	42.4	27.1	8.7
4	670.8	66.4	38.5	10.6
5	753.2	94.6	56.4	15.3
6	783.0	153.9	78.6	19.5
7	456.8	180.1	119.4	28.3
8	1075.4	238.0	153.6	36.1
9	1340.9	305.8	208.3	45.3
10	1511.9	387.6	274.8	57.2
11	1596.6	489.9	351.0	70.3
12	1669.5	591.9	425.0	92.4
13	1748.2	737.9	511.7	123.3
14	1903.9	840.7	608.8	164.7
15	2020.2	969.9	720.0	214.1
16	2171.0	1121.2	835.1	274.3
17	2234.9	1259.3	945.3	339.1
18	2441.0	1399.2	1072.1	450.0
19	2517.6	1544.6	1193.9	547.8
20	2561.4	1685.0	1352.0	647.8
21	2602.1	1800.7	1490.4	770.4
22	2646.8	1922.9	1635.0	936.3

TABLE 22(Continued)

Month	Obligations	Production	Payments	Deliveries
23	2717.4	2035.2	1793.2	1187.1
24	2723.3	2134.4	1903.3	1319.0
25	2749.8	2231.1	2018.5	1494.2
26	2779.0	2308.6	2124.4	1649.1
27	2751.1	2373.0	2242.2	1792.3
28	2702.7	2438.7	2282.2	1937.3
29	2752.7	2490.9	2365.5	2067.7
30	2784.7	2540.6	2472.0	2158.1
31	2791.5	2585.3	2483.8	2248.4
32	2810.0	2625.5	2545.2	2321.4
33	2873.6	2639.4	2594.8	2395.6
34	2850.8	2662.2	2533.3	2458.6
35	2856.8	2678.4	2663.3	2505.0
36	2865.6	2693.5	2692.9	2539.6
76	2836.3	2765.9	2765.9	2702.6

Source: Sample of 51 defense procurement contracts.

TABLE 23

OBLIGATIONS, PRODUCTION, PAYMENTS AND DELIVERIES
DATA FOR NAVY SUBSAMPLE
(MILLIONS OF DOLLARS)

Month	Obligations	Production	Payments	Deliveries
1				
2	269.6	30.6	20.0	6.4
3	426.0	39.5	25.9	8.2
4	598.2	58.5	35.0	9.8
5	662.5	79.3	49.2	13.2
6	679.8	127.4	65.4	15.7
7	826.1	140.5	96.2	22.6
8	935.3	182.6	120.9	27.6
9	995.3	232.7	164.4	32.1
10	1112.4	294.7	210.8	40.1
11	1183.2	367.3	268.8	49.1
12	1190.1	439.7	322.6	66.3
13	1255.5	525.1	387.2	91.8
14	1384.7	612.8	458.5	126.3
15	1465.0	708.6	538.2	165.1
16	1562.0	817.2	635.4	198.8
17	1574.0	912.8	686.5	234.0
18	1719.6	1007.9	771.6	304.6
19	1787.3	1105.1	850.6	363.1
20	1815.2	1203.6	959.6	417.1
21	1849.8	1282.1	1057.9	490.4
22	1880.5	1368.8	1162.7	604.0

TABLE 23 (Continued)

Month	Obligations	Production	Payments	Deliveries
23	1925.0	1448.2	1279.0	801.3
24	1919.9	1515.4	1355.3	887.5
25	1944.6	1584.9	1435.8	1014.5
26	1976.7	1633.9	1511.0	1124.9
27	1941.7	1675.2	1597.6	1227.1
28	1879.9	1716.1	1611.7	1333.5
29	1917.9	1747.8	1666.9	1423.9
30	1948.7	1780.2	1712.8	1492.4
31	1950.8	1808.5	1749.5	1548.3
32	1963.2	1833.8	1797.6	1601.8
33	1969.7	1835.9	1824.7	1642.5
34	1994.3	1849.1	1849.0	1693.0
35	1997.7	1861.0	1868.5	1723.9
36	2006.1	1870.8	1889.6	1747.0
76	1970.7	1907.9	1907.8	1838.9

Source: Subsample of 35 Navy procurement contracts.

TABLE 24

OBLIGATIONS, PRODUCTION, PAYMENTS AND DELIVERIES DATA FOR AIR FORCE SUBSAMPLE (MILLIONS OF DOLLARS)

Month	Obligations	Production	Payments	Deliveries
1				0.0
2	54.9	1.1	0.1	0.0
3	59.1	3.0	1.2	0.6
4	72.6	8.0	3.5	0.8
5	90.7	15.3	7.3	2.1
6	103.2	26.5	13.2	3.9
7	130.7	29.6	23.2	5.7
8	140.1	55.4	32.7	8.6
9	345.6	73.2	43.9	13.2
10	399.5	92.9	64.0	17.1
11	413.4	122.6	82.2	21.3
12	479.4	152.2	102.9	26.1
13	492.7	212.9	124.5	31.5
14	519.2	227.9	150.3	38.3
15	555.2	261.2	181.8	49.0
16	609.0	304.7	217.7	75.6
17	660.0	346.5	258.8	105.1
18	721.4	391.4	300.5	145.2
19	730.3	439.5	343.3	184.8
20	746.2	481.4	392.4	230.7
21	752.3	518.6	432.5	280.0
22	766.3	554.0	472.3	332.4

TABLE 24 (Continued)

Month	Obligations	Production	Payments	Deliveries
23	792.4	587.0	514.2	385.7
24	803.4	619.1	548.0	431.5
25	805.2	646.2	582.7	479.7
26	802.3	674.7	613.4	524.2
27	809.4	697.8	644.4	565.2
28	822.8	722.5	670.5	603.8
29	834.8	743.2	698.6	643.9
30	836.0	760.5	714.2	665.7
31	840.7	776.8	734.3	700.0
32	846.8	791.8	747.6	719.5
33	853.9	803.4	770.1	752.5
34	856.5	813.1	784.3	765.6
35	859.1	817.4	794.8	781.1
36	859.5	822.7	803.3	792.3
76	865.6	858.0	858.0	863.7

Source: Subsample of 16 Air Force procurement contracts.

TABLE 25

OBLIGATIONS, PRODUCTION, PAYMENTS AND DELIVERIES
DATA FOR AIRCRAFT SUBSAMPLE
(MILLIONS OF DOLLARS)

Month	Obligations	Production	Payments	Deliveries
1	63.8	21.1	15.7	5.0
2	100.1	25.3	18.2	5.0
3	255.1	30.5	20.7	5.2
4	397.1	44.8	26.3	5.3
5	455.3	57.8	31.7	5.4
6	456.1	72.9	37.0	5.5
7	587.4	92.4	58.3	9.4
8	681.1	117.9	68.7	9.8
9	743.3	150.7	97.5	9.9
10	813.0	195.5	133.2	13.5
11	872.2	245.9	169.3	16.0
12	936.8	299.7	206.4	22.1
13	954.1	394.3	253.3	31.1
14	1089.6	436.2	302.3	42.4
15	1184.1	517.5	359.8	55.3
16	1319.3	612.9	442.3	82.9
17	1346.5	697.6	490.8	11.9
18	1549.0	785.7	571.1	182.1
19	1583.2	878.6	643.9	230.6
20	1607.2	969.3	751.3	287.9
21	1643.9	1046.9	842.3	357.3
22	1661.8	1134.1	942.0	459.2

TABLE 25(Continued)

Month	Obligations	Production	Payments	Deliveries
23	1697.9	1201.1	1031.2	581.8
24	1750.6	1269.9	1107.3	667.1
25	1716.6	1331.4	1180.1	783.9
26	1753.1	1383.8	1255.4	897.5
27	1712.7	1422.8	1336.8	987.1
28	1643.8	1461.2	1348.2	1088.2
29	1699.9	1495.1	1409.1	1178.8
30	1726.6	1526.5	1451.3	1238.5
31	1731.5	1556.6	1490.0	1300.9
32	1745.8	1578.4	1535.6	1358.3
33	1755.1	1591.1	1571.1	1413.0
34	1779.0	1608.7	1600.4	1462.8
35	1780.7	1620.5	1623.6	1497.6
36	1783.2	1632.6	1646.1	1525.0
60	1739.3	1676.0	1676.0	1625.9

Source: Subsample of 23 aircraft procurement contracts.

TABLE 26

OBLIGATIONS, PRODUCTION, PAYMENTS AND DELIVERIES
DATA FOR MISSILE SUBSAMPLE
(MILLIONS OF DOLLARS)

Month	Obligations	Production	Payments	Deliveries
1	30.2	0	0	0
2	62.8	3.1	0.4	1.3
3	68.3	6.5	3.0	2.3
4	110.8	12.9	6.8	3.6
5	135.0	23.5	16.8	7.3
6	163.0	42.1	29.8	10.8
7	205.0	61.5	44.4	15.0
8	228.7	88.7	64.3	21.8
9	420.5	115.8	84.0	29.7
10	494.4	144.9	108.2	37.4
11	518.4	187.4	142.5	47.6
12	526.3	225.8	172.5	61.5
13	585.9	266.1	202.9	81.7
14	604.9	316.0	241.5	110.1
15	623.6	353.3	286.1	145.0
16	637.6	394.5	325.0	175.8
17	674.2	437.8	361.7	208.6
18	673.5	478.4	397.0	240.4
19	715.9	519.3	435.2	281.4
20	735.0	557.5	477.5	318.2
21	738.3	583.6	511.7	359.0
22	764.5	606.9	544.1	403.3

TABLE 26 (Continued)

Month	Obligations	Production	Payments	Deliveries
23	768.0	640.9	600.3	515.6
24	720.5	662.4	623.6	546.2
25	780.0	686.9	654.5	587.7
26	772.1	704.6	675.2	615.9
27	777.7	721.9	698.2	645.0
28	788.7	740.4	714.5	670.0
29	793.2	753.8	731.8	692.6
30	795.1	767.4	743.2	709.3
31	796.7	778.4	755.6	728.7
32	800.9	790.1	768.5	740.0
33	804.1	793.0	779.2	752.4
34	806.4	796.6	784.4	758.2
35	809.0	799.4	789.3	764.6
36	809.3	801.0	793.1	768.2
60	816.6	817.3	817.3	803.4

Source: Subsample of 15 missile procurement contracts.

TABLE 27

OBLIGATIONS, PRODUCTION, PAYMENTS AND DELIVERIES DATA FOR ELECTRONICS AND OTHER SUBSAMPLE (MILLIONS OF DOLLARS)

Month	Obligations	Production	Payments	Deliveries
1	145.3	0.3	0.5	0.1
2	161.8	3.0	1.3	0.1
3	161.8	5.1	3.4	1.3
4	163.1	7.8	5.4	1.7
5	163.1	11.1	8.0	2.6
6	163.9	14.9	11.7	2.6
7	164.0	19.6	16.7	3.9
8	165.5	23.1	20.7	3.9
9	169.0	28.9	26.7	5.7
10	204.7	47.1	33.4	6.3
11	216.1	56.6	39.2	6.8
12	206.4	66.3	46.5	8.9
13	208.2	77.5	55.6	10.5
14	209.5	88.5	65.0	12.2
15	212.4	99.1	74.1	13.8
16	214.1	144.5	85.8	15.6
17	214.2	124.0	92.8	18.5
18	218.5	135.1	104.0	27.6
19	218.5	146.7	114.8	35.9
20	219.1	158.3	123.3	41.6
21	219.8	170.2	136.5	54.1
22	220.4	181.9	149.0	74.0

TABLE 27 (Continued)

Month	Obligations	Production	Payments	Deliveries
23	251.4	193.3	161.7	89.7
24	252.2	202.1	172.3	105.7
25	253.1	212.6	183.9	122.6
26	253.6	220.3	193.8	135.6
27	260.8	220.3	206.9	160.2
28	270.3	237.1	219.5	179.5
29	259.6	242.1	224.6	196.4
30	263.0	246.8	232.5	210.3
31	263.3	250.3	238.2	218.8
32	263.3	253.0	241.1	223.0
33	264.5	255.3	244.5	229.5
34	265.4	256.9	248.5	237.5
35	267.1	258.4	250.5	242.8
36	273.2	259.9	253.7	246.4
60	280.3	272.0	272.0	272.7

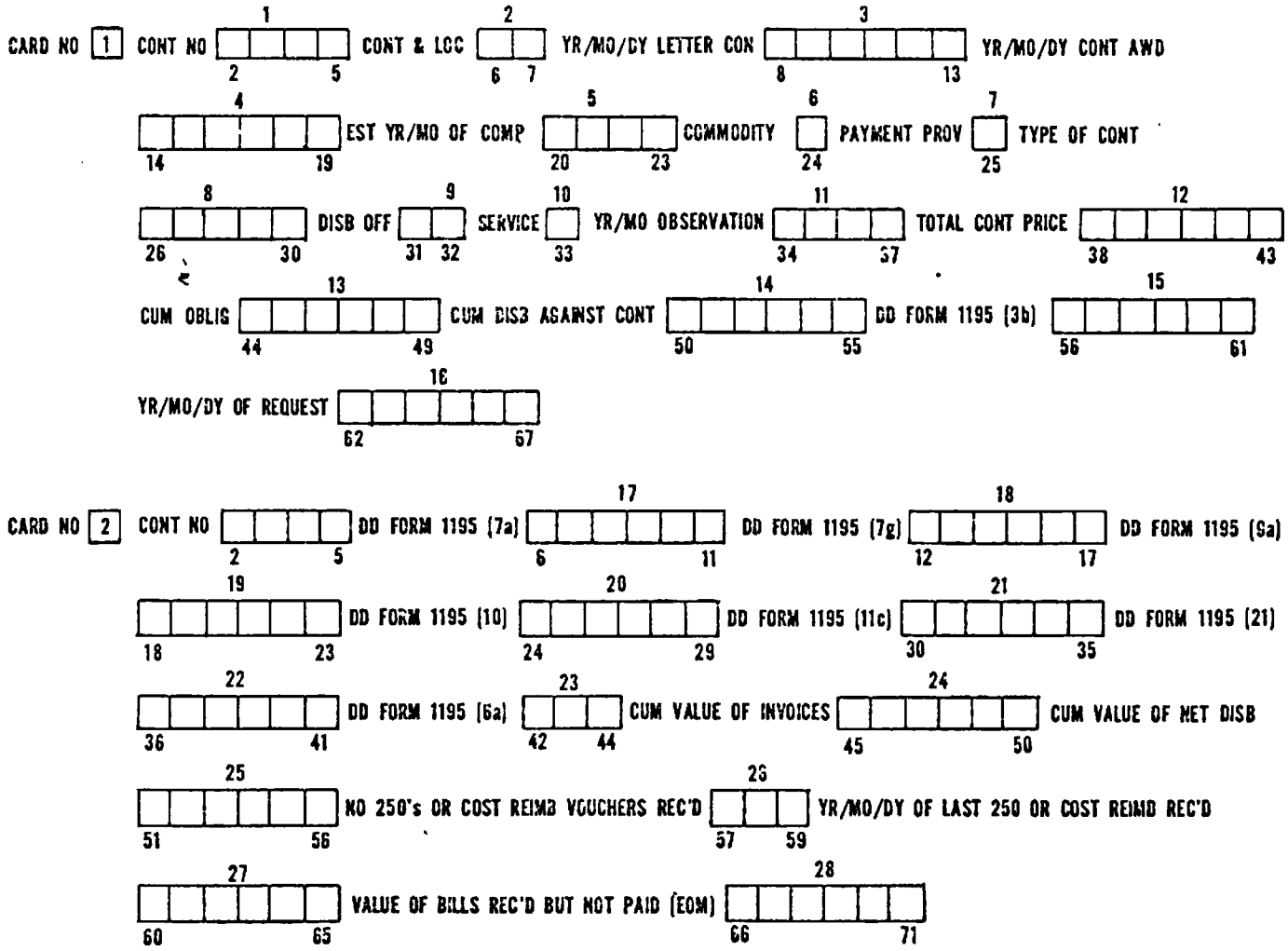
Source: Subsample of 13 electronics and other procurement contracts.

APPENDIX B

The information collected on the sample contracts from the accounting and disbursing offices is shown on Exhibit A. The first two items identify the contract number, the contractor, and the contractor location. These pieces of information are entered according to a coding procedure. This is done in the interest of economy of effort in keypunching and in order to assure the participating contractors anonymity. The dates of the first letter contract and the first definitized contract are entered in items three and four. Item five gives the estimated year and month of the last hardware delivery on the contract. The commodity being purchased is entered in item six. This identifies the contract according to aircraft, missile and space systems, or electronics and communications programs. The payment provision code entered in item seven identifies the contract as permitting progress payments or not permitting progress payments and the type of contract code in item eight identifies the contract as being either of the fixed price or cost reimbursement variety.

The information in items nine and ten identify respectively the Department of Defense disbursing office and the military service administering the contract.

ACCOUNTING/DISBURSING OFFICE REPORT



Item 11 records the appropriate year and month for which all other entries pertain. The total contract price and the Government obligations on the contract are entered in items 12 and 13 respectively. The cumulative disbursements by the Government on the contract are listed in item 14. This entry and all other entries on the questionnaire are recorded as of the end of the month (EOM) indicated in item 11.

The information required in items 15 through 23 is obtained only on fixed price contracts with progress payments. Item 15 requires the contract price of items which are still to be delivered and/or accepted. This represents the total billing price of the undelivered items and/or delivered items not yet accepted and invoiced under the contract. The year, month, and day required in item 16 is the date of the last progress payment request (DD Form 1195) on the contract for the observation month given in item 11. Item 17 requires the cumulative direct material costs on the contract and item 18 requires the cumulative total costs on the contract. The information required in item 19 is the prime contractor's progress payments to its subcontractors and the information in item 20 is the prime contractor's progress payments to its subcontractors plus its subcontractor billings which have not been paid. The progress payments value entered in item 19 is gross of shipment liquidations and the progress payments value included in item 20 is net of shipment liquidations.

The entry in item 21 gives the cumulative costs on the contract eligible for progress payments from the Government. This is equal to the lesser of either the appropriate progress payment percentage, e.g., 80 percent, times the total contract price given in item 12, or the appropriate progress payment percentage times the cumulative costs on the contract given in item 18 plus 100 percent of the progress payments made by the prime contractor to its subcontractors as given in item 20. The prime contractor's unliquidated progress payments are recorded in item 22. This value equals the prime contractor's total progress payments received net of a specified portion of the value of all deliveries to the Government. The information in item 23 is the total number of progress payment requests issued by the prime contractor as of the end of the observation month.

The entry in item 24 is the gross amount of all shipment billing documents received by the disbursing office. Item 25 is the value of all payments made by the disbursing office to the contractor on the basis of either progress billings or shipment billings. Items 26 and 27 require the physical number of shipment billings or cost reimbursement billings and the date of the last one of either type received inthe observation month. The information in item 28 is the value of all billing documents received by the disbursing activity but not paid as of the last day of the observation month. This could be labeled the Government's accounts payable on the contract.

A sheet identical to Exhibit A is filled in for each month of activity on all the sample contracts. The first sheet is for the first month in which any activity was recorded in the disbursing or accounting files for the contract. This could be the month when the letter or definitized contract was awarded, when obligations were recognized on the contract, when billing documents were received from the contractor, or when payments were made to the contractor, whichever event occurred first. The last sheet will be filled in for the last month when any activity occurred on the contract or for June 1969. Consecutive sheets will be completed for all months between the month of first activity and the month of last activity or June 1969. All values are entered as of the end of the observation month. Each entry comes from the official files and records of the appropriate Department of Defense accounting or disbursing office.

APPENDIX C

The information collected on the sample contracts from the contractor's own files and records is shown in Exhibit B. The first six items on the questionnaire identify the contract number, the contractor, the contractor's plant location, the dates of the letter and definitized contract awards and the estimated or actual date of last hardware delivery. Item seven gives the number of sub-contracts or purchase orders issued by the prime contractor whose value exceeds $100,000. The first year and month in item eight identifies when the first activity on the contract occurred. This activity could have been receipt of a letter or definitized contract, issuance of sub-contracts or purchase orders, or incurrance of costs.

The values in item nine give the firm negotiated amount of the prime contract as of the end of each month listed in item eight. It should be noted that there is often a significant lag between the time the Government authorizes additional work and the time when prices and conditions are officially negotiated. This was particularly true during the Vietnam buildup. The information in items 10 and 11 separates the prime contractor's purchase orders and subcontracts between those for commercial items, i.e. items also purchased by other firms, and custom built items, i.e. items built exclusively to the contractor's own design. Presumably, the timing of the economic impact

PRIME CONTRACTOR DATA

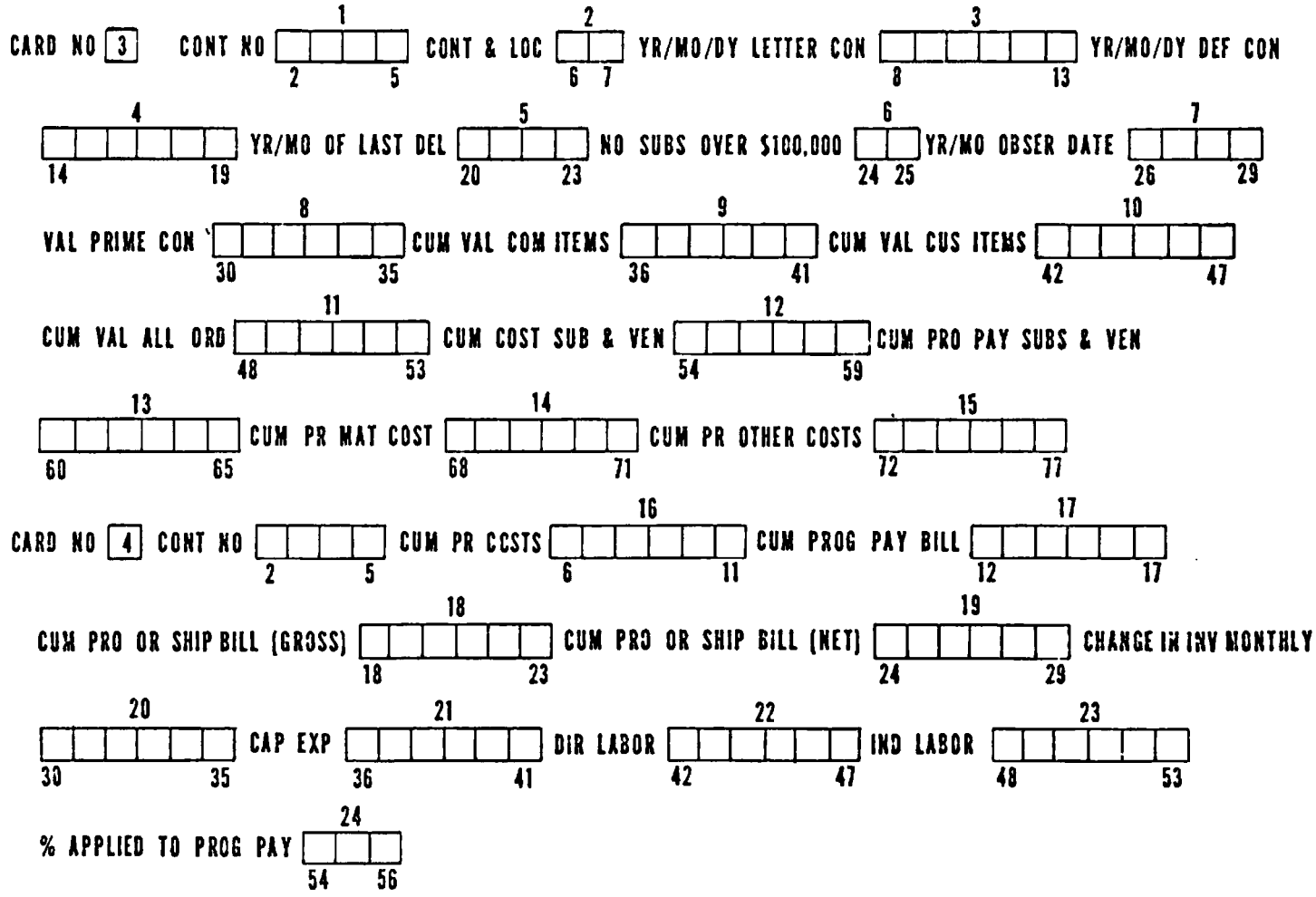


Exhibit B

is somewhat different between these categories. The information in item 12 provides a time series of the prime contractor's total purchase orders and subcontracts.

The entries in item 13 give the estimated or actual costs of the subcontractors and vendors on the basis of the subcontracts and purchase orders shown in item 12. The cumulative costs incurred by subcontractors and vendors is equivalent to the prime contractor's "termination liability". The information in item 14 is the prime contractor's progress payments to subcontractors and vendors. This value is recorded net of shipments or liquidations. Two points should be made on the item 14 values. First, not all subcontractors and vendors receive progress payments from the prime contractor. Second, for those vendors and subcontractors who do receive progress payments, the values in item 14 indicate roughly the amount of work completed by these vendors and subcontractors on which deliveries or shipments have not been made.

The most essential information collected from the prime contractor is listed in items 15, 16, and 17. The entries in these items provide a time series of the prime contractor's actual costs on the contract. The materials cost information recorded in item 15 is the net value of all goods and services received by the prime contractor from other firms. This is the "value added" to the contract by subcontractors and vendors and is recorded as of the date when the prime contractor receives a shipment billing or physical shipment. The other costs information recorded

in item 15 is all prime contractor costs incurred, including overhead or general and administrative costs. This is the "value added," net of profits, to the contract by the prime contractor and is recorded as of the date of production. The information in items 15, 16 and 17 is collected directly from the prime contractor's internal books and records.

The information in items 18, 19 and 20 gives the prime contractor's billings to the Government. Item 18 provides a time series of the prime contractor's progress payment billings at the effective repayment rate. These are the actual payments the prime contractor requested from the Government on the basis of progress billings. Item 19 is the gross value of prime contractor shipments to the Government and item 20 is the net value of payments requested from the Government on the basis of shipments. The latter is net of liquidations resulting from previously received progress payments. On a non progress payment contract, item 18 would always equal zero and items 19 and 20 would be equal.

The information in item 21 is the net change in "stores" inventories. These are materials received from subcontractors and vendors for the contract which have not been applied to work-in-process. Item 22 is the value of prime contractor capital improvements resulting from the contract. Items 23 and 24 record the direct and indirect labor applied to the contract. These values are a subset

of the "other costs" information recorded in item 16. The direct labor cost is an actual value extracted directly from the prime contractor's accounting records. The indirect labor cost is part of overhead and is an estimate, usually a ratio of direct labor. Item 25 records the applicable progress payment percentage for the contract.

Some of the information requested on Exhibit B could not be completed on all contracts. This largely resulted from differences in contractor accounting systems. The questions which could not be answered in some cases were:

(a) The number of subcontracts awarded in excess of $100,000 (item seven).

(b) Identification of subcontracts and purchase orders as being for commercial items or for goods made to custom design (items 10 and 11).

(c) The time phased costs of subcontractors or vendors (item 13).

(d) Estimates of the portion of capital expenditures which was attributable to specific contracts (item 22).

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