DoD Inflation Handbook

Gregory A. Wise
Charles B. Cochran

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MCR Federal LLC.
McLean, Virginia USA

Foreward

This book developed from a PA&E analyst's observations that inflation adjustments had been misapplied to several significant analytical products used to inform decisions in the Department of Defense. In at least one case the misapplication changed the net present value (the deciding factor in the analysis) against the recommendation. The DoD deals in large sums of money, frequently spent over several years. Even small factors can result in large adjustments for major programs. The use of incorrect inflation indices can easily generate a change of millions of dollars for even a relatively small program.

As a result the Office of the Secretary of Defense (Program Analysis and Evaluation) decided to contract for this book. The intent was to provide a relatively comprehensive treatment of the topic of inflation with a focus on common applications and the user/analyst. For those dealing with DoD budgeting and inflation for the first time, the book would provide readily accessible directions and examples. The book is also intended to provide a more rigorous background for the analyst seeking a detailed understanding of the topic, or needing advice for how to handle a particularly complex issue or application. Navigational aids are designed to guide either individual to the appropriate section of the book for their specific purpose.

Arriving at the right combination of ingredients to attain these goals has been a challenge. We hope that we have come near the mark.

The Authors

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1 Introduction

1.1 How to use this book

This Handbook is intended as an instructional and reference text on how to account for inflation in most Department of Defense applications. It is organized to be rapidly accessible for the new and the experienced analyst alike. It is also organized around the three primary applications of inflation adjustment, Programming and Budgeting, Budget Analysis, and Cost Estimation.

The inside cover of the book provides charts for cross-referencing instructional text with examples and practice problems for most of the common applications. These charts are also provided in a guide on page 155. The Handbook is organized as follows:

1.2 Instructional Text

Chapters 2-5 are instructional text. These chapters provide in depth discussion of inflation theory. Chapter 2 is a basic explanation of inflation; what it is, and what it is not. This chapter is mostly academic in nature. It provides the theoretical background for the remainder of the book. Many users will simply skip this chapter in order to quickly attain the information on how to solve their current problem. This chapter can be referenced if a theoretical basis for reaching a more thorough understanding of the subject is desired.

Chapter 3 is a discussion of policy as it applies to inflation and financial data. Inflation policy begins with the Office of Management and Budget (OMB) which promulgates the rules that govern both budget submission and expenditure accounting for the Executive Branch of the United States Government. Further policy guidance is provided by the Office of the Under Secretary of Defense Comptroller (OUSD(C)). Annual policy decisions concerning the “correct” inflation rates to apply to past and future appropriations, obligations and expenditures are based on inflation statistics and forecasts from other government agencies, but actual inflation rates applied to specific budget lines may be determined in several different ways. Each of the Military Departments provide further instructions for the application of inflation to specific commodities. Furthermore the application of inflation indices can differ across the Military Departments. Locally developed inflation indices are used at many levels to determine inflationary effects for some commodities, while some inflationary adjustments are merely a recognition of actual price changes.

Chapter 4 provides a description of the selection and creation of inflation indices. While most indices are created by government economists, some indices are generated in support of specific programs or support functions by program office analysts. Several program offices create their own inflation indices for either budgeting purposes or for the purpose of providing realistic analysis of financial streams over time.

Chapter 5 provides a basic tutorial on the Planning Programming Budgeting and Execution (PPBE) system. A complete discussion of the PPBE system could easily fill a book of its own. This chapter is an overview that provides the basis for understanding the applications that follow in Chapters 6 and 7. The conventions that apply to the PPBE system provide perspective on the application of functions in those chapters. This chapter can be safely skipped by most users of the book either because they are interested in other applications, or because they are, in fact, programmers and budgeters, who are already familiar with the PPBE system. The discussion will be useful, however, for new program analysts or for analysts that are dealing with unfamiliar programming issues.

1.3 Applications

Chapters 6-8 are dedicated to applications of inflation adjustments. The adjustments are divided into three areas: PPBE, Budget Applications and Cost Estimation. Each area has its own chapter. Each chapter has examples of calculations common to that area of analysis. Each chapter also has a related set of exercises and solutions in Appendix I to reinforce the concept and to provide a second parallel solution to prevent any misunderstanding.

The PPBE chapter begins with macroeconomic applications, and then narrows down to specific cases for PPBE processes. This chapter includes constant and then year adjustments, changes in inflation forecasts, calculation of budgetary effects of pay increases based on fiscal year vs. calendar year increases, adjustment of indices for outlay rates of multiyear appropriations, and methods of generating indices.

The Budget Analysis chapter provides examples for comparison of budgets and expenditures across years. This chapter is aimed at the policy analyst who needs to correctly compare financial numbers in two different years, or who needs to evaluate trends in financial data. Ideally the policy analyst will be able to avoid many of the common pitfalls that result from the misapplication of financial adjustments by referring to the examples in this chapter.

Chapter 8 contains examples of inflation calculations in cost estimation. It includes a discussion of Cost Estimating Relationships (CERs), the appropriate choice of indices, constant and then year adjustments, the effects of different funding policies, and the application of risk. Appendix I contains problems and solutions for Chapters 6-8. Appendix II contains reference data in support of examples, and problems for Chapters 6-8.

1.4 Reference

Following the Appendices are several sections that serve as a guide to locate appropriate reference materials within the context of this handbook as well as to outside sources. There is a guide to the handbook with charts directing users to the appropriate sections of the book. There is an acronym list, a glossary, a list of references, and an index.

2 Basic Inflation

Inflation is a simple concept that affects any purchase, expense or asset accumulation over time. In the simplest terms inflation is the change in general price levels over time. The concept of inflation for a single product is the price change for that product over time. But once one considers multiple goods and products the concept becomes much more unwieldy. In the macroeconomic sense inflation is the change in buying power of money over time, and this is a familiar concept to most of us. There are considerable complexities, however, in comparing prices over time when the goods in the economy are not purchased in the same proportions, and are not constant in quality. The problem is more complex when we consider subsets of the economy. The Federal Government increases that complexity even further by comparing dollars which are appropriated in a given year, but spent over a period of years.

In this chapter we define what inflation is. We also describe some common misperceptions to explain what inflation is not. We explain how inflation is measured, and we demonstrate some of the complexities of dealing with inflation indices. Simple examples are used to demonstrate the concepts that will be applied later in this handbook. The analyst is advised to review the introductory paragraphs to each section to verify his or her understanding. Each section feeds into later discussion of specific topics in the application of inflation to DoD processes.

2.1 What Inflation Is

2.1.1 Definition

Inflation is defined as a sustained rise in the general price level, or the proportionate rate of increase in the general price level per unit of time.[1] The opposite of inflation is deflation, which is a general decrease in the price level of most commodities.

2.1.2 Current Year Dollars (Then Year Dollars)

Current Year Dollars are valued in the count of dollars that actually make the transaction. Typically we think of these as being dollars spent (Outlays) in the given year, but current year dollars may also represent Budget Authority (BA) or Total Obligation Authority (TOA) for a given year. The difference between these

[1] The MIT Dictionary of Modern Economics, Fourth Edition, edited by David Pearce, The MIT Press, Cambridge MA, 1992, p. 205.

three is explained in the Glossary or in the chapters that follow. Current dollars are also known as then year dollars.

For example the 2006 Green Book shows that DoD TOA was $286,958M in FY2000. This is measured in FY 2000 dollars or in current or then year dollars.

2.1.3 Base Year Dollars (Constant Dollars)

Base Year Dollars are valued in dollars that are directly comparable to the Current Dollars for a given year. Base Year Dollars are also known as constant dollars. For FY 2000 the FY 2006 Green Book shows that DoD TOA was $337,723M in FY06 constant dollars. This would be the value of the actual FY 2000 TOA ($286,958M) required to acquire the same amount of goods and services in FY 2006.

2.2 What Inflation Is Not

There are several financial accounting practices that also deal with the value of money over time. While these functions are related to inflation, and even use similar mathematics, they do not represent the same phenomena as inflation. The analyst must be very careful to identify exactly what effect he or she is accounting for and use the appropriate theoretical construct to adjust the costs accordingly. These related temporal concepts include discount rates, exchange rates, interest rates and Facilities Capital Cost of Money (FCCOM). The following sections discuss each of these concepts and how they differ from inflation.

2.2.1 Discount Rate

Discount rates reflect the degree to which both costs and benefits in the future are less valuable than costs or benefits today. People generally prefer money or goods today rather than at some point in the future, even if prices do not change. Discount rates are measured in terms of the value in currency today of a good versus the delivery of that good at some time in the future. The discount rate may be unrelated to the price. The effect of discounting may work with or against the effect of inflation depending on the transaction being considered. The discount rate measures the relative value of a good over time measured in current year dollars. In contrast, inflation is, by definition, the change in price over time.

For example, you want to buy 10 acres of land. To you that land is worth $200 per acre or $2,000 today. You have a discount rate of 5%, so that right now you would be willing to pay $2,000 to take ownership of the land today, or you would pay $1,900 today to take ownership of the land next year.

If the price of the land this year is $1,000 and the inflation rate for land prices is 8% per year, the total price of the land next year will be $1,080. At that time your valuation of that land may have changed at some other rate. At that time it may be worth $2,000 to you immediately, just like last year, it may be worth only $1,900, or even some other value.

Table 2-1 shows the effect of inflation and the effect of discounting.

	Value of Delivery This Year	Price This Year	Value Of Delivery Next Year (in this year dollars)	Price Next Year (in next year dollars)
Buyer	$2,000	$1,000	$1,900	$1,080
Seller		$1,000		$1,080

Table 2-1: Inflation vs. Discounting

The point here is that the discount rate reduces the preset value of the future good while the inflation rate increases the future price of the good.

2.2.2 Exchange Rates

Exchange Rates are the relative values of two currencies. The inflation rate is the relative purchasing power of a single currency over time. Exchange rates are generally expressed as the amount of foreign currency that can be obtained for a dollar. The number of yen per dollar for example, does not represent a change in the general price level, but rather a change in the relative prices of the two currencies. The change in exchange rate does not necessarily mean that commodity prices in dollars in the United States will change at all. Prices may remain constant, or they may go up or down if the commodity is imported from a country with whom our exchange rate has changed.

In general internal inflation tends to reduce the relative value of a currency and therefore reduce the exchange rate. Similarly a falling exchange rate tends to result in inflation as foreign goods become more expensive in dollar terms. In the Defense Budget, foreign purchases are a relatively small proportion of the total. Inflation rates are applied to the entire Defense Budget, but changes in exchange rates are applied only to that portion of the budget that is used to purchase goods in other countries. As explained in Section 5.2.3.2, the effect of exchange rates is realized in a separate Program Budget Decision than inflation.

2.2.3 Interest Rates

Interest rates reflect the time value of money. As an asset, money can be used to invest in profit making enterprises or can be loaned to someone else for that purpose. Money is very liquid and can be loaned for any length of time, even as short a period as overnight. Interest is the fee that someone will pay to borrow that money over that period of time. When there are many investment opportunities (i.e. in a growing economy) interest rates tend to be high because there is a high demand for money, but when there are very few investment opportunities (i.e. in a slumping economy) interest rates tend to be low.

Interest rates are related to inflation because when prices are increasing lenders require a greater fee to loan out their money, since that money will be worth less in the future. If, for example, inflation is 3% per year, then a lender would expect more than that in interest as payment to loan money out for a year. Otherwise his or her buying power would decrease at the end of the year. The difference between the interest rate and the inflation rate is called the real interest rate. The interest rate unadjusted for inflation is called the nominal interest rate. Interest rates are usually greater than the anticipated inflation rate, but there are cases (recent years in Japan would be a case in point) where the inflation rate is greater than the interest rate. This would be an example of a negative real interest rate.

The prevailing interest rate is also the rate of return that someone can earn for a straightforward investment in bonds. Therefore the interest rate is frequently used as the discount rate for investment activities. OMB Circular A-94 actually uses a prevailing interest rate as the appropriate discount rate for evaluating government investments.

2.2.4 Depreciation

Depreciation measures the value of an asset over time. The concept of depreciation allows for the percentage of the useful life of an asset that remains. For example a car may be expected to last for 10 years, and therefore each year it would decrease in value as it has fewer useful years remaining. Depreciation can also refer to the change in market value of an asset that loses value over time. In efficient markets, the price of an asset would reflect the remaining useful life.

The depreciation need not be constant over time, however. In the car example, as the car ages it becomes less modern and less desirable. Therefore the car may depreciate at a higher percentage in early years and more slowly later in its life. Depreciation is hard to measure, but has important tax code applications. For most tax purposes, items depreciate according to a specific rate for that asset class.

While depreciation reduces the price of an asset over time, inflation tends to increase prices over time. Depreciation considers the value (price) of an asset as it ages, but inflation considers the price of the same item, in the same condition at different times.

2.2.5 Facilities Capital Cost of Money

The Facilities Capital Cost of Money (FCCOM) is the fee directed by the Federal Acquisition Regulation (FAR) and Defense Federal Acquisition Regulation Supplement (DFARS) to compensate government contractors for investments in capital infrastructure that improve on the capability of the contractor. FCCOM is calculated as a percentage paid (for opportunity cost) of undepreciated capital used in a government contract. FCCOM is an allowable return on investment to the contractor and is therefore not included as a contractor cost. It is stated as an allowable percentage rate of return published twice per year in P.L. 92-40.

An example would be a manufacturer of specialized military aircraft parts that invests in an improved milling machine that significantly decreases costs of spare parts. FCCOM would be paid to the contractor as a rate against the value of the milling machine after depreciation. This fee is considered a fair return on the capital investment that is still tied up in the milling machine. That capital investment is no longer present once it has been depreciated, but the undepreciated part continues to provide improved value to the government.

2.3 Simple Inflation Example

This section uses some simplified examples to demonstrate what inflation is and how it is measured. In the examples that follow we are going to assume an economy with four goods; cars, computers, houses and hamburgers. We will observe the prices of these goods over three years. The prices are as follows:

	Year 1		**Year 2**		**Year 3**	
Good	Price	Quantity	Price	Quantity	Price	Quantity
Cars	$10,000.00	1000	$11,000.00	1100	$12,500.00	1150
Computers	$1,000.00	5,000	$800.00	7,000	$650.00	10,000
Houses	$100,000.00	100	$120,000.00	125	$150,000.00	130
Hamburgers	$1.00	100,000	$1.05	100,000	$1.10	100,000

Table 2-2: Prices and Quantities of Four Goods Over Three Years

2.3.1 An Inflation Index

An inflation index accounts for the change in prices over time. The inflation index between Year 1 and Year 2 accounts for both the change in prices and the relative weights of the quantities of the goods in the economy. In Year 1, the relative quantities of cars, computers, houses, and hamburgers were purchased for a total cost of $25.1M. The same quantity of goods purchased in Year 2 would cost $27.105M for an inflation rate of 8%. The inflation index would generally be displayed as 108 or 1+inflation rate times 100.

Inflation = (Σp1q/Σp2q)-1

Raw Inflation Index = (1+Inflation)*100

Or generalized, $RI_{i+1} = RI_i$*(1+Inflation, Year i), where RI_i = Raw Index, Year i

In this case: inflation =
(((10,000*1,000)+(1,000*5,000)+(100,000*100)+(1*100,000))/((11,000*100)+(800*5,000)+(120,000*100)+(1.05*100,000)))-1 = 8%

2.3.2 Base Years

The index calculated above uses the quantities as well as the prices. Clearly some weighting must be used to properly distribute the effect of a given price on the economy as a whole. (An unweighted average of prices, for example, would result in an inflation rate of 18.7%.) Therefore any inflation index must rely on some assumption about the relative importance of the different prices. Generally the price increases are weighted by the relative value of the goods sold in the economy at a given time.

For the sample data in Table 2-2, the prices were weighted by the quantities in Year 1, so that the inflation index represents the cost of purchasing the same quantities in Year 2.[2] This would be an inflation index with a base year of Year 1. An alternative would be to calculate the inflation index based on Year 2 quantities. That would be an index with Year 2 as the base year.[3] Inflation rates and indices are calculated using a specific base year assumption that should be identified whenever inflation adjustments are made.

2.3.3 Base Year Rates and Indices

Table 2-3 shows the inflation indices for each year using each of the three base years. Note that the base year does change the inflation rate as well as the repre-

[2] This is also called a Laspeyres price index.
[3] This is also called a Paasche price index.

sentation of the index. The table below is calculated from the data in Table 2-2 using the methods shown in sections 2.3.1.

	Inflation Indices		
	Base Year 1	**Base Year 2**	**Base Year 3**
Year 1	100.0	93.3	85.5
Year 2	108.0	100.0	89.8
Year 3	122.9	113.3	100.0

	Inflation Rates		
	Base Year 1	**Base Year 2**	**Base Year 3**
Year 1	NA	NA	NA
Year 2	8.0%	7.2%	5.1%
Year 3	13.9%	13.3%	11.4%

Table 2-3: Table of Inflation Indices and Rates Over Three Years

Inflation indices reflect the relative value of dollars in the year of concern relative to a base year. Thus the indices also show the effect of compounding of inflation rates over time.

2.4 Inflation for Commodity Baskets

Calculating inflation indices is also complicated by the existence of commodity or market sector indices. In the economy that we described in the previous section, the economy could be divided into food and material. Each of these subsets of the economy could have their own index. These market sector indices are useful when the cost of goods and services are increasing in one sector at a different rate than in other sectors, especially when the relevant budget is overweighted in a more inflationary sector. An example of this is the health care sector, where prices in the 1990's increased at a rate faster than prices overall.

The calculation of market sector inflation rates and indices is calculated just as it is for the market overall. Furthermore the weighted average increase across all of the different sectors will equal the inflation rate or index for the economy as a whole. The Department of Defense has different indices for each appropriation as well as for some other categories. These commodity indices show when a certain commodity class has prices that increase at a faster rate than the overall market. The commodity indices also prevent categories with relatively slow price growth from receiving unnecessary generous funding adjustments.

2.5 Inflation for Commodity Baskets that Spend Out over Time

The Department of Defense Planning, Programming, Budgeting, and Execution Process (PPBE) further complicates the application of inflation because inflation rates are calculated on money that is spent in different years. Budget Authority (BA) (and for that matter Total Obligational Authority (TOA)) are not spent in the year that they are made available to the DoD. Therefore the inflation indices for these funds take into account the period of time over which they are spent or the outlay rate. For the example below, inflation indices are calculated that assume that all funds are expended at 75% in the first year and 25% in the second year.

2.5.1 Inflation Indices for Multiyear Funds

In this case we use the same inflation indices calculated for single year assumptions, but we spread the actual outlay or expenditure across two years. This allows us to determine the buying power of BA in the year that it is authorized, and the relative value of BA for other years as well.

	Budget Authority	Outlays for Year 1 BA (current dollars)	Outlays for Year 2 BA (current dollars)	Outlays for Year 1 BA (constant dollars)	Outlays for Year 2 BA (constant dollars)
Year 1	1000	750		750.00	
Year 2	1000	250	750	231.51	694.52
Year 3			250		203.34
			Year 1 value	981.51	897.86
			Index	100	109.3

Table 2.4. Indices for MultiYear Funds

Constant dollar outlays are calculated just as in section 2.3.1. Once these values have been calculated the BA indices can be calculated as follows:

BA index =
(Σconstant dollars outlays / Σconstant dollar outlays for the base year) * 100
BA index1 = ((750+231.51) / (750+231.51)) *100 = 100
BA index2 = ((694.52+203.34) / (750+231.51)) * 100 = 109.3

3 DoD Inflation Policy and Guidelines

Every February, the executive branch of the U.S. government submits a budget to the U.S. Congress proposing expenditures and revenues. This submission is called the President's Budget (PB). While the budget outlines expenditures for the next fiscal year, starting October 1, many of the proposed programs cover obligations over several years. This makes it necessary to account for inflation.

For example, it may take seven years to build an aircraft carrier. But only a small proportion of the expenditures for that program will occur in the first year covered by the PB. Yet nobody would make a decision on the appropriate level of funding without considering the full cost over the life of the program. In the absence of inflation, it would be sufficient to add up all of the costs as if they occurred in base year dollars. But with inflation, base year dollars may only buy half as much in the seventh year of a program as they would in the first year, depending on the rate of inflation in the intervening years. The Department of Defense in particular has a high proportion of programs that span multiple years, making the consideration of inflation of high importance in the budget and planning process.

Table 3-1 illustrates the effect of inflation on a fictional weapons system procured over five years. The system would cost $1 billion to procure if all of the expenditures could be made in the first year. But the effects of inflation in future years require greater appropriations over the five year duration of the program to account for the reduced purchasing power of today's dollars. In this case, the projected cost of the system is not $1 billion, but nearly $1.08 billion. In many cases the difference will be even greater, due to the relative front-loading of expenditures in this example. Note the calculations for purchasing power of the base year dollars in the out years and the requirement in then year dollars to meet the requirement in base year dollars, based on the inflation assumptions given:

Purchasing Power, TY$ = (BY$)/(1 + Cumulative Inflation)
Requirement, TY$ = (Requirement, BY$) * (1 + Cumulative Inflation)
TY$ = Then Year Dollars BY$ = Base Year Dollars

For example, for Year 3:

Purchasing Power, TY$ = $300m/(1.0815) = $277.4m
Requirement, TY$ = $300m * 1.0815 = $324.5m

Year	1	2	3	4	5	Total
Inflation (annual)		5%	3%	7%	2%	
Cumulative Inflation (Base Year 1)		5%	8.15%	15.72%	18.03%	
Base Year $	100m	400m	300m	150m	50m	1 billion
Purchasing Power, Then Year $	100.0m	381.0m	277.4m	129.6m	42.4m	930.4m
Requirement, Then Year $	100.0m	420.0m	324.5m	173.6m	59.0m	1077.1m

Table 3-1: Effect of Inflation and Outlays

The difficulty arises in that we have reasonably good statistics on previous years' inflation, but planning a budget for a new program requires information about inflation in future years. For this, it is necessary to make a forecast, or best guess, of future inflation for several years beyond that. As the previous chapter illustrated, it is not even as simple as that. Inflation for one set of goods in the economy is often different than for another set of goods. So not only is inflation forecast for multiple years into the future, but for different sets of goods.

The PB requires that programs account for inflation in future years. Moreover, it requires that all federal agencies follow similar guidelines to arrive at their estimates for future inflation. This facilitates the evaluation of programs across agencies during the budget process. This chapter will address the questions:

- How is inflation measured?
- How is inflation predicted?
- Who measures and forecasts inflation?
- What is the schedule for inflation measurements and forecasts?
- Where does DoD get its inflation data?
- How does DoD use inflation data?

3.1 Office of Management and Budget (OMB)

The Office of Management and Budget (OMB) is the Executive Branch office charged with assisting the President of the United States in overseeing the preparation of the federal budget. In helping to formulate the President's spending plans, OMB evaluates the effectiveness of agency programs, policies and procedures, assesses competing funding demands among agencies, and sets funding priorities. OMB ensures that agency reports, rules, testimony, and proposed legislation are consistent with the President's Budget and with Administration policies. In addition, OMB oversees and coordinates the Administration's procurement, financial management, information, and regulatory policies.[4]

[4] "OMB's Mission," Office of Management and Budget, http://www.whitehouse.gov/omb/organization/role.html.

3.1.1 Inflation Statistics

The Budget Enforcement Act requires that baseline estimates for discretionary accounts for all Federal departments and agencies be adjusted for inflation in two parts. Personnel and pay-related costs are adjusted by a factor that is related to the projected year-over-year increase in the U.S. Department of Labor's Bureau of Labor Statistics' (BLS) Employment Cost Index (ECI) for wages and salaries of private sector employees – with adjustment for the annualization of the previous year's pay raise, and adjustment for changes in retirement and health insurance costs. Pay raises take effect on the first pay period after January 1st of each year, whereas the inflation rates are calculated for the fiscal year. Inflation rates for pay are further broken down into military and civilian pay.

The non-pay portion of each account is adjusted by the projected increase in the chain-weighted price index for the Gross Domestic Product (GDP). Estimates of outlays for entitlement programs, like military retirement, are generally driven by demographic assumptions and cost-of-living adjustments (COLAs) triggered by projected increases in the Consumer Price Index (CPI).

The law does not specify what the President must propose, in the budget's policy estimates, for any given account. At the time the budget is submitted to Congress, prospective pay increases have generally not yet been enacted, so the Budget includes a projection. There may also be a Presidential proposal for the Federal pay increases, and that would be reflected in the policy budget.

OMB does not generate historical inflation data. It relies primarily on data prepared by the BLS and the U.S. Department of Commerce's Bureau of Economic Analysis (BEA). The CPI, issued monthly by BLS, provides a measure of the prices paid by the general public of a wide variety of products and services. The Producer Price Index (PPI), also issued monthly by BLS, measures the change in prices over time received by the sellers of products and services. BLS also issues a monthly Current Employment Statistics (CES), providing information on employment, hours, and wages. Finally, BLS issues a quarterly ECI, which includes not only wage data, but information on the cost of benefits as well. OMB also incorporates analysis of the GDP price indices provided quarterly by BEA.

The CPI tracks changes in the prices paid by consumers for a representative basket of goods and services. A subset, CPI-U, tracks prices paid by urban consumers, with prices collected in 87 urban areas throughout the country and from about 23,000 retail and service establishments. The weight for an item is derived from reported expenditures on that item as estimated by the Consumer Expenditure Survey. The CPI is the most widely used measure of inflation, and as such serves as an important guide in making economic decisions.[5] The PPI measures price change from the perspective of the seller. This contrasts with the CPI, which measures price changes from the purchaser's perspective. Sellers' and purchasers' prices may differ due to government subsidies, sales and excise taxes, and distribution costs.

Each month the CES survey of about 160,000 businesses and government agencies provides detailed industry data on employment, hours, and earnings of workers on nonfarm payrolls. The data from the CES include series for total employment, average hourly earnings, average weekly hours, average weekly earnings, and average weekly overtime hours in manufacturing industries. It is used to analyze earnings trends and wage inflation.[6]

The ECI measures labor costs as they change over time. The data show changes in wages and salaries and benefit costs, as well as changes in total compensation. It provides summary information for all workers, along with separate industry and government worker categories. It reports compensation changes by industry, occupational group, union and nonunion status, region, and degree of urbanization.

The GDP implicit price deflator (or GDP deflator) is defined as the GDP measured in current dollars divided by the GDP measured in constant dollars. This ratio accounts for the effects of inflation by reflecting the change in the prices of the basket of goods that make up the GDP as well as the changes in the basket itself. Changes in consumption patterns or the introduction of new goods and services are automatically reflected in the deflator. The GDP deflator shows how much a change in the base year's nominal GDP reflects changes in the price level.

3.1.2 Inflation Forecasts

Having gathered the aforementioned economic data, OMB works together with the U.S. Department of the Treasury and the President’s Council of Economic Advisers (CEA) in what is known as the “Troika” to compile a six-year economic forecast, which includes projected inflation. This memo is typically issued in December to provide guidance to agencies as they prepare their budgets for the next fiscal year. Figure 3-1 is a reproduction of the table including the forecast released on December 17, 2004 for the FY 2006 President’s Budget. It includes actual data from 2003, preliminary estimates for 2004, and projections for 2005-10 for Nominal GDP, Real GDP, the GDP price index, the CPI, unemployment, short-term interest rates, long-term interest rates, and employment. Separately,

[5] “CPI Overview,” Bureau of Labor Statistics, U.S. Department of Labor, http://www.bls.gov/cpi/cpiovrvw.htm.
[6] “Current Employment Statistics,” Bureau of Labor Statistics, U.S. Department of Labor, http://www.bls.gov/ces/home.htm.

OMB provides a forecast of the Refiners' Acquisition Cost (RAC) of oil based on observations from the futures market for petroleum.

Administration Economic Forecast

	Nominal GDP	Real GDP (chain-type)	GDP price index (chain-type)	Consumer price index (CPI-U)	Unemployment rate (percent)	Interest rate, 91-day Treasury bills (percent)	Interest rate, 10-year Treasury notes (percent)	Nonfarm payroll employment (millions)
	Percent change, fourth quarter to fourth quarter				Level, calendar year			
2003 (actual)	6.2	4.4	1.7	1.9	6.0	1.0	4.0	129.9
2004	6.3	3.9	2.3	3.4	5.5	1.4	4.3	131.3
2005	5.5	3.5	1.9	2.0	5.3	2.7	4.6	133.4
2006	5.6	3.4	2.0	2.3	5.2	3.5	5.2	135.5
2007	5.4	3.2	2.1	2.4	5.1	3.8	5.4	137.5
2008	5.4	3.2	2.1	2.4	5.1	4.0	5.5	139.2
2009	5.3	3.1	2.1	2.4	5.1	4.1	5.6	140.9
2010	5.3	3.1	2.1	2.4	5.1	4.2	5.7	142.5

<1> Based on data available as of December 3, 2004.

Sources: Council of Economic Advisers, Department of Commerce (Bureau of Economic Analysis), Department of Labor (Bureau of Labor Statistics), Department of the Treasury, and Office of Management and Budget.

Figure 3-1: Troika Economic Forecast, FY 2005

The third column of the Troika forecast, GDP price index, is the figure that is used for projected inflation.

3.2 Office of the Under Secretary of Defense (Comptroller)

OMB provides direct and specific guidance for the inflation assumptions that should be used in preparing the DoD budget. There are assumptions for pay and benefits and oil prices, as well as general inflation assumptions. The DoD budget office is familiar with the OMB assumptions, and how they should be used in preparing budget estimates.

In late January or early February, the Office of the Under Secretary of Defense (OUSD), Comptroller, issues inflation guidance to all the departments within DoD to be used in the preparation of the PB for the upcoming fiscal year, as well as the Program Objective Memoranda (POM) for the year after that. The guidance process is depicted in Figure 3-2. The inflation guidance replaces the assumptions issued the previous year, and contains projections for eight non-pay inflation rates and three pay-related inflation rates covering the eight fiscal years beginning with the most recently concluded year. The non-pay inflation rates are: Procurement, RDT&E (Research, Development, Test and Evaluation), Military Construction, Operations & Maintenance (O&M, excluding fuel and DHP), Fuel, Military Personnel (non-pay), Defense Health Program (DHP), and CPI-U Medical (Urban CPI, Medical). The pay inflation rates are: ECI, Military Pay, and Civilian Pay. In addition to the inflation assumptions, the memo prescribes outlay rates for multiyear programs extending to seven years. The outlay rates outline the percent of the total cost of the program to be spent in a given year, with the corresponding inflation assumptions applied to that year. For FY 2006, different outlay rates for 71 purchase categories were outlined in the inflation guidance memo. OUSD (C) also issues a PBD to update inflation assumptions from those used in previous years.

DoD's full-funding acquisition policy provides for anticipated future inflation up front rather than on a yearly basis, and makes assumptions about future inflation, which are particularly important for the budget and the POM development. If the initial assumptions about future inflation are too low, DoD must either request more funding or buy less. Program delays and extensions expose programs to higher than planned levels of inflation, thereby increasing costs. Conversely, if the assumptions about future inflation are too high, then DoD has over-budgeted for inflation and the excess inflation dollars can be withdrawn from DoD Total Obligation Authority (TOA) appropriations. The excess inflation dollars may revert to OMB, may be applied to the Administration's higher priority programs, pay down the Federal deficit, or be returned to the services as a plus up.

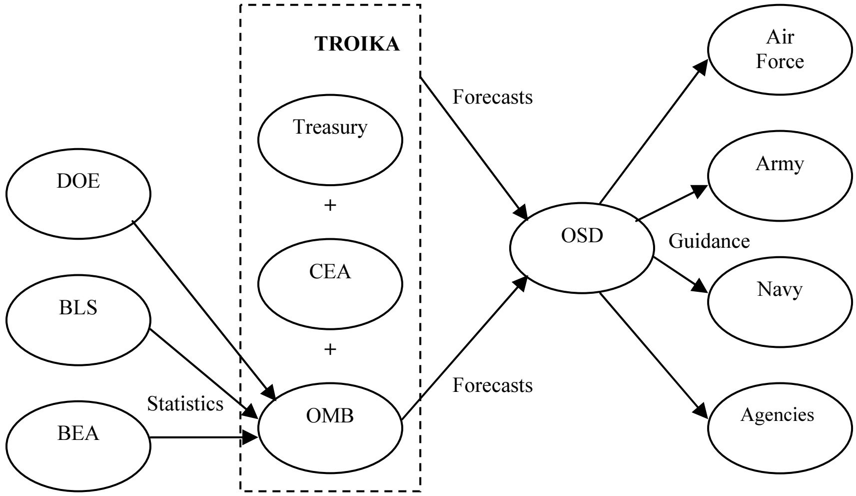


Figure 3-2: Inflation Guidance Process

OSD prescribes prices for petroleum, oil, lubricants (POL) in the stock fund, and for wage board pay in the industrial fund. Individual commands (with OSD approval) establish more detailed prices in the industrial fund. The Departments of the Air Force, Navy, and Army each have their own procedures in place for implementing the inflation guidance issued by OSD, including provisions for sources to use if the guidance is delayed.

3.3 Air Force

Specific Air Force policy on inflation is provided in Air Force Instruction 65-502 on Inflation, dated 21 January 1994. It is summarized below.

3.3.1 Policy

The Deputy Assistant Secretary of the Air Force, Cost and Economics (SAF/FMC) develops Air Force inflation indices based on the inflation guidance issued by OSD. SAF/FMC provides the appropriation level inflation indices to the Deputy Assistant Secretary, Budget (SAF/FMB), other Secretariat and Air Staff offices and major commands (MAJCOM), field operating agencies (FOA), and direct reporting units (DRU). Analysts must use these indices in all budget materials, including multiyear budget planning estimates and current services estimates.

For cost analyses and estimates, analysts should also use the latest SAF/FM inflation indices. OSD-approved inflation rates are used for specific appropriation categories (for example, O&M, procurement, RDT&E, military construction, etc.). These rates remain in effect until superseded by subsequent SAF/FM direction.

HQ AFMC/FM produces inflation data sheets, based on SAF/FMC inflation indices, for all major weapon systems. HQ AFMC/FM can delegate preparation of inflation data sheets for weapons systems with specially approved inflation rates to a System Program Office (SPO).

The SAF/FM Budget Operating Appropriations Division (SAF/FMBO) can establish and use a detailed breakdown of inflation rates within the operations and maintenance (O&M) appropriation. In this case, the sum of inflation for all of the items, weighted by the proportion of each item to the total appropriation, must equal the O&M weighted index prescribed by OSD, as transmitted by SAF/FMC.

3.3.2 Exceptions

In some analyses, such as those including medical expenses, certain categories of energy costs, or foreign inflation, special rates of inflation may be appropriate. SAF/FM can help commands obtain such special rates when they are available, or can be constructed. When an analysis requires rates not provided by OSD (for example, coal, steel, auto, etc.), it is possible to use other sources, such as historical indices published by the Bureau of Labor Statistics in the Survey of Current Business, forecasts of the Department of Energy, or reputable economic forecasts.

In the budgeting process, the SPO for major weapon system procurements can request an exemption from OSD approved inflation indices based on unique, well-documented contractual arrangements between the SPO and the prime contractor, or between the United States and allies co-producing a weapon system. Otherwise, the system must use SAF/FMC inflation indices.

3.4 Navy

The OSD inflation guidance memo has two sets of inflation figures for the eight non-pay indices, one for outlays and one for budget authority. The Navy uses the rates in the “Outlays” section. In addition, the Navy uses the Procurement (purchases) and O&M Fuel rates and from the “Pay Raise Assumptions” the Military and Civilian pay escalation rates.

The Navy publishes an alternative source of rates in January of each year, known as Budget Guidance Memorandum BG XX-X, which can be used if the OSD guidance is late. The BGM restates the OSD annual inflation rates for four cost elements: Fuel, Other (all purchases), Military pay and Civilian pay. FMB may use different equations that result in rates and indices that are similar but slightly different from the Navy's. If OSD is late in issuing guidance, FMB may issue preliminary guidance using the prior year's outlay rates.

3.5 Army

The Army issues guidance based on the OSD inflation memo. Action officers should use the inflation indices published by SAFM-BUC-F to compute inflation and real growth/spending for the nonpay portion of an appropriation.

The official indices published by the SAFM-BUC-F are based on OSD-provided rates, which are averages for use in budget preparation. Inflation calculated with these indices may vary from the actual inflation experienced in many programs. However, at the appropriation or title level, official OSD inflation rates must be used for computing inflation in the budget even though the resulting amounts expended may be different.

Certain Procurement, RDTE, and MILCON contracts have built-in escalation clauses with rates that differ from the standard rates. In these cases, the actual contract rates should be used.

Indices applying specifically to the Army include:

Procurement Appropriations (PAs), including indices for procurement of Aircraft (APA), Missiles (MIPA), Weapons and Tracked Combat Vehicles (WTCV), Ammunition (AMMO), and Other Procurement, Army (OPA) system requirements.

Operation and Maintenance, Army (OMA): These indices are for that portion of the OMA appropriation not covered by special guidance on pay raises; Army or Defense Working Capital Fund rates; Petroleum, Oil and Lubricant prices; and utilities.

Military Construction, Army (MCA): These indices are for use in conjunction with local adjustment factors and guidance.

3.6 Examples

Nearly all of the inflation rates used by DoD are a linear combination of the following five rates: Military Pay, Civilian Pay, Fuel, Medical, and O&M (excluding fuel). Some rates in fact are equal to 100% of one of the five source rates. Others are a 50/50 combination. The formula for the composite rate would be:

> Composite Rate =
> Proportion 1 * Rate 1 + Prop. 2 * Rate 2 + … + Prop. X * Rate X, where there are X component rates making up the composite rate

Consider the inflation rate for a fictional index composed of 25% Military Pay, 15% Civilian Pay, 10% Fuel, and 50% O&M for FY 2006. The inflation rates for FY 2006 listed for these four indices from the February 2005 inflation guidance from OSD are listed in Table 3-2:

Index	FY 2006	FY 2007	FY 2008	FY 2009-11
Military Pay	3.1%	3.4%	3.4%	3.4%
Civilian Pay	2.3%	2.3%	2.3%	2.3%
Fuel	-9.6%	-6.1%	-1.8%	2.1%
O&M	2.0%	2.1%	2.1%	2.1%

Table 3-2: Selected OSD Inflation Rates, February 2005

Hence, the inflation rate for FY 2006 for the composite index, as shown in Table 3-3, would be:

$$.25*.031 + .15*.023 + .1*(-.096) + .5*.02 = .0116 = 1.16\%$$

The preceding example also illustrates the volatility of the fuel index – in FY 2005, the inflation rate for fuel was 33.0%.

Index	Weight	Inflation, FY 2006
Military Pay	25%	3.1%
Civilian Pay	15%	2.3%
Fuel	10%	-9.6%
O&M	50%	2.0%
Composite Index	100%	1.16%

Table 3-3: Computation of Composite Index

Outlay rates are combined with inflation rates to determine a spending profile for an appropriation. Using the same data from the previous example, consider a $1 million dollar procurement for an Army project with the same mix of Military Pay, Civilian Pay, Fuel, and O&M. Civilian Pay and Fuel are considered completely spent in the first year of the project. But Military Personnel (Army) and O&M (Army) have outlay rates associated with them, meaning that an appropriation for one year will be spent out over multiple years. The outlay rates for this example are listed in Table 3-4:

Index	FY06	FY07	FY08	FY09	FY10	FY11
Military Pay	88.26%	10.36%	1.38%			
Civilian Pay	100%					
Fuel	100%					
O&M	38.03%	48.27%	8.14%	2.98%	1.19%	1.39%

Table 3-4: Outlay Rates

So, for a $1 million program distributed as in the previous example, the expenditures would be spread out over six years, as shown in Table 3-5.

Index	Total	FY06	FY07	FY08	FY09	FY10	FY11
Military Pay	$250,000	$220,650	$25,900	$3,450			
Civilian Pay	$150,000	$150,000					
Fuel	$100,000	$100,000					
O&M	$500,000	$190,150	$241,350	$40,700	$14,900	$5,950	$6,950
Total	$1,000,000	$660,800	$267,250	$44,150	$14,900	$5,950	$6,950

Table 3-5: Outlays

However, due to inflation (3.4% for Military Pay across all years and 2.1% for O&M across all years), the purchasing power of that $1 million procurement is actually less, as shown in Table 3-6. For example, the FY10 O&M outlay can only purchase:

FY10 O&M Outlay, BY$ =
(FY10 O&M Outlay, TY$)/(Compounded Inflation Since ’06) =
$\$5950/(1.021)^4$

Index	Total	FY06	FY07	FY08	FY09	FY10	FY11
Military Pay	$248,925	$220,650	$25,048	$3,227			
Civilian Pay	$150,000	$150,000					
Fuel	$100,000	$100,000					
O&M	$491,317	$190,150	$236,386	$39,043	$13,999	$5,475	$6,264
Total	$990,242	$660,800	$261,434	$42,270	$13,999	$5,475	$6,264

Table 3-6: Purchasing Power of Outlays

3.7 DoD Inflation Policy and Guidelines for Cost Estimates

OMB Circular 94, Section 7 instructs all federal agencies to avoid the necessity of using inflation forecasts as much as possible for cost estimates, as they introduce additional risk into the estimate. OSD guidance reflects the OMB language, which is further mirrored in instructions published by each service branch to its analysts. However, as stated throughout this handbook, it is frequently impossible to avoid using inflation forecasts due to the multi-year nature of many defense programs. When it is necessary to use an inflation forecast, OMB instructs agencies to use the GDP deflator forecast in the President's economic assumptions for the year in question. Since publication of OMB Circular 94, the Bureau of Economic Analysis has substituted the GDP Price Index for the GDP deflator.

Instructions for applying inflation in cost estimates generally incorporate the same procedures described throughout this handbook for the budget process and for budget analysis. Individual agencies have established their own polices and procedures which may differ from those established by OSD.

4 Developing and Selecting Indices

4.1 Inflation Statistics

Four measurements of the U.S. economy form the primary basis for the forecasts of inflation used by OMB and OSD. The Gross Domestic Product (GDP), prepared by the Bureau of Economic Analysis (BEA), is a measure of the market value of goods and services produced in the economy in a particular period. The Consumer Price Index (CPI), prepared by the Bureau of Labor Statistics (BLS), provides another measure of inflation, and is made up of 200 subcategories of items. OMB Circular A-94 lists the GDP deflator as the preferred measure of overall inflation for forecasting purposes, but the sub-indices of the CPI provide data useful for forecasting inflation within certain sectors of the economy. BLS also publishes an Employment Cost Index (ECI), which measures wages and benefits, and is used in forecasting inflation for civilian and military labor costs, though pay raises and benefits are set by policy decisions. Finally, fuel costs are measured by the Refiner Acquisition Cost (RAC), published monthly in the "Monthly Energy Review," put out by the Energy Information Administration (EIA) at the Department of Energy.

4.2 Gross Domestic Product

GDP is a measure of the market value of goods, services, and structures produced in the economy in a particular period. Quantities and prices are expressed as index numbers with the reference year equal to 100. There are two types of GDP which are measured slightly differently. Nominal GDP measures the value of everything produced in an economy by adding up the value of all the goods and services at current prices. It is also known as current GDP. Real GDP measures the quantity of goods and services produced by holding prices constant from a base year and only adjusting for changes in the amount of goods and services produced.

The GDP implicit price deflator (or GDP deflator) is defined as the nominal (current dollar) GDP divided by the real (constant dollar) GDP. The GDP deflator measures inflation by reflecting both the change in the prices of the goods that make up the GDP as well as the changes in the composition of the "basket" of goods. In January 1996 the formula for real GDP was changed to link price changes from year to year using a Fisher formula to incorporate weights from two adjacent years. These annual changes are "chained" together to form time series of quantity and price indices. Changes in consumption patterns or the introduction of new goods and services are automatically reflected in the deflator. The GDP deflator shows how much a change in the base year's GDP relies upon changes in the price level.

To illustrate how the GDP deflator works, consider the simple economy depicted in Table 4-1 that produces four products over two years. In this two-year example, the calculations are similar to the pre-1996 calculations of the GDP deflator as a ratio of GDP in current dollars to GDP in constant dollars.

Product	**Year 1**		**Year 2**	
	Quantity	**Price**	**Quantity**	**Price**
A	100	$27	120	$26
B	300	$15	250	$17
C	250	$1	200	$1.25
D	50	$4.50	100	$5

Table 4-1: Four Product Economy, GDP

The GDP in current dollars for Year 2 is merely the sum of all products in the economy multiplied by their prices:

GDP, current = 120 * $26 + 250 * $17 + 200 * $1.25 + 100 * $5 = $8120

The GDP in constant dollars for Year 2, using Year 1 as a base, is arrived at by taking Year 2 quantities and multiplying by Year 1 prices:

GDP, constant = 120 * $27 + 250 * $15 + 200 * $1 + 100 * $4.50 = $7640

The GDP deflator is the ratio between the two: $8120/$7640 = 1.063, for an inflation rate of 6.3%.

The Bureau of Economic Analysis (BEA) started using the GDP Price Index as a measure of the prices paid for goods and services produced by the U.S. economy in 1996 as an alternative to the GDP deflator, but OMB Circular A-94 still instructs agencies to use forecasts of the GDP deflator as the basis for predicting overall inflation or inflation comprising a “typical” basket of goods. Note that “GDP” in GDP Price Index refers to “Gross Domestic Purchases” and not “Gross Domestic Product.”

Currently, the annual economic forecast issued by the “Troika” of BEA, the U.S. Department of the Treasury, and the President’s Council of Economic Advisors publishes forecasts of the GDP Price Index rather than the GDP deflator. This makes the GDP Price Index the preferred measure of inflation absent other instructions. There are cases when other inflation measures are used.

4.3 Consumer Price Index

The Consumer Price Index (CPI) is the most widely reported index of inflation, as it directly measures the change in prices of a "basket" of goods and services over time. The GDP deflator is preferred as an overall measure as it captures changes to the mix of goods in the overall economy over time, but it does not measure inflation for individual goods and services. The CPI does capture very detailed data on a wide variety of goods and services, making it very useful for measuring inflation within a specific sector of the economy, and even for the overall economy as long as the basket of goods and services does not change significantly. To account for changes to the basket, the composition of the CPI needs to be periodically updated. Since 1999, product substitution within the basket has been allowed on a monthly basis.

The CPI is issued every month by BLS. It is used both to adjust wages and salaries for millions of workers covered by collective bargaining agreements and to keep pensions, rents, royalties, alimony and child support payments in line with changing prices.

BLS data collectors gather price information from selected department stores, supermarkets, service stations, doctors' offices, rental units, etc. For the entire month, about 80,000 prices are recorded in 87 urban areas. Price data is collected on specific goods and services with precisely defined qualities or characteristics. Any changes to the quality or characteristics of the items are also recorded. BLS uses scientifically selected samples of goods, services, and retail outlets. The Consumer Expenditure Survey (CES) from a national sample of about 30,000 families provides detailed information on spending habits, enabling the construction of the weighted CPI basket. About 16,800 families are surveyed to identify outlets where households purchase various types of goods and services. Census data is used to select the urban areas where prices are collected.

Once the data is collected, specialists check it for accuracy and consistency and make any necessary corrections or adjustments. Changes in prices are then calculated by computer and further reviewed by commodity analysts before conversion into indices for each product category and region, as well as the overall CPI. The entire process of reviewing, analyzing, and publishing the data is finished about 20 days after the last data are collected.

Over 200 categories are represented, arranged into eight major groups, including: food and beverages; housing; apparel; transportation; medical care; recreation; education and communication; and other goods and services. Also included within these major groups are various government-charged user fees, such as water and sewerage charges, auto registration fees, and vehicle tolls. In addition, the CPI includes taxes (such as sales and excise taxes) that are directly associated with the prices of specific goods and services. However, the CPI excludes taxes (such as income and Social Security taxes) not directly associated with the purchase of consumer goods and services. The CPI does not include investment items, such as stocks, bonds, real estate, and life insurance, as these items relate to savings and not to day-to-day consumption expenses.

CPI-U-Medical is used for health care inflation forecasts in the budgeting process. In addition, program offices have the ability to request the use of other inflation rate forecasts not provided by OSD as long as they are from reputable sources. Given that CPI indices provide detailed inflation data on a wide variety of goods and services, forecasts based on other CPI sub-indices would be legitimate candidates for alternative inflation rates.

It is often difficult to tell from raw (unadjusted) statistics whether developments between any two months reflect changing economic conditions or seasonal patterns. Therefore, the CPI is adjusted to remove the effect of seasonal influences; those which occur at the same time and in about the same magnitude every year. Among these influences are price movements resulting from changing climatic conditions, production cycles, changeovers of models, and holidays.

In addition to seasonal adjustments, rapid changes in the quality of some goods, such as consumer electronics and computers, require adjustments to provide a meaningful picture of the economy. With computers, for example, computing power increases very quickly, whereas price for the same computing power decreases very quickly. Using the same methods used for other goods, such as bananas, would show rapid deflation with respect to computers. But the minimum computing power available is always increasing, making it virtually impossible to compare the price change in the same item over time. So a hedonic price index is used, meaning a regression on a fixed set of characteristics of the computer is run, and price changes calculated by comparing computers that are at a similar place in the spectra of available computers over the periods in question. A graphical depiction of this is displayed in Figure 5-1.

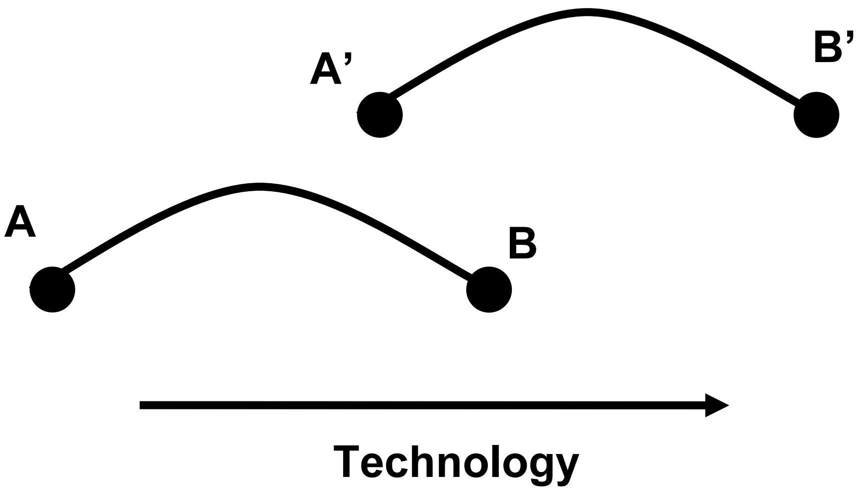


Figure 4-1: Hedonic Index
Compare price of A with A' and B with B'

BLS periodically adjusts its calculation of the CPI through annual Consumer Expenditure Surveys and Point-of-Purchase Surveys, and the census conducted every 10 years by the Department of Commerce.

To calculate the CPI for the same four product economy considered in the GDP example, it is necessary to first construct a basket of goods as shown in Table 5-2. Since the CPI examines the change in price of the same basket of goods over time, the quantities are held constant from Year 1 to Year 2. This kind of calculation, using the prior year's quantity, is called a Laspeyres index. Consider the basket consisting of products A, B, and C (notice that the basket does not consist of all goods in the economy) with their Year 1 quantities.

Product	**Year 1**		**Year 2**	
	Quantity	**Price**	**Quantity**	**Price**
A	100	$27	100	$26
B	300	$15	300	$17
C	250	$1	250	$1.25
D	50	$4.50	100	$5

Table 4-2: Three Product Economy, CPI

CPI (Year Y) = Basket (Year Y) / Basket (Year X), where X is the base year

Basket (Year Y) = $P_Y(A) * Q_X(A) + P_Y(B) * Q_X(B) + P_Y(C) * Q_X(C)$

Basket (Year X) = $P_X(A) * Q_X(A) + P_X(B) * Q_X(B) + P_X(C) * Q_X(C)$

Basket (Year 1) = 100 * $27 + 300 * $15 + 250 * $1 = $7450
Basket (Year 2) = 100 * $26 + 300 * $17 + 250 * $1.25 = $8012.50

The CPI for Year 2 is then $8012.50/$7450 = 1.076, for an inflation rate of 7.6%. Compare this to the 6.3% rate using the GDP deflator.

4.4 Employment Cost Index

The Employment Cost Index (ECI) is a quarterly measure of changes in labor costs. It is based on compensation cost data obtained from a survey of establishments. Like the CPI, it is measured with a base year equal to 100, with labor inflation calculated by dividing one year's index by the previous year's index and multiplying by 100. The survey covers all occupations within the private economy (excluding farms, households, and the self-employed) and the public sector (excluding the Federal Government). In the September 2005 quarter, the ECI sample included about 41,000 occupations in the private sector and about 3,500 occupations in State and local governments.

BLS statisticians select a sample of business establishments and State and local government operations within each selected area. Establishments are classified by industry as defined by the Standard Industrial Classification Manual (SIC) prepared by the U.S. Office of Management and Budget. Occupations are defined narrowly to ensure that homogeneous groups of employees are studied. Classifications of major occupational groups include: professional specialty occupations; technical occupations; executive, administrative, and managerial occupations; sales occupations; administrative support, including clerical occupations; precision production, craft, and repair occupations; machine operators, assemblers, and inspectors; transportation and material moving occupations; handlers, equipment cleaners, helpers, and laborers; and service occupations.

Field economists visit worksites for data collection. The wage and benefit information is then summarized in a quarterly report sent back to the establishment for review.

Benefit costs are calculated based on the current price of benefits and current plan provisions. The annual cost is then divided by the annual hours worked to yield the cost per hour worked for each benefit. The information needed to calculate benefit costs depends on the specific benefit plan. Benefits covered by the survey are: paid leave; supplemental pay; insurance benefits; retirement and savings benefits; legally required benefits, such as Social Security; and other benefits, such as severance pay.

The ECI is a standard Laspeyres fixed-employment weighted index. It is calculated with fixed employment weights from the Occupational Employment Survey. A wage index for the ECI is a weighted average of the cumulative wage changes within each major occupational group, with the base-period wage the fixed weight for each group.

Over the course of a year, the rate of wage and benefit change is affected by events that follow a more or less regular pattern each year. For example, wage and benefit adjustments in State and local governments, especially schools, are concentrated in the June-September period. Increases in the Social Security tax rate and earnings ceiling, when they occur, always take effect in the December-March period. Wage and benefit adjustments in construction often occur in the summer during which there is the most activity in the industry. Adjusting for these seasonal patterns makes it easier to observe the cyclical and other non-seasonal movements in the series. In evaluating changes in a seasonally adjusted series, it is important to note that seasonal adjustment is merely an approximation based on past experience.

There is no formal connection between the ECI and military and civilian pay raises. There is an informal connection through a law requiring the President to increase military pay by the same percentage as federal white-collar workers. These civilian pay raises are in turn partially based on the ECI, with 0.5 percent subtracted. However, Table 4-3 makes it clear that such rigid connections between the three pay inflation rates are not always maintained, with the 2005 OSD guidance listing military and civilian pay increases generally significantly below the ECI, and not matching each other either.

Year	**ECI**	**Military**	**Civilian**
2004	2.6	4.15	4.1
2005	3.4	3.5	3.5
2006	4.2	3.1	2.3
2007	4.2	3.4	2.3
2008	4.2	3.4	2.3
2009	4.2	3.4	2.3
2010	4.2	3.4	2.3
2011	4.2	3.4	2.3

Table 4-3: OSD Inflation Guidance, 2005, Pay

In practice, the Congress regularly waives the provision for an automatic military pay raise and enacts one instead. The civilian pay raise, as influenced by the ECI, clearly does have an influence on the Administration's proposal and the Congress's passing of the military pay raise.

4.5 Refiner Acquisition Cost

The Refiner Acquisition Cost (RAC) of crude oil is published in the Monthly Energy Review by the Department of Energy and represents the average price paid by refiners for crude oil booked into their refineries. It forms the basis for inflation forecasts for fuel, along with data from the futures market. The data excludes unfinished oils but includes the Strategic Petroleum Reserve (SPR). The composite cost is the weighted average of domestic and imported crude oil costs.

The Department of Defense makes its refined fuel purchases in a two-step process involving both the Defense Logistics Agency (DLA) and the individual Service or Agency customers. The DLA, through the Defense Working Capital Fund (DWCF), purchases most of the fuel and subsequently sells it primarily to DoD customers, allowing DoD to take advantage of price breaks for large quantity purchases and stabilizing prices over the short term. Therefore, projected fuel inflation rates within DoD may differ from the RAC due to the mitigating affects of the DWCF in the short term, but the two should be in closer alignment for longer range forecasts.

4.6 Selecting Indices

One of the first steps in performing a budget analysis is selecting inflation indices appropriate to the programs being analyzed. OSD has directed that all programs, except those justifying program peculiar rates, should use the OSD approved indices issued in annual guidance. Individual agencies create indices based on the OSD indices, and analysts should use those as directed. The general rule of thumb is to choose the index that reflects the closest match in its basket of goods. For example, Military Personnel would be a poor selection for the development of a new aircraft carrier. However, it may be one of several indices that go into the analysis of that program.

A very small number of programs have program peculiar inflation indices which have been approved for use on that program only, in lieu of the OSD indices. For example, a program that makes very intensive use of a particular raw material, steel for example, might use an index not in the OSD-guidance, such as CPI-Steel from the sample economy, assuming it has received OSD approval for using that index.

Beyond the choice of which index to use, there is a further choice of raw or weighted index. Raw indices are used to change the base year and may also be used for appropriations which do not cover more than one year, such as Military Pay, Civilian Pay, and Fuel. Weighted indices are used for conversions between then year and constant year dollars in appropriations spent down over multiple years. Table 4-4 delineates when to use raw and when to use weighted indices. Raw indices are used for changing constant dollars in one year to constant dollars in another year. Weighted indices are used for converting between then year dollars and constant year dollars for Total Obligational Authority (TOA) covering multi-year programs.

Raw	**Weighted**
Constant Year-Constant Year	Then Year-Constant Year
	Then Year-Then Year
	Constant Year-Then Year

Table 4-4: Raw vs. Weighted Indices

Finally, it is necessary to choose the index from the proper year. Generally the indices issued most recently are used, with possible conversions to a different base year depending on the first year of a program or the year being analyzed. However, there are cases when it is necessary to back out a previous year's inflation forecasts before applying the current inflation forecasts. This occurs when only the TOA is given and the inflation assumptions have changed. Backing out the original inflation assumptions reverts the budget back to the constant dollar amounts, allowing application of the new assumptions.

4.7 Constructing Indices

In the current environment, it is relatively rare that an analyst will need to construct a new index for a program that differs from indices already provided by OSD or individual agencies. There are two generally accepted methods for constructing such indices made up of more than one commodity that account for their relative weights.

The Relative of Weighted Aggregates Index (RWAI) multiplies the unit price and quantity for each item in the market basket for the index for a given year, and adds the results for all items. This figure is then divided by a similar calculation for the base year. The quotient provides the inflation rate for the entire basket from the base year to the target year. This is similar to the arithmetic mean calculation for the CPI discussed in Chapter 6.

RWAI =
((Price$_B$ 1 * Quantity$_B$ 1) + (Price$_B$ 2 * Quantity$_B$ 2) + … + (Price$_B$ X * Quantity$_B$ X)) / ((Price$_A$ 1 * Quantity$_A$ 1) + (Price$_A$ 2 * Quantity$_A$ 2) + … + (Price$_A$ X * Quantity$_A$ X)) for given year B relative to base year A

The Average of Weighted Relatives Index (AWRI) is somewhat more complicated. Unit prices are multiplied by quantities for each item in the basket, to determine the weight for each item compared to the others. An inflation index for each individual item is also calculated relative to the base year. Then the relative weights of each item are multiplied by their indices, which are then added together to form the weighted index.

AWRI =
(Weight 1 * Index 1) + (Weight 2 * Index 2) + … + (Weight X * Index X)

Where Weight Y =
(Price$_B$ Y * Quantity$_B$ Y) / ((Price$_B$ 1 * Quantity$_B$ 1) + (Price$_B$ 2 * Quantity$_B$ 2) + … + (Price$_B$ X * Quantity$_B$ X)) for each item Y in the basket in year B

And Index Y =
Price$_B$ Y / Price$_A$ Y is the inflation index for item Y in year B relative to Year A.

Consider the 3-item economy in Table 4-5 as a demonstration of each index:

Item	Year 1 Qty.	Year 1 Price	Year 2 Qty.	Year 2 Price
A	10	$1.25	12	$1.40
B	15	$2.00	14	$2.10
C	20	$0.75	21	$0.70

Table 4-5: 3-Item Economy to Demonstrate RWAI and AWRI

Plugging the quantities and prices into the two equations we get:

RWAI =
((12 * $1.40) + (14 * $2.10) + (21 * $0.70)) / ((10 * $1.25) + (15 * $2.00) + (20 * $0.75) = $60.90 / $57.50 = 1.059, for a 5.9% increase.
Weight A =
(12*$1.40)/((12*$1.40)+(14*$2.10)+(21*$0.70)) = $16.80/$60.90 = .276
Weight B =
(14*$2.10)/((12*$1.40)+(14*$2.10)+(21*$0.70)) = $29.40/$60.90 = .483

Weight C =
(21*$0.70)/((12*$1.40)+(14*$2.10)+(21*$0.70)) = $14.70/$60.90 = .241

Index A = $1.40 / $1.25 = 1.12
Index B = $2.10 / $2.00 = 1.05
Index C = $0.70 / $0.75 = 0.93

AWRI =
(.276 * 1.12) + (.483 * 1.05) + (.241 * 0.93) = 1.040, for a 4.0% increase

5 The PPBE Process

This chapter addresses the PPBE process and the application of inflation to the process throughout. The Planning Programming Budgeting and Execution (PPBE) process governs every financial aspect of the DoD. Many of the documents referenced in this chapter are not publicly available. Some documents are internal DoD working documents that are not released outside of the DoD, and several are classified due to their sensitive nature. An analyst dealing with the PPBE process cannot generally expect to have access to a comprehensive set of documentation, and must be satisfied to obtain the documentation required to perform his or her assigned tasks. Nonetheless this chapter provides a general overview of the process to provide the analyst with a frame of reference for tasks within the process.

5.1 Why PPBE?

Why include a discussion of the Planning, Programming, Budget, and Execution System (PPBE) in this handbook? PPBE is the basis for all financial transactions in the DoD. Every dollar based transaction in the Department passes through this system. A cost estimator should have an understanding of PPBE to understand the context of his or her estimate. Every cost estimate is used in making decisions that will be implemented in PPBE. As such, the same rules and conventions should be followed, or at least the translation between cost estimates and PPBE should be clear.

Cost estimators seldom become involved in the inner workings of PPBE. They are unlikely to have to deal with government entities outside of DoD, and do not commonly become involved with the Office of the Under Secretary of Defense Comptroller. Nonetheless the following discussion will assist the cost analyst by providing an understanding of:

- The reason inflation is accounted for in certain ways,
- The status of a program relative to the PPBE process which includes:
    - The budgetary maturity of the program,
    - The risks to program success,
    - The level of interest in and oversight of the program, and
- The requirements of the Program Manager for cost estimates.

This handbook is also intended as a resource to other analysts besides cost estimators. These analysts, program, budget, or functional analysts, also need a basic understanding of the PPBE process to understand the context of their analysis and to apply inflation consistently to analysis across the DoD.

5.1.1 Cost Estimates and PPBE

Cost estimation is an important part of the PPBE process. Programs are initiated based on an assessment of the requirements or benefits of the program and the cost estimate of attaining that capability. No program in the budget is open ended, so every program has to have specific resources allocated to it. That allocation process is always informed by a cost estimate. The cost estimate may be a detailed and intensive estimate developed over time or a quick rough order of magnitude (ROM) estimate to establish a working budget. In either case, the program resource allocation is based upon the best information available, and new information is considered as it becomes available.

Every two years, new Program Objective Memoranda (POM) is generated and every year a new budget is developed based on the latest information about the costs of the program. Just like Milestone decisions that define a program baseline, these budgetary decisions allocate the exact dollars available to the program for the future. Budgetary decisions can even terminate an otherwise healthy program in order to reallocate funds to a more important purpose. It is extremely important that the cost estimates reflect the best information about the program in a way that is not confused by issues of inflation methodologies, or other technical issues.

5.2 The PPBE Process

The Planning Programming Budgeting and Execution Process is a formal process that continues to evolve over time. Each of the four phases is characterized by specific information requirements and decisions that are relevant to that phase. The formats for the information requirements and the decision processes may change from year to year, but the overall process has been relatively stable for several decades.

At any given time each of the four processes is actively shaping some specific timeframe. The current year is in the execution phase. The following year is in the budgeting phase. The programming phase is looking two to six years into the future, and the planning phase is addressing from 2 to 15 years and beyond. The decisions associated with each phase are heavily interrelated. Budgetary decisions often have implications for future programs and planning, and planning and programming decisions can create the impetus for current year resource reallocations. The concurrency and interrelationship of the phases can make PPBE complex and confusing even to veterans of the process. Figure 5-1 depicts the concurrent and overlapping nature of PPBE.

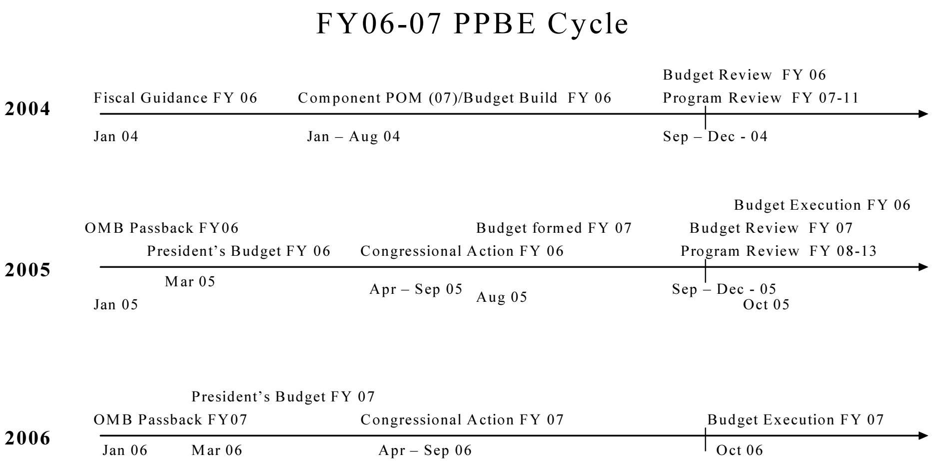


Figure 5-1 The Planning, Programming, Budgeting, and Execution Process (PPBE)

The Office of the Secretary of Defense has developed a calendar for the decisions in the PPBE process that focuses the attention of the senior leadership on specific phases at specific times. The critical documents that reflect these decisions are: the Strategic Planning Guidance, the Joint Programming Guidance, Fiscal Guidance, Program Objective Memoranda, Program Decision Memoranda, Budget Estimate Submission, Program Budget Decisions, the President's Budget, and the National Defense Appropriations Act. Each of the processes and the associated decision documents will be discussed in the sections that follow.

5.2.1 Planning

Defense Planning is conducted through a series of documents that provide direction from the National Command Authority to the Defense Components and the Combatant Commanders. Planning documents begin with broad themes and are refined in successive documents to focus on specific capabilities and finally on programs that are the basis of day-to-day management and financial oversight in the DoD. Defense planning begins with the President's National Security Strategy that establishes the projected threats to the United States and the strategies for protection against those threats. The Secretary of Defense publishes the National Defense Strategy that translates the vision of the National Security Strategy into the actions required by the Department of Defense, and the Chairman of the Joint Chiefs of Staff publishes the National Military Strategy that provides implementation guidance to the Chiefs of Staff of the Services.

Contingency Planning Guidance is provided by the Office of the Secretary of Defense in collaboration with the Joint Staff to direct the Combatant Commanders through the Joint Strategic Capabilities Plan to develop war plans and requirements for capabilities that are included in the Integrated Priority List. Concurrently OSD is executing the Enhanced Planning Process that develops the Strategic Planning Guidance from the National Military Strategy. The Strategic Planning Guidance links the requirements identified in the National Military Strategy to fiscal realities to provide constrained planning guidance. The second part of the Enhanced Planning Process is the development of the Joint Programming Guidance that directs the DoD components on what they must fund in their Program Operating Memoranda. The issuance of the Joint Programming Guidance marks the end of the planning phase of the PPBE process.

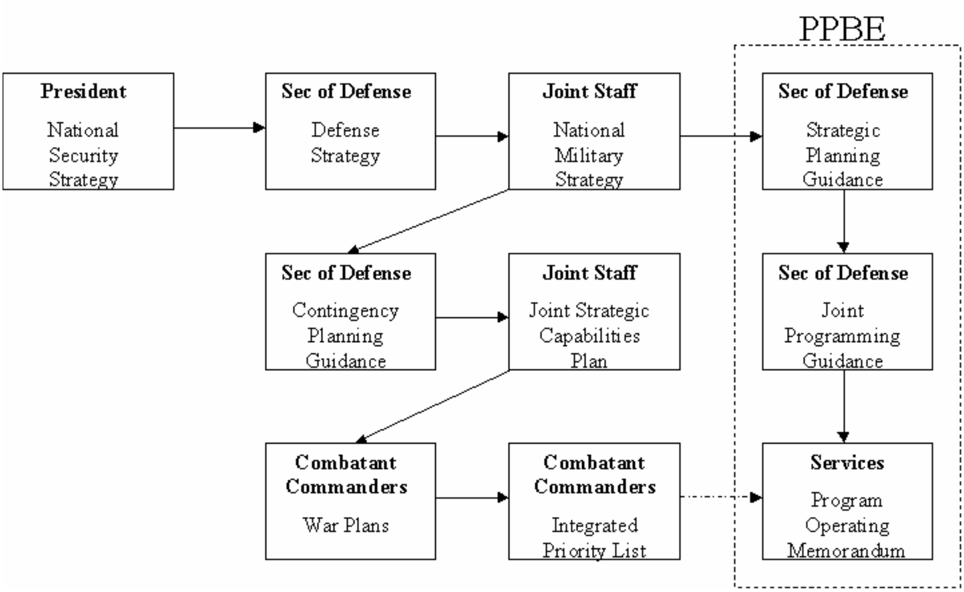


Figure 5-2 The Defense Strategic Planning Process

5.2.1.1 Requirements

The initial portion of the Planning process is deliberately not resource constrained. The National Military Strategy defines what the Military must accomplish. Contingency Planning Guidance directs the Combatant Commanders to plan for certain potential situations. The services determine what capabilities are required to meet their projected wartime missions. War Plans are developed with the forces that will be available from the military services in the short term. These plans are constrained by existing force structure, but not by budgetary constraints.

5.2.1.2 Transition to Program development

The initial shaping of the DoD Program comes with the creation of the Strategic Planning Guidance that introduces fiscal realities onto the National Military Strategy. The Joint Programming Guidance further refines the direction provided to the military components by making initial tradeoffs to provide achievable resource constrained guidance. The Integrated Priority List developed by the Combatant Commanders provides insight into the relative priorities of the warfighters, and informs the decisions of the components as they develop their programs.

5.2.2 Programming

The Programming Process is the development of an integrated spending plan based on the identified requirements and priorities of the National Command Authority, the Joint Staff, and the components. The Programming process takes place in three phases. The first phase is providing guidance to the components. The second phase is the bottom up build of the program by the components. The third phase is the review of the component programs for compliance with guidance, for fact of life changes, and for changes resulting from tradeoffs within the program.

5.2.2.1 Fiscal Guidance

Fiscal Guidance is developed by the Office of the Secretary of Defense in accordance with the Guidance provided to the DoD by the Office of Management and Budget. Fiscal Guidance provides the hard numbers that must be met by the overall program for each component. Fiscal Guidance provides a topline number for each of the years in the program. Fiscal Guidance accounts for inflation and known program changes. In even years the program baseline is extended out for two more years. This is the ultimate control on the process in the building of component Program Objective Memoranda. Fiscal Guidance is issued in then year dollars.

5.2.2.2 Service/Component Programming

Components take the absolute topline guidance provided in the Fiscal Guidance and direction from the Joint Programming Guidance to build a program, often from the bottom up. Resource sponsors at the service and component levels build their future funding requirements based on their requirements from the Joint Programming Guidance and on the best information available concerning the cost of meeting those requirements.

Funding is identified by Program Elements that define the execution of a specific mission. Each program element may have multiple appropriations or resource types. The resource types include forces and material quantities, manpower (military and civilian), and funds by appropriation. The program element is the basic building block of the Future Years Defense Program (FYDP). Program elements can be further grouped together to provide insight into overall funding for specific types of programs such as central medical programs, ground combat systems, or other aggregate categories.

The Program Objective Memorandum consists of a population of the FYDP database along with supplemental supporting documentation. FYDP data is provided by the components in then year dollars. A constant dollar FYDP is developed by OSD based on inflation assumptions. The FYDP database is checked for compliance with fiscal guidance and with other directives such as the Joint Programming Guidance. Further analysis on the funding data is also possible based on the need to provide analytical support to decisionmakers in the Program / Budget Review.

5.2.2.3 Program Review

The Program Review is conducted concurrently with the Budget Review (discussed below), but has a different focus. The Program Review offers the opportunity to adjust funding in the FYDP (Program) due to:

- Mistakes,
- New information,
- Recognized funding shortfalls or imbalances,
- New initiatives.

Program Review Issues can be submitted by the components, the Joint Staff, the Combatant Commands, or OSD. Program Review Issues should generally be funding neutral. Where certain program elements require additional funding, proponents are strongly encouraged (sometimes required) to identify a source of funds for that purpose. Decisions concerning program review issues are made by the Deputy Secretary of Defense and are published in a Program Decision Memorandum. The program Decision Memorandum provides direction as to the amount of funding to be moved between program elements and appropriations and the general purpose of the change.

5.2.3 Budgeting

Once the program has been finalized it is submitted with the final budget to the Office of Management and Budget. The Budget is prepared for submission by the President to Congress. The first year after the budget year becomes the basis for the following year's budget. In odd years the first program year is automatically translated into the initial budget position. In even years the components have the opportunity to rebuild their budgets along with rebuilding a new POM and adding two new years to the Program Baseline. The Budget Review allows for changes before the budget is submitted to OMB, and Congress for passage into law.

5.2.3.1 Service/Component Budgets

In odd years the FYDP is automatically translated from the FYDP database into the DoD Comptroller Information System. No actions or reviews on the part of the Services are necessary to build the Budget Estimate for these years, though budget justification materials are still required to support analysis in the Budget Review.

In even years the components generate new budgets, and new programs from the ground up based on the latest DoD guidance. The Program years are submitted to the OSD PA&E to go into the FYDP database as described above. The Budget, however, is submitted to the Office of the Under Secretary of Defense Comptroller for entry into the Comptroller Information System. The budget is not organized around program elements, but is built on appropriations, Budget Activity Codes, Budget Project Codes and Treasury Codes per DoD Financial Management Regulation 7000.14-R. Thus budget documents are not always possible to track back to the program elements with certainty.

5.2.3.2 Budget Review

The Budget Review is conducted concurrently with the Program Review, but with a different focus. Where the Program Review focuses on the future years, and, in general, reflects significant changes in the policy or priority of DoD programs, the Budget Review focuses on the next budget year and is intended primarily to make fact-of-life changes to the budget based upon newly realized inflation rates, exchange rates or other realized costs. PBD's add and delete funding from various program lines. Once the amount of money is moved, cognizant authorities may be able to reallocate some funds within those categories, but the PBD totals are effective regardless.

Budget Review issues tend to have future year implications that require corresponding changes to the future year programs. Program Review issues frequently imply common sense changes to the next budget year. Consequently OSD PA&E and the OUSD(C) work closely together to ensure that Program and Budget Review items are reflected in both financial databases and that issues are only considered in one venue. Decisions from the Budget Review are documented by Program Budget Decisions (PBDs) that are signed by the Deputy Secretary of Defense. Changes in both exchange rates and inflation rate assumptions lead to PBDs that account for these changes. Other annual PBDs relate to funding lines such as military and civilian personnel, family housing, fuel, etc.

5.2.3.3 OMB and the President's Budget

The Office of Management and Budget monitors the Program and Budget Reviews and is notified of major issues of concern in these reviews. In some cases these issues are of sufficient importance that OMB or the president intervenes with input in the form of OMB "passback." These changes are mandated by the Executive Office of the President and are generally handled internally within DoD as Program Budget Decisions.

Once the final DoD Budget is obtained, it is fixed and forwarded to OMB. This budget is called the President's Budget position. It includes both the final version of the DoD budget as well as the associated FYDP with the future years funding. This Budget is submitted by the President to Congress for consideration as a starting point for Congressional negotiations on the Defense Appropriations Act.

5.2.3.4 Congressional Action

Congress has two related bills associated with the Defense budget. The Defense Authorization Act originates in the House Armed Services Committee, and provides the approval for the DoD to undertake specific activities. The Defense Appropriations Act originates in the Appropriations Committee and actually funds the budget for the budget year. Both Acts must, of course, pass both houses of Congress and be signed by the President to become law.

The Defense Appropriations Act is quite detailed, and consists of several hundred pages. In addition to general spending guidelines, and allocation of funding by specific appropriations categories, the Act may also include other funds control and tracking and reporting procedures. All of these restrictions and allocations are a matter of law and must be tracked and reported accurately by the DoD.

5.2.4 Execution

Execution of the Defense Budget, obligations and outlays, must be tracked according to the direction provided in the Defense Appropriations Act. Obligations of funds are made when the specific dollar amounts are set aside by the responsible government office to pay for a specific contract or activity. Different appropriations have different time periods within which they must be obligated. Within appropriations categories the DoD is mostly free to move funds to new purposes or even program elements. Movement of funds across appropriations or Subactivity Groups (SAGs) requires a reprogramming action and approval by Congress if the amount is above a certain threshold.

5.2.4.1 Spend out

Not all funds must be obligated in the budget year. Some appropriations may be obligated over two, three, or even five years. Once funds have been obligated they still must actually be transferred to the intended recipient. This outlay rate is even more delayed than the obligation of funds. Weighted inflation indices actually account for the delay in outlays over time for funds that are appropriated in a given year because they account for the inflation across the several years that funds are actually expended.

5.2.4.2 Budget Accounting

The DoD Budget is identified in several ways, but the primary measure is Total Obligation Authority (TOA). TOA is the amount that the component can obligate (spend) during the year. Budget Authority (BA) and Outlays are also tracked as important measures of Defense spending, but are less relevant to most funding decisions. Budget Authority is the authority granted by Congress to obligate new money. TOA includes prior year unobligated funds that have not expired. Outlays are the actual transfer of funds from the Treasury which may trail obligations by a significant period.

5.2.5 The Schedule

The PPBE process is actually a biennial process even though many events occur every year. The Program / Budget Review, for example occurs every year, but the Program and Budget Reviews refer to different year's funds. The process can become confusing if one is not careful about remembering which year in the process is at which stage in the review process. A two year cycle is shown in Figure 5.1 above. Note that this two year cycle overlaps with both the prior and later cycles so that not all PPBE functions occurring in these years are depicted.

6 PPBE Applications and Examples

The examples and problems in this section are based on a simplified fictional future economy described in full in Appendix II. The scenario is that some global catastrophe has greatly reduced the size of the U.S. economy to just 19 goods and services. But the U.S. Government and DoD structure, budget process, and inflation planning remain the same, allowing a detailed examination of all of the inflation related applications and calculations using a manageable amount of data.

6.1 Background

The data in Appendix II lists all of the goods and services produced in the sample economy for 10 years. During the first year there are 10 items, and every year an additional item is added, so that by year 10 there are 19 items. A subset of the 10 goods is used to compute an overall CPI, sector-specific CPI's, the GDP, and GDP deflator. Since the economy has grown and changed significantly during the first five years, the basket of goods making up the CPI is changed in FY 6, requiring a way to compare inflation between years with different baskets.

In addition to the statistics on this economy, annual forecasts of inflation are made based on the historical CPI and GDP data. The forecasts are similar to the actual inflation guidance provided by OMB and the Troika to OSD. The methodologies for deriving the economic statistics related to inflation are well-documented by BLS, BEA, and other sources. But the methodologies for deriving the economic forecasts provided by the Troika are closely held, making it a "black box" for which the inner workings are not important for the actual use of the forecasts. As such, while the forecasts in the sample economy are based on the historical data, the actual model used is not relevant to applying the forecasts. Similarly, outlay rates were varied from year to year within a range and do not represent actual OSD rates. They mimic changes that occur from year to year in the OSD outlay rates.

6.2 Converting Between Constant and Then Year Dollars

There are four main conversion tasks involving the historical data, each with several variations: 1) converting constant dollars in one year to then year dollars in another year; 2) converting then year dollars in one year to constant dollars in another year; 3) converting then year dollars in one year to then year dollars in another year; and 4) converting constant year dollars in one year to constant year dollars in another year. Raw inflation indices are used for conversions between constant year dollars in different years. Weighted indices are used for conversions between constant and then year dollars in either direction, and for conversions between then year dollars in one year and then year dollars in another year, which is essentially a then year to constant year conversion coupled with a constant year to then year conversion.

6.2.1 Constant Year to Then Year

Constant year dollars are converted to then year dollars to determine the Total Obligational Authority (TOA) needed to cover the costs of a multi-year program due to the effects of inflation. Constant year dollars are converted to then year dollars by multiplying the constant dollar amount by the weighted index of the appropriation in the given year relative to the base year. If the base year is set to 1.000 in the weighted index table, the equation is:

Then Year $ = Constant $ * Weighted Index (TY)

If the base year is not set to 1.000, the more general form of the equation is needed:

Then Year $ =
((Constant $) / Weighted Index (CY)) * Weighted Index (TY)

6.2.2 Then Year to Constant Year

Then year dollars are converted to constant dollars to remove the effects of inflation from a multi-year program to determine the costs in constant dollar terms. This facilitates comparisons across programs. Then year dollars are converted to constant dollars by dividing the then year dollar amount by the weighted index of the appropriation in the given year relative to the base year. If the base year is set to 1.000 in the weighted index table, the equation is:

Constant $ = Then Year $ / Weighted Index (TY)

If the base year is not set to 1.000, the more general form of the equation is needed, utilizing the raw index for the constant year (CY) to convert from the base year to the constant year:

Constant $ = ((Then Year $) / Weighted Index (TY)) * Raw Index (CY)

6.2.3 Then Year to Then Year

Converting then year dollars in one year to then year dollars in another year can facilitate comparisons in like dollar terms, though in general this will be done with constant dollars. To convert from then year dollars in one year to then year dollars in another year, multiply the originating then year dollar amount by the ratio of the weighted indices of the target year and the originating year:

Then Year $ (Yr. B) =
Then Year $ (Yr. A) * (Weighted Index (B) / Weighted Index (A))

The analyst will run across the term Budget Year Multiplier (BYM) in reference to then year to then year conversions. The BYM is the ratio of the then year weighted index to the base year weighted index.

Budget Year Multiplier (BYM) =
Weighted Index (TY) / Weighted Index (CY)

As such, an alternate solution would be:

Then Year $ (Yr. B) = Then Year $ (Yr. A) * (BYM (B) / BYM (A))

The BYM is not necessary to solve the problem, as the constant year terms cancel out when substituting the right sight of the BYM equation into the equation above. But the analyst should be aware of the term, and can use the budget year multiplier in place of the weighted indices to solve the problem.

6.2.4 Constant Year to Constant Year

Converting from one constant year to another constant year is used to change the base year of constant dollars. This conversion requires the use of raw indices rather than weighted indices like the other conversions. To convert constant dollars from one year to another, simply multiply the constant dollar amount by the raw index of the target year relative to the base year. If the base year is set to 1.000, the equation is:

Constant $ (Year B) = Constant $ (Year A) * Raw Index (Year B)

If the base year is not set to 1.000, the more general form of the equation is needed:

Constant $ (Year B) =
Constant $ (Year A) * (Raw Index (B) / Raw Index (A))

6.2.5 Examples

To demonstrate the conversions described above, consider the notional table of raw and weighted indices from FY6-9 listed in Table 6-1.

Year	Raw	Weighted
FY6	0.967	1.001
FY7	1.000	1.032
FY8	1.025	1.071
FY9	1.058	1.097

Table 6-1: Notional Raw and Weighted Indices, FY6-9

To convert $1000 constant year dollars, base year FY7 into FY9 then year dollars, divide by the weighted index for FY7 and multiply by the weighted index for FY9:

$1000 FY7 CY$ = ($1000 / 1.032) * 1.097 = $1063 TY (FY9)

To convert $1000 FY8 then year dollars to FY6 constant dollars, divide by the weighted index for FY8 and multiply by the raw index for FY6:

$1000 FY8 TY$ = ($1000 / 1.071) * 0.967 = $903 FY6 CY$

To convert $1000 then year dollars in FY9 to then year dollars in FY6, multiply by the ratio of the FY6 weighted index to the FY9 weighted index:

$1000 FY9 TY$ = $1000 * (1.001/1.097) = $912 FY6 TY$

Finally, to convert $1000 FY6 constant dollars to FY8 constant dollars, multiply by the ratio of the FY8 raw index to the FY6 raw index:

$1000 FY6 CY$ = $1000 * (1.025/0.967) = $1060 FY9 CY$

6.3 Inflation Forecasts

Inflation forecasts are provided to the analyst by OSD through their department. Once a year OSD issues a memo to all DoD departments containing inflation guidance for the year covering general procurement, fuel, medical, military pay, and civilian pay. OSD bases this guidance on forecasts prepared by the Office of Management and Budget (OMB). OMB develops its forecasts in conjunction with the U.S. Department of the Treasury and the President's Council of Economic Advisors (CEA), based on historical data from the Bureau of Labor Statistics (BLS), Bureau for Economic Analysis (BEA), and the U.S. Department of Energy. The forecast rates for the pay indices are forecasts of the actual policy decisions regarding pay, which is set by policy, not necessarily projections of the increase in pay for the overall economy, although historical data is part of the basis for those forecasts. The formulas for the inflation forecasts made by OMB are not made public, and the analyst will not have a need to understand their derivation.

Each year, generally in December, OMB issues its inflation guidance to all government agencies, including DoD. The fiscal year (FY) runs from October through September of the next year, and is named according to the calendar year that begins in the January following the beginning of the fiscal year. For example, FY2005 runs from October 1, 2004 through September 30, 2005. Using the sample economy again, the memo issued in December of Year 4 will include the actual inflation rates for Fiscal Year 3 (FY3), the preliminary rates for FY4, and projections for FY5 through FY10. In terms of budget preparation, FY4 is already completed, FY5 is already in progress, the budget for FY6 is already in advanced stages of preparation, so the target of the memo is the preparation of FY7 budgets. Table 6-2 shows an inflation forecast for the sample economy. The OSD memo will also include outlay rates, discussed in Section 6.6, which are combined with the projected inflation rates to derive inflation indices for various programs.

Dec Y4	**FY3**	**FY4**	**FY5**	**FY6**	**FY7**	**FY8**	**FY9**	**FY10**
Procurement	5.9%	9.5%	8.3%	8.7%	8.7%	8.7%	8.7%	8.7%
Index	73.2	77.6	85.0	92.0	100.0	108.7	118.1	128.3
Military Pay	7.7%	7.1%	7.3%	7.5%	7.5%	7.5%	7.5%	7.5%
Index	75.1	80.9	86.7	93.0	100.0	107.5	115.6	124.3
Civilian Pay	4.8%	9.1%	7.6%	7.0%	7.0%	7.0%	7.0%	7.0%
Index	76.0	79.6	86.8	93.5	100.0	107.0	114.4	122.4
Fuel	-15.4%	9.1%	0.9%	4.4%	4.4%	4.4%	4.4%	4.4%
Index	102.8	87.0	94.9	95.8	100.0	104.4	109.0	113.8
Medical	13.6%	12.0%	12.5%	12.2%	12.2%	12.2%	12.2%	12.2%
Index	62.2	70.7	79.2	89.1	100.0	112.2	125.9	141.3

Table 6-2: Inflation Forecast

While the December, Year 4 memo from OMB, and the OSD guidance, typically issued a month or two later, are targeted at the FY7 budget, the rates contained therein are to be used for all calculations involving inflation, including revisions to the FY6 budget, Program Objective Memoranda (POM) and the Future Years Defense Plan (FYDP), which don't follow the same calendar cycle as the DoD budget.

Many defense programs cover multiple years. Examples of multi-year programs and inflation accounting will be given in the section on outlays, Section 6.6. Consider first the task of creating a budget for FY7, accounting for the inflation forecasts in Table 6-6, for programs covering only one year. For this example, the assumption is that all money appropriated for FY7 is spent in FY7. Thus inflation only needs to be accounted for through FY7. At the time of the memo, the current year is FY5. If a budget is created in FY5 for FY7, the amount of inflation between FY5 and FY7 needs to be incorporated into the budget. First, the projected need for FY7 needs to be calculated in current FY5 dollars. Then the budget for FY7 will simply be the budget in FY5 dollars multiplied by the ratio between FY7 dollars and FY5 dollars, as shown in Table 6-3.

Category	In FY5 $	FY5 Index	FY 7 Index	FY7/FY5	FY7 Budget
Procurement	$35,000	85.0	100.0	1.176	$41,160
Military Pay	$20,000	86.7	100.0	1.153	$23,060
Civilian Pay	$15,000	86.8	100.0	1.152	$17,280
Fuel	$12,000	94.9	100.0	1.054	$12,648
Medical	$18,000	79.2	100.0	1.263	$22,734
TOTAL	$100,000				$116,882

Table 6-3: Adjusting Budget for Inflation

The inflation rates used to calculate the FY7 budget were merely projections. New data can change the projected inflation, and thus would change the FY7 budget request. Consider the inflation forecast for the sample economy from December, Year 5, in Table 6-4. The FY7 budget has not been submitted by the President to Congress yet. Either before or after submission of the President's Budget (PB), the analyst may be faced with the task of updating the budget request with the new inflation assumptions.

Dec Y5	FY4	FY5	FY6	FY7	FY8	FY9	FY10	FY11
Procurement	9.5%	10.6%	10.2%	9.5%	9.4%	9.4%	9.4%	9.4%
Index	68.4	75.0	82.9	91.4	100.0	109.4	119.7	131.0
Military Pay	7.1%	6.7%	6.8%	7.0%	7.2%	7.2%	7.2%	7.2%
Index	76.6	82.0	87.5	93.5	100.0	107.2	114.9	123.1
Civilian Pay	9.1%	4.2%	5.8%	5.9%	5.8%	5.8%	5.8%	5.8%
Index	78.5	85.7	89.2	94.4	100.0	105.8	112.0	118.6
Fuel	9.1%	26.7%	20.8%	13.8%	13.3%	13.3%	13.3%	13.3%
Index	52.6	57.4	72.7	87.9	100.0	113.3	128.4	145.5
Medical	12.0%	14.3%	13.5%	13.4%	13.0%	13.0%	13.0%	13.0%
Index	60.7	68.0	77.7	88.2	100.0	113.0	127.8	144.4

Table 6-4: Revised Inflation Forecast

If the needs have changed, then the task requires creating a new budget in FY6 dollars and converting to FY7 dollars. But if the assumption is that the requirement remains the same and simply needs to be recalculated according to the new inflation assumptions, the method used depends on what information the analyst has available. If the analyst knows the original budget in FY5 dollars, then it is simply a matter of performing the same calculations as in the previous example with the new table of inflation assumptions. If only the final budget submission is available, it is necessary to back out the inflation assumptions from the previous year, and then apply the result to the new inflation assumptions. Essentially, the task becomes to find the budget requirement in FY5 dollars relative to the inflation assumed at that time to occur by FY7.

To back out the assumptions from December, Year 4, it is simply a matter of multiplying the budget by the inverse of the ratio used to go from the FY5 dollars to the FY7 dollars. So the budget is multiplied by the old FY5 index (call it oldFY5) divided by the old FY7 index (oldFY7). Then the new assumptions are applied, multiplying the resulting budget in FY5 dollars by the new FY7 index (newFY7) divided by the new FY5 index (newFY5), as shown below:

Revised FY7 budget =
old FY7 budget * (oldFY5/oldFY7) * (newFY7/newFY5)

or, alternately:

Revised FY7 budget =
old FY7 budget * (oldFY5/newFY5) * (newFY7/oldFY7)

However, since different inflation rates are applied for different parts of the budget, it is necessary to perform this calculation for each budget category that has its own inflation rate. This is demonstrated in Table 6-5.

Category	Old Budget	OldFY5	OldFY 7	NewFY5	NewFY7	Revised Budget
Procurement	$41,160	85.0	100.0	75.0	91.4	$42,636
Military Pay	$23,060	86.7	100.0	82.0	93.5	$22,797
Civilian Pay	$17,280	86.8	100.0	85.7	94.4	$16,522
Fuel	$12,648	94.9	100.0	57.4	87.9	$18,381
Medical	$22,734	79.2	100.0	68.0	88.2	$23,354
TOTAL	$116,882					$123,690

Table 6-5: Change in Inflation Assumptions

Note that the change in budget does not directly reflect the inflation rate over the two year period, but the change in the inflation assumptions from the previous year, which in this case call for greater inflation than originally predicted, particularly for fuel. For these reasons, it is important for analysts and cost estimators to document which specific inflation indices were used.

Changes in assumptions for periods that overlap in their TOA have uncertainties due to unspent obligations from the original assumptions. Therefore, the analyst could consider backing out the original assumptions to a base year for which the spend out is complete and documented, so that both old and new assumptions operate under a common frame of reference.

6.4 Pay Raises

The inflation rates for nearly all budget items are a reflection of their actual expected inflation in the overall economy. The exception is pay, both military and civilian. Pay raises in federal government budgets are set by policy, which are generally influenced by expected pay increases in the overall economy, but the relationship is much less direct. The OSD inflation guidance from February 2005 lists the projected Employment Cost Index (ECI), which is what the increase in the price of labor is expected to be in the economy, along with the projected increases in military pay and civilian pay. For 2007 and beyond, it listed the ECI at 4.2%, Military Pay at 3.4%, and Civilian Pay at 2.3%. Table 6-6 displays the OSD inflation guidance for pay as released in December 2004. An analysis of these projected inflation rates for pay clearly shows that the policy decisions for military and civilian pay cannot be predicted by the ECI.

	ECI	**Military Pay**	**Civilian Pay**
2004	2.6	4.15	4.1
2005	3.4	3.5	3.5
2006	4.2	3.1	2.3
2007-11	4.2	3.4	2.3

Table 6-6: OSD Inflation Guidance - Pay

The second thing that distinguishes the inflation rates for pay is that pay raises in the federal government, both civilian and military, go into effect on January 1 of each year, and are presented according to a calendar year. Budgets cover the fiscal year, which runs from October 1 through September 30. The year attached to the fiscal year is the year that begins on the January 1st after the start of the fiscal year. For example, FY2005 runs from October 1, 2004 through September 30, 2005. Therefore, when accounting for inflation in the pay indices the analyst needs to make conversions between the calendar year and fiscal year. Further complicating matters, there are at least two methods in use of making the conversion, each of which yield different results. The two methods will be demonstrated using the data from Table 6-7, which lists the projected pay raises for military and civilian pay in the sample economy.

Dec Y4	CY3	CY4	CY5	CY6	CY7	CY8	CY9	CY10
Military Pay	7.7%	7.1%	7.3%	7.5%	7.5%	7.5%	7.5%	7.5%
Index	75.1	80.9	86.7	93.0	100.0	107.5	115.6	124.3
Civilian Pay	4.8%	9.1%	7.6%	7.0%	7.0%	7.0%	7.0%	7.0%
Index	76.0	79.6	86.8	93.5	100.0	107.0	114.4	122.4

Table 6-7: Projected Pay Raises, Calendar Year (CY) 3-10

The first method makes the calendar year to fiscal year conversion by taking the average of the pay raise for the first three months of the fiscal year, coming from the first calendar year, and the last nine months of the fiscal year, coming from the second calendar year. The formula thus becomes:

$$\text{FY5 pay increase} = (\text{RateCY4} + 3 * \text{RateCY5})/4$$

While this method provides a good approximation of the fiscal year pay increase, it fails to compound the raise from the first calendar year with the second calendar year. To accurately reflect the real pay increase from one fiscal year to the next, it is necessary to calculate the pay for both fiscal years and compare the two. The pay for FY4 is equal to three months of the pay from CY3 plus nine months the pay of CY3 multiplied by the pay increase for CY4 (call it R4). The pay for FY5 is equal to three months of the pay from CY4 (= 3 * CY3 * R4) plus nine months the pay of CY4 times the pay increase for CY5 (= 9 * CY3 * R4 * R5). The formula is thus:

$$\text{FY5 Pay Increase} = \frac{3 * CY3 * R4 + 9 * CY3 * R4 * R5}{3 * CY3 + 9 * CY3 * R4} = \frac{(3 * CY3 * R4) * (1 + 3 * R5)}{(3 * CY3 * R4) * (1/R4 + 3)} = \frac{1 + 3 * R5}{1/R4 + 3}$$

CY3 Pay = Calendar Year 3 Pay R4 = Pay Raise, Year 4 (%)

The difference in results between the two calculations is minimal. Applying these two methods to the calendar year increases in Table 6-8, the following fiscal year rates can be computed:

Dec Y4	CY/FY3	CY/FY4	CY/FY5	CY/FY6	CY/FY7	CY/FY8	CY/FY9	CY/FY10
Military Pay	7.7%	7.1%	7.3%	7.5%	7.5%	7.5%	7.5%	7.5%
Method 1		7.250%	7.250%	7.450%	7.500%	7.500%	7.500%	7.500%
Method 2		7.241%	7.253%	7.453%	7.500%	7.500%	7.500%	7.500%
Civilian Pay	4.8%	9.1%	7.6%	7.0%	7.0%	7.0%	7.0%	7.0%
Method 1		8.025%	7.975%	7.150%	7.000%	7.000%	7.000%	7.000%
Method 2		8.062%	7.951%	7.142%	7.000%	7.000%	7.000%	7.000%

Table 6-8: Calendar to Fiscal Year Conversions

6.5 Composite Inflation Rates

Every year OSD provides inflation guidance based on five spending categories: procurement, military pay, civilian pay, fuel, and medical. The rates for the procurement category are repeated for various other categories, such as Research, Development, Testing and Evaluation (RDT&E), Operations and Maintenance (O&M) minus fuel and the Defense Health Plan (DHP), and Military Personnel minus pay. In addition, OSD provides an inflation rate for DHP separate from the general medical inflation rate. Although these are not all of the inflation rates that are used within the Department of Defense they form the basis for composite rates that combine two or more of these categories to simplify the inflation accounting for some programs. Table 6-9 shows a forecast from the sample economy from OMB’s guidance to OSD in December of Year 7, extending out Year 13. The Steel rate is not in the OMB or OSD guidance, but is included as an additional rate used in one of the examples. The examples of combining these six rates into composite rates will be based on this table.

Dec Y7	FY6	FY7	FY8	FY9	FY10	FY11	FY12	FY13
Procurement	10.4%	47.5%	35.1%	28.9%	25.2%	22.4%	20.5%	20.5%
Military Pay	3.1%	3.0%	3.1%	3.7%	4.2%	4.6%	5.0%	5.0%
Civilian Pay	12.0%	7.1%	8.8%	8.3%	8.2%	7.9%	7.7%	7.7%
Fuel	-13.2%	6.1%	-0.3%	3.1%	4.7%	4.0%	4.9%	4.9%
Medical	9.4%	5.7%	6.9%	8.4%	9.2%	9.8%	10.1%	10.1%
Steel	14.3%	6.3%	8.9%	9.2%	7.0%	7.3%	8.1%	8.1%

Table 6-9: Inflation Rate Categories

Composite rates are calculated by taking a weighted average of their component rates. The weights may be fixed over time, or they may adjust as the relative weights of the components change. The analyst should not have to compute the weights, but should expect they will be given by OSD or one of the services.

In order to compute the composite rates two items are needed. First, the relative proportions of the categories making up the composite category are needed, expressed as a percentage of the total expenditures in the new category. Second, the actual rates are needed. Table 6-10 shows the allocation of the component categories in the composite category.

Composite	Component 1	Component 2	Component 3
Military Personnel	Military Pay – 70%	Procurement – 30%	
O&M	Procurement – 60%	Fuel – 30%	Medical – 10%
Aircraft	Procurement – 50%	Steel – 30%	Fuel – 20%

Table 6-10: Composite Inflation Rates

There are a couple of things to note about Table 6-10. First, the percentages shown are arbitrarily chosen and do not necessarily correspond to the levels the analyst might actually encounter for similarly named composite categories. For example, it is clear for the O&M category that DHP is one of the components. However, the sample economy only has a medical index and not a DHP index, so CPI-Medical has been used as a substitute, even though the inflation rates projected for DHP and CPI-Medical generally do not match. In addition, a twist has been added to the Aircraft category, throwing in an index that is measured in the sample economy, but is not reflected in the OSD inflation guidance.

The composite rates are calculated by taking the weighted average of their component rates:

> Composite Rate =
> Rate 1 * Proportion 1 + Rate 2 * Proportion 2 + … + Rate i * Proportion i, where the proportions are the relative shares of each rate

To compute the composite rate for Year 10 for Military Personnel, the first step is to look up the projected inflation rates for its component pieces, Procurement (25.2%) and Military Pay (4.2%). The weighted average is calculated by multiplying each rate by that component's proportion within the composite category. For Military Personnel, Procurement is multiplied by 30% and Military Pay by 70%. A similar procedure would be followed to calculate the rate for O&M for Year 10, with Procurement accounting for 60%, Fuel at 30%, and Medical at 10%. The process would be repeated for each year in the table. Table 6-11 shows the results.

	Procurement	Military Pay	Fuel	Medical	Composite Rate
Rate – Y10	25.2%	4.2%	4.7%	9.2%	
Military Personnel	.3 * .252	.7 *.042			= .105 = 10.5%
O&M	.6 * .252		.3 * .047	.1 * .092	= .1745 = 17.45%

Table 6-11: Calculating Composite Rates

The Aircraft rate requires that an appropriate rate for steel be found and approved by OSD. In the sample economy, a CPI for steel is available. For Year 10, the rate is 7.0%. With this rate it is possible to calculate the composite rate, using the Procurement and Fuel rates as well:

$$\text{Aircraft, Year } 10 = .5 * .252 + .3 * .070 + .2 * .047 = .1564 = 15.64\%$$

Computing the composite rates for the rest of the table is simply a matter of replacing the Year 10 rates for Procurement, Military Pay, Fuel, Medical, and Steel with the appropriate rates for the other years, as shown in Table 6-12.

Dec Y7	FY6	FY7	FY8	FY9	FY10	FY11	FY12	FY13
Military Personnel	5.29%	16.35%	12.70%	11.26%	10.50%	9.94%	9.65%	9.65%
O&M	3.22%	30.90%	21.66%	19.11%	17.45%	15.62%	14.78%	14.78%
Aircraft	6.85%	26.86%	20.16%	17.83%	15.64%	14.19%	13.66%	13.66%

Table 6-12: Composite Inflation Rates

6.6 Outlay Rates

More than most U.S. Government agencies, the Department of Defense has many programs which require expenditures over multiple years. Building a ship or an aircraft, setting up or decommissioning a military base, researching and developing missiles, tanks, and other warfighting equipment, all take place over a considerable amount of time. These programs are also very expensive, creating an incentive to improve the ability to plan by granting authority to spend money appropriated in one year over a period of years. This is the origin of outlay rates, which provide a profile of how money appropriated for a program will be spent over time according to the type of program. Some categories of appropriations, such as Military Pay, Civilian Pay, and Fuel, are required to be spent 100% within the year of appropriation. Other categories are allowed to be spent over a period of as many as seven years, such as shipbuilding.

Each budget category has an outlay profile which specifies the percent of the appropriation which should be spent in a given year. The relevance of inflation should be clear – money appropriated and spent in the same year need not account for inflation. Money appropriated in this year but spent over the next several years needs to account for the inflation that will occur over that time. Inflation indices (as opposed to inflation rates) are calculated by combining the inflation rates projected over the years covered by the appropriation with the outlay rates authorized for that budget category. Table 6-13 shows an example of outlay rates from the sample economy for FY8.

FY8 Outlay Rates								
	FY8	FY9	FY10	FY11	FY12	FY13	FY14	Total
Procurement	27	35	25	13				100
Ships	19	22	10	17	10	13	9	100
Aircraft	24	36	30	3	4	3		100
Weapons	26	32	15	13	7	7		100
Vehicles	7	46	29	5	6	7		100
Ammunition	20	45	21	7	7			100
Military Pay	100							100
Civilian Pay	100							100
Energy	100							100
Medical	75	19	6					100
Military Personnel	85.4	7	5	2.6				100
Civilian Personnel	85.4	7	5	2.6				100
O&M	46.4	26.4	18.1	9.1				100

Table 6-13: Outlay Rates, FY 8

An appropriation for any one year will therefore have a spending profile which will extend up to seven years into the future. For example, if the outlay rates shown in Table 6-13 were in effect for an appropriation of $1000 for each budget category, it would not be difficult to calculate how much of that $13,000 would be spent in each year from Year 8 to Year 14 as shown in Table 6-14. It is simply a matter of distributing the amount allocated for each category according to the outlay profile, and adding up the totals. Inflation will diminish the buying power of each appropriation not spent entirely in the first year, as discussed in the next section.

	FY8	FY9	FY10	FY11	FY12	FY13	FY14	Total
Procurement	270	350	250	130				$1,000
Ships	190	220	100	170	100	130	90	$1,000
Aircraft	240	360	300	30	40	30		$1,000
Weapons	260	320	150	130	70	70		$1,000
Vehicles	70	460	290	50	60	70		$1,000
Ammunition	200	450	210	70	70			$1,000
Military Pay	1000							$1,000
Civilian Pay	1000							$1,000
Energy	1000							$1,000
Medical	750	190	60					$1,000
Military Personnel	854	70	50	26				$1,000
Civilian Personnel	854	70	50	26				$1,000
O&M	464	264	181	91				$1,000
Total	$7,152	$2,754	$1,641	$723	$340	$300	$90	$13,000

Table 6-14: Outlays FY8

Given that appropriations are often spent down over multiple years, in any given year, money may be available from multiple years of appropriations. Each fiscal year may have a different outlay profile, even for the same budget category. Table 6-15 shows a procurement program with four years of appropriations covering seven years.

Procurement	FY7	FY8	FY9	FY10	FY11	FY12	FY13	Total
FY7 Appropriation	300	440	170	90				$1,000
FY8 Appropriation		270	350	250	130			$1,000
FY9 Appropriation			330	440	150	80		$1,000
FY10 Appropriation				350	370	150	130	$1,000
Total	$300	$710	$850	$1,130	$650	$230	$130	$4,000

Table 6-15: Multiple Year Appropriation

6.6.1 Budget Authority, Total Obligational Authority and Outlays

The annual National Defense Budget Estimates, otherwise known as the "Green Book," defines Budget Authority (BA), Total Obligational Authority (TOA) and outlays and distinguishes among them.

Budget Authority is the authority to incur legally binding obligations of the Government which will result in immediate or future outlays. Most Defense BA is provided by Congress in the form of enacted appropriations.

Total Obligational Authority, which is the then year output of applying weighted indices to outlays, as described above, expresses the value of the direct defense program for a fiscal year. It may differ from BA due to obligations not being incurred before the budget authority expires, transfers of unobligated balances, transfers of budget authority, other Congressional action, or offsetting receipts from the public, such as might occur from admissions fees for an event.

Outlays are the actual expenditures of obligations. Outlays may or may not fall in the same year as the budget authority that created them, especially for major acquisition and construction programs with outlay profiles as described above.

6.7 Indices

One effect of spending down an appropriation over multiple years is that inflation makes the buying power of that appropriation less than if it had all been spent in one year. Consider an FY7 appropriation for $1000 along with the projected inflation for FY 7-10, as shown in Table 6-16. In this case, then year dollars need to be converted to constant dollars. Recall the formula:

CY$ = TY$ * (CY Index/TY Index)

For example, for FY8 the conversion is:

CY$ = $440 * (100.0/108.7) = $405

The rest of the table is shown below, displaying the effect of inflation on the purchasing power in the out years of the appropriation.

	FY 7	FY 8	FY 9	FY 10	Total
Appropriation	$300	$440	$170	$90	$1,000
Inflation	8.7%	8.7%	8.7%	8.7%	
Index	100.0	108.7	118.1	128.3	
FY7 $	$300	$405	$144	$70	$919

Table 6-16: Effect of Inflation on Appropriation

Inflation indices combine the inflation rate forecasts and outlay rates published annually by OSD to account for the reduced buying power of multi-year appropriations due to inflation. The services publish their own inflation indices based on the OSD data. The Army has one method for calculating its indices, and the Navy and Air Force use a different method.

6.7.1 Army

The Army combines outlay rates and inflation rates to form indices through a strict weighted average. The indices are used both to convert then year dollars to constant dollars and constant dollars to then year dollars over the life of a program. In the case of appropriations, the budget is allocated in current dollars, but expenditures take place over a number of years. The conversion from constant to then year dollars provides an indication of the purchasing power of the appropriation in each year it is being spent down, and the weighted average of all the years gives a comparison of what the appropriation is able to purchase over the life of the program versus what it would be able to purchase if all expenditures were to occur in the first year.

The conversion from then year dollars to constant dollars taking outlays into consideration is useful in planning and budgeting. If the analyst knows the current cost of an item that needs to be purchased in a future year of an appropriation being budgeted for, then it is possible to budget enough for that item to account for the higher cost likely when it is purchased.

The first step in the Army calculation of an index for a multi-year appropriation is to set the first year of the appropriation to an inflation index of 1.00 (not the usual 100.0). Next, it calculates the appropriate inflation indices for the rest of the years of the appropriation. Then the index is formed simply by multiplying the outlay rate for each year by the inflation index for that year, and summing up the results.

> Weighted Index, Army = (Outlay 1 * Index 1) + (Outlay 2 * Index 2) + … + (Outlay X * Index X), where the outlays represent the percent the appropriation allocated to each year and the indices representing the inflation index for the year, with Index 1 set to 1.000

For example, if the outlay rates and inflation indices for Ammunition in FY8 are as shown in Table 6-17, the inflation index for Ammunition accounting for outlays is 1.135, as shown in the table.

To illustrate the application of this index, consider an FY8 budget for an Ammunition appropriation seeking to purchase what would be $5000 worth of goods if everything was purchased in FY8. Since this appropriation will be spent over multiple years, it is necessary to account for inflation, so the index is used to determine what the budget request should be to ensure that it is possible to purchase everything in the request. The index allows the analyst to simply multiply the current dollar need ($5,000) by the index value (1.135) to arrive at the amount needed ($5,675).

Ammunition Index – FY8	Outlay Rate	Inflation Index/100	Outlay Weighted Index	Budget	Requirement
FY8	.20	1.000	.200	$1,000	$1,000
FY9	.45	1.094	.492	$2,250	$2,462
FY10	.21	1.197	.251	$1,050	$1,257
FY11	.07	1.310	.092	$350	$459
FY12	.07	1.433	.100	$350	$502
TOTAL	1.00		1.135	$5,000	$5,675

Table 6-17: Combining Outlay Rates and Inflation Rates (Army)

The alternative requires a few more steps but reaches the same result. First, multiply the total budget by the percent allocated for each year according to the outlay profile to determine how much of the budget will be spent each year. The cost of the items budgeted by fiscal year will be equal to the inflation index for that year multiplied by the amount of the budget allocated for that year. Adding the results over all fiscal years provides the total budget requirement to accomplish the task. In this case, the sum is equal to $5,680. The difference between this and the $5,675 figure reached using the other method is due to rounding. The advantage of coming up with an index is that it can be used for all budgets using the same outlay profile.

6.7.2 Navy/Air Force

The method the Army uses assumes that the outlay rates are provided in constant dollar terms. The method the Navy and Air Force use assumes that the outlays are given in then year dollars, necessitating a change in the calculation. The Army method would still provide a good approximation, even with outlays in then year dollars, but generally provide a higher TOA than the method used by the Air Force and Navy. If the outlay rates are in then-year dollars, there is a conflict if they are applied to inflation indices expressed in base-year terms. For example, the 20% outlay for FY8 based on $5,000 is $1,000, but when the requirement was raised to $5,675, the FY8 outlay did not increase to $1,135.

Then year dollars (TY$) are equal to constant dollars (CY$) multiplied by the inflation index (I). Conversely, constant dollars are equal to then year dollars divided by the inflation index:

$$TY\$ = CY\$ * I$$
$$CY\$ = TY\$ / I$$

In the case when outlays are spread over multiple years, the formulas change to account for the expenditure rates (E_i) for each year "i" and inflation indices (I_i) for the corresponding years:

$$CY\$ = (TY\$ * E_1) / I_1 + (TY\$ * E_2) / I_2 + \ldots + (TY\$ * E_i) / I_i \text{ , so}$$
$$CY\$ = TY\$ * (E_1 / I_1 + E_2 / I_2 + \ldots + E_i / I_i) \text{ and}$$
$$TY\$ = CY\$ * (1 / (E_1 / I_1 + E_2 / I_2 + \ldots + E_i / I_i))$$

The weighted index is the second part of the expression:

$$\text{Weighted Index (Navy, Air Force)} = (1 / (E_1 / I_1 + E_2 / I_2 + \ldots + E_i / I_i))$$

Applying the formulas to the outlay profile and raw inflation indices from the previous example, a different, more accurate index is calculated, as shown in Table 6-18.

Weighted Index =
1/((.20/1.000) + (.45/1.094) + (.21/1.197) + (.07/1.310) + (.07/1.433)) =
1/(.888) = 1.126

Ammunition Index – FY8	Outlay Rate	Inflation Index/100	Outlay / Inflation Index	Budget
FY8	.20	1.000	.200	$1,000
FY9	.45	1.094	.411	$2,250
FY10	.21	1.197	.175	$1,050
FY11	.07	1.310	.053	$350
FY12	.07	1.433	.049	$350
TOTAL	1.00		.888	$5,000
Navy/Air Force			1.126 (=1/.888)	$5,630
Army Method			1.135	$5,675

Table 6-18: Inflation Indices, Air Force and Navy

The yearly requirements are then just the overall appropriation requirement multiplied by the individual yearly outlay rates. For example, the expected expenditure in FY10 would be as follows:

FY10 = $1050 * 1.126 = $1182

A comparison of the outlay profiles of the two methods is provided in Table 6-19.

	Budget CY$	Army TY$	AF/Navy TY$
FY8	$1,000	$1,000	$1,126
FY9	$2,250	$2,462	$2,534
FY10	$1,050	$1,257	$1,182
FY11	$350	$459	$394
FY12	$350	$502	$394
TOTAL	$5,000	$5,675	$5,630

Table 6-19: Comparison of Weighted Index Methodology

Another formulation of this problem is computing the buying power in the out years of an appropriation expressed in then year dollars, in other words, converting then year dollars into constant dollars. This time assuming $5,000 has been appropriated for the same program, the buying power over the life of the program is the budget divided by the index, that is:

Buying power = $5,000 / 1.126 = $4,440

This figure demonstrates that if the inflation assumptions hold and if more than $4,440 worth of purchases are required in current dollars, then there will not be enough in the program to complete the task.

6.8 Appropriations and Funding Cycles

The appropriation a program is funded from has an affect on when items can be procured. Certain appropriations require the consideration of inflation, whereas others are spent down within one year and do not incur inflation.

6.8.1 Full Funding

As stipulated in DoD Directive 5000.1, it has been a long-standing DoD policy to seek full funding of acquisition programs, based on the most likely cost. The implication of this is the need to project inflation and outlay rates for multi-year programs. Certain appropriations, such as military pay, civilian pay, and fuel are expected to be spent in the year appropriated, whereas others, such as procurement, are fully funded over more than one year. This means the obligation over multiple years is fully appropriated in the first year of the program.

6.8.2 Incremental Funding

Incremental funding is used when the total cost of the project is greater than what is available at the desired start time. The budget for the project is included in the contract, but is awarded incrementally as it becomes available. The overall scope of work and pricing does not change from the original contract amount. The incremental funds are added by modifications, but the modifications are not intended to extend the period of performance or to add money to the full amount of the contract.

Incremental funding is the way most programs are funded by Congress. It provides that only funds required to accomplish work are included in the budget request for that fiscal year. DoD is the exception to that practice, with full funding of multi-year programs the norm, but there are cases when the full amount of funding for a multi-year program is not available when budget decisions are made.

To illustrate the difference between the incremental and full funding, consider an example. Assume an RDT&E program and a production program of equal length (three years) and of equal value ($30 million) both start on the first day of FY7. Both programs are expected to incur costs of $15 million in FY7, $10 million in

FY8, and $5 million in FY9. The RDT&E program will be funded from three different fiscal year appropriations: $15 million in FY7, $10 million in FY8, and $5 million in FY9. The production program will be funded in its entirety from the FY7 procurement appropriation. Recall that then year dollars are equal to constant year dollars times the then year index over the constant year index. So due to inflation, the then year requirement for $30 million in base year purchases over the three years is $30.58m, as illustrated in Table 6-20.

		Appropriation			
	$ Type	**FY7**	**FY8**	**FY9**	**Total**
CPI, BY1		116.1	119.1	125.2	
RDT&E	BY	$15m	$10m	$5m	$30m
	TY	$15m	$10.21m	$5.37m	$30.58m
Procurement	TY	$30.58m	$0m	$0m	$30.58m

Table 6-20: Full Funding vs. Incremental Funding

6.8.3 Supplemental Funding

Supplemental funding is required when a fully funded program runs out of money before the goal is accomplished. This can occur when the scope of the project changes after the budget is awarded, if the project runs over budget for other reasons, or if funds from the budget were re-programmed for other projects, leaving a shortfall for the project.

6.9 Contracts

Inflation indices are also used by cost analysts for the preparation of Economic Price Adjustment (EPA) clauses in contracts. These clauses shift the risk that inflation will differ from forecast inflation to the Government. EPAs are generally used on major production buys and long performance periods where the risk is greater due to the compounding of inflation over time or the sheer volume of the purchase which makes even smaller differences between actual and projected inflation more significant. The EPA clause contains an index projecting inflation tailored to the specific project over the contract period of performance. The clause also contains a mechanism to adjust contract costs to reflect differences between projected and actual price levels at the time of contract performance.

6.10 Advanced Topics: Inflation Statistics

6.10.1 Consumer Price Index

The Consumer Price Index (CPI) measures the change in price of a basket of goods over time. Two different methods have been used to calculate the Consumer Price Index in recent years – the arithmetic mean and the geometric mean. The arithmetic mean refers to taking a weighted average of a set of quantities, and was used by BLS to calculate the CPI until 1999. In 1999, BLS started using the geometric mean to help account for substitution to lower priced items for goods undergoing higher than the average inflation. To illustrate how the CPI has been calculated using both methods, consider the basket of goods from the sample economy depicted in Table 6-21. Out of a total of 10 items in the entire economy in Year 1, four have been selected as representative of the items the typical consumer might purchase, along with quantities proportionate to the amount that would be purchased. The basket consists of bananas, coconuts, wood, and tourism. Actual units are not important as long as for each unit of tourism, costing $7.00, two units of wood, eight units of coconuts, and 10 units of bananas are purchased. The quantities of each item are held constant from year to year, with changes in price recorded.

	FY 1	FY 1	FY 2	FY 3	FY 4
	Quantity	**Unit Cost**	**Unit Cost**	**Unit Cost**	**Unit Cost**
Bananas	10	1.25	1.30	1.40	1.35
Coconuts	8	2.00	2.10	2.15	2.20
Wood	2	5.00	5.25	5.50	5.40
Tourism	1	7.00	6.85	7.15	7.00

Table 6-21: Sample Economy "Basket"

After choosing the basket items, the next step is to determine their proportion. While the actual recorded quantities consumed in the economy can be used, for the purposes of the example, it is sufficient to use smaller quantities that maintain the same proportion to each other as in the larger economy. This simplifies math performed by hand, though in real applications, computers would be used. Given that the basket is already a subset of the economy deemed to be representative, it is already an approximation. Therefore, it is appropriate to use rounded figures. In the sample economy, the quantities for bananas, coconuts, wood, and tourism are already rounded to the nearest thousand, so the proportions can be easily reduced, as shown in Table 6-22.

	Quantity	Thousands	Reduces to
Bananas	50,000	50	10
Coconuts	40,000	40	8
Wood	10,000	10	2
Tourism	5,000	5	1

Table 6-22: Basket Quantities

6.10.1.1 Arithmetic Mean

Using the pre-1999 arithmetic mean method, the CPI is computed by adding up the total price of all of the goods in the sample basket, as follows:

Basket Price =
$q_1 * p_1 + q_2 * p_2 + \ldots + q_i * p_i$, where q_i is the quantity of item "i" in the base year and p_i is the price of item "i" in the target year

In the example, 10 bananas are multiplied by their average price, computed by taking a sample of banana prices across establishments which sell bananas, eight coconuts are multiplied by their average prices, two units of wood and one unit of tourism are multiplied by their average price, and all of the results are added together to arrive at the price of the CPI basket. In this case the price is:

Base Year CPI Basket Price =
10 * 1.25 + 8 * 2.00 + 2 * 5.00 + 1 * 7.00 = 45.50

In the base year, FY 1 in the example, the CPI is set to 100.0, equivalent to 45.50 monetary units spent for the basket. To compute the CPI for another year, it is necessary to add up the price of that same basket of goods in that year, holding the quantities of the items in the basket constant, and compare that price to the price in the base year, which was 45.50. For example, in FY 2-4, the prices of all the items added together are:

FY 2: 10 * 1.30 + 8 * 2.10 + 2 * 5.25 + 1 * 6.85 = 47.15
FY 3: 10 * 1.40 + 8 * 2.15 + 2 * 5.50 + 1 * 7.15 = 49.35
FY 4: 10 * 1.35 + 8 * 2.20 + 2 * 5.40 + 1 * 7.00 = 48.90

The CPI for any given year is then computed by taking the price of the basket computed for that year and dividing by price in the base year:

CPI, Year i, BY j (Arith. Mean) =
(Basket Price (Year i) / Basket Price (Year j)) * 100

For the example, the CPIs for FY2-4 are thus calculated and shown in Table 6-23:

CPI, FY 2 = (47.15/45.50) * 100 = 103.6
CPI, FY 3 = (49.35/45.50) * 100 = 108.5
CPI, FY 4 = (48.90/45.50) * 100 = 107.5

	FY 1	FY 2	FY 3	FY 4
Total	45.50	47.15	49.35	48.90
CPI, Arith. Mean	100.0	103.6	108.5	107.5
Inflation		3.6%	4.7%	-0.9%

Table 6-23: CPI FY 1-4, Using Arithmetic Mean

Finally, with the help of the CPI, it is possible to compute inflation for any given time period, at least for this basket of goods, which is taken to be representative of the economy as a whole from the typical consumer's point of view. The inflation for any given period is computed by dividing the CPI of the end point by the CPI at the beginning of the period being considered and subtracting 1:

Inflation (Year X to Year Y) = (CPI (Year Y) / CPI (Year X)) - 1

For example:

Inflation, FY 1 to FY 2: 103.6/100.0 – 1 = .036 = 3.6% inflation
Inflation, FY 2 to FY 3: 108.5/103.6 – 1 = .047 = 4.7% inflation
Inflation, FY 3 to FY 4: 107.5/108.5 – 1 = -.009 = -0.9% inflation
Inflation, FY 1 to FY 4: 107.5/100.0 – 1 = .075 = 7.5% inflation

There are two things to note about these calculations. First, from FY 3 to FY 4, there was *negative* inflation, otherwise known as deflation. It is not very common, but it can occur. Second, the inflation from Year 1 to Year 4 is the inflation for the 3-year period, not the annual inflation. To compute the average annual inflation between two years not adjacent to each other, it would be necessary to take the x^{th} root of the proportion between their CPIs before subtracting 1, where x is the number of years separating the two CPIs:

Average Annual Inflation (Year X to Year Y) =
$(\text{CPI (Year Y) / CPI (Year X)})^{(1/(Y-X))} - 1$

In the case of the average annual inflation from FY 1 to FY 4:

Average Annual Inflation, FY1 to FY4 = $(107.5/100.0)^{1/3} - 1 = 2.4\%$

6.10.1.2 Geometric Mean

In 1999 BLS switched to using the geometric mean for computing the CPI. This calculation yields different results than using the arithmetic mean, making it impossible to accurately compare indices computed before and after the change. Fortunately, the new method does not require any additional data, and thus the CPI for earlier years can be recalculated using the geometric mean. The geometric mean formula yields the inflation rate directly, from which the CPI can be derived. It is calculated by multiplying the relative change in prices for all items taken to the power of the proportion of that item's cost share in the basket in the base year. For the years in the above example, using the geometric mean yields the same CPI and inflation rates. But this is not always the case.

The first step is to calculate the cost share for all items. Recall the formula for the basket price in the base year:

> Basket Price =
> $q_1 * p_1 + q_2 * p_2 + \ldots + q_i * p_i$, where q_i is the quantity of item "i" in the base year and p_i is the price of item "i" in the target year

The price share of each item is:

> Price Share of Item in Basket =
> $(q_j * p_j) / (q_1 * p_1 + q_2 * p_2 + \ldots + q_i * p_i)$ for any item "j" in the basket.

This is calculated for each item. Inflation is then calculated by taking the change in price for each item to the power of its price share in the market basket, and taking the product of this result across all items in the basket, subtracting 1:

> Inflation (Geometric Mean) =
> $(p_1(Y)/p_1(X))^{\text{Price Share 1 (BY)}} * (p_2(Y)/p_2(X))^{\text{Price Share 2 (BY)}} * \ldots * (p_i(Y)/p_i(X))^{\text{Price Share i (BY)}} - 1$, where $p_j(Z)$ = price of item j in Year Z and Price Share j (BY) = the price share of item j in the base year, as calculated in the formula above

The CPI can then be calculated by multiplying the CPI from the previous year by one plus the inflation rate:

> $CPI_{X+1} = CPI_X * (1 + \text{inflation rate (year X+1)})$

For example, if CPI, FY4 is 107.5 and the inflation rate for FY5 is 13.4%, then:

CPI, FY5 = 107.5 * (1 + 0.134) = 121.9

To illustrate, consider Table 6-24 with price data from the sample economy for the base year (FY1) and FY4 and FY5, for which we wish to calculate the inflation rate between FY4 and FY5.

		FY1(BY)	FY4	FY5
	Quantity	**Unit Cost**	**Unit Cost**	**Unit Cost**
Bananas	10	1.25	1.35	1.85
Coconuts	8	2.00	2.20	2.40
Wood	2	5.00	5.40	5.50
Tourism	1	7.00	7.00	7.20
CPI, AM			107.5	122.9
Inflation, AM			-0.9%	14.3%
CPI, GM			107.5	121.9
Inflation, GM			-0.9%	13.4%

Table 6-24: Comparison of Arithmetic Mean and Geometric Mean Inflation

The calculations for each are shown below:

Inflation (Arithmetic Mean):

$$\frac{(10 * 1.85 + 8 * 2.40 + 2 * 5.50 + 1 * 7.20)}{(10 * 1.35 + 8 * 2.20 + 2 * 5.40 + 1 * 7.00)} - 1 = 14.3\%$$

Inflation (Geometric Mean):

$$(1.85/1.35)^{25/91} * (2.40/2.20)^{32/91} * (5.50/5.40)^{20/91} * (7.20/7.00)^{14/91} - 1 = 13.4\%$$

where the exponents represent the price share of that item in the basket of goods during the base year (e.g. (10*1.25)/(10*1.25 + 8*2.00 + 2 * 5.00 + 1 * 7.00) = 12.5/45.5 = 25/91)

The inflation rate given by the CPI is highly dependent on the items chosen to make up the basket of goods. Consider a basket made up not of the four items from the sample economy chosen for the previous examples, but made up of Fuel, Milk, Medical Care, and Steel. The base year (FY 1) quantity and prices for FY 1-5 are given in Table 6-25. The CPI and annual inflation rate are computed for each year, using the geometric mean method, and are compared to the figures arrived at using the basket of goods from the earlier example. As can be seen from the table, the inflation rates bear very little resemblance to each other, since the prices for these four items did not change at the same rates as the prices for the other four items.

	FY 1	FY 1	FY 2	FY 3	FY 4	FY 5
	Quantity	Unit Cost	Unit Cost	Unit Cost	Unit Cost	Unit Cost
Fuel	200	2.50	3.25	2.75	3.00	3.80
Milk	15	2.20	2.25	2.30	2.25	2.35
Medical Care	25	20.00	22.00	25.00	28.00	32.00
Steel	2	10.00	12.00	15.00	13.00	14.00
Total		1053.00	1257.75	1239.50	1359.75	1623.25
CPI, GM		100.0	119.0	117.3	128.6	153.7
Inflation			19.0%	-1.4%	9.6%	19.5%
Other Basket			3.6%	4.7%	-0.9%	13.4%

Table 6-25: Effect of Using a Different Basket

This large difference in inflation rates achieved by using a different basket of goods might call into question the validity of the CPI itself. Two factors minimize the danger of arriving at an inaccurate general inflation rate. The first is that the actual basket of goods used by BLS in deriving the CPI is much more comprehensive than the limited baskets used for our examples, which are merely meant to demonstrate the basic concepts and mathematics behind computing the CPI. The basket the BLS uses is much more representative of the products and services the typical consumer will encounter. The second factor that exaggerates the differences in the two baskets in the examples is that the quantities and prices of the products and services were arrived at independently of each other, and thus should have no relation to each other. In the real economy, with some exceptions, the prices of goods and services tend to rise and fall together.

For the purpose of providing inflation guidance within the Department of Defense, the overall CPI is less important than certain subindices. The CPI for items related to health care is used to help generate inflation forecasts for health care separate from overall inflation. Within the sample economy, a CPI for fuel prices is used as a proxy for the Refiner Acquisition Cost (RAC) used for the inflation forecast for fuel. In addition, program offices can apply to OSD for exemptions from published inflation guidance if they can show another inflation forecast will more accurately reflect future inflation in their programs due to special circumstances. The CPI for steel is used in the sample economy as an example of this.

In the sample economy, CPI-Medical, CPI-Fuel, and CPI-Steel are calculated as if they are each composed of one individual item. For example, CPI-Fuel is not a composite of oil, gas, coal, solar, wind, and nuclear, but is a generic term representative of all fuels. In this case, the arithmetic mean and geometric mean methods give the same result. If these indices were in fact made up of multiple related items, then the arithmetic and geometric means would be calculated as they were for the overall CPI in the examples above. Table 6-26 shows the value of three indices calculated for the sample economy separate for the generic market basket for years FY1-4.

	FY1	**FY2**	**FY3**	**FY4**
Medical – Unit Price	20.00	22.00	25.00	28.00
Medical Index	100.0	110.0	125.0	140.0
Inflation		10.0%	13.6%	12.0%
Fuel – Unit Price	2.50	3.25	2.75	3.00
Fuel Index	100.0	130.0	110.0	120.0
Inflation		30.0%	-15.4%	9.1%
Steel – Unit Price	10.00	12.00	15.00	13.00
Steel Index	100.0	120.0	150.0	130.0
Inflation		20.0%	25.0%	-13.3%

Table 6-26: Specialized CPI Indices

Sometimes it is desirable to change the base year of the CPI without changing the basket composition. To do this another year is set equal to 100.0 and all of the other years are adjusted so that their indices remain in the same proportion to each other:

$$CPI\ (New\ Base\ Year) = (CPI_{OLD} * 100) / CPI_{OLD}\ (New\ Base\ Year)$$

CPI_{OLD} is the CPI in a given year using the old base year, and CPI_{OLD} (New Base Year) is the CPI of the new base year as calculated using the old base year.

Table 6-27 shows all 10 years of the sample economy for the four products making up the CPI basket in FY 1. The CPI for Base Year 1 has been computed for all years using the geometric mean the same way as in the examples above. Suppose there is now a need to use a new base year, for example FY 6. The CPI for FY 6 then becomes 100.0. The CPIs for other years are then calculated simply by dividing the CPI in that year by the CPI in FY 6 with FY 1 as the base year and multiplying by 100. For example, the CPI in FY 4, with a base year of FY 6 is:

CPI, FY 4, Base Year 6 = (107.4/117.5) * 100 = 91.4

Instead of using one year as a base year, often the average of several years is taken as the base. This reduces the chance of an abnormally high or low inflation year skewing the CPI. To find the individual CPI levels in the base years, it is necessary that the average level is 100.0. If there are three years making up the base period, then the sum of the CPI values for the three years should equal 300.0, but due to inflation within that period, it is not necessary that any individual year be equal to 100.0. To find the indices for the base years, add up the index values for those same years with another base year, for example FY 1. Then divide that number into the number of base years in the new index multiplied by 100. Multiply the result by the index value in each of the years in the Base FY 1 index to arrive at the new base year values. Other years in the new index can be calculated in the same way or by multiplying the value of the preceding year by 1 plus the inflation rate. The formula is similar to that using one base year:

CPI (New Base Year) = (CPI_{OLD} * 100) / Average CPI_{OLD} (New Base Year)

CPI_{OLD} is the CPI in a given year using the old base year, and Average CPI_{OLD} (New Base Year) is the Average CPI of the new base years as calculated using the old base year.

For example, to find the CPI for Year 8 using FY 4-6 as the base years, the steps would be:

Step 1: CPI, FY4 + CPI, FY5 + CPI, FY6 (all BY1) = 107.4 + 121.8 + 117.5 = 346.7
Step 2: 300/346.7 = .865
Step 3: FY8, Base Years 4-6 = 115.9 * .865 = 100.3

	Qty	FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	FY9	FY10
Bananas	10	1.25	1.30	1.40	1.35	1.85	1.70	1.50	1.55	1.60	1.65
Coconuts	8	2.00	2.10	2.15	2.20	2.40	2.35	2.20	2.30	2.35	2.45
Wood	2	5.00	5.25	5.50	5.40	5.50	5.60	6.00	5.75	6.00	6.30
Tourism	1	7.00	6.85	7.15	7.00	7.20	6.80	7.10	7.40	7.30	7.50
Inflation Rate			3.6%	4.7%	-0.9%	13.4%	-3.5%	-3.5%	2.2%	2.4%	3.9%
CPI, BY1		100.0	103.6	108.4	107.4	121.8	117.5	113.4	115.9	118.7	123.3
CPI, BY6		85.1	88.2	92.3	91.4	103.7	100.0	96.5	98.6	101.0	104.9
CPI, BY4-6		86.4	89.5	93.7	92.9	105.4	101.7	98.1	100.3	102.7	106.7

Table 6-27: Changing Base Years

The last item to be aware of is that the composition of the basket making up the CPI can change over time. Some goods become more prevalent, and others less widespread or may even disappear altogether. This creates a difficulty in comparing the price of a basket made up of one set of goods to a basket from a different year made up of a different set of goods, or perhaps the same goods in different proportions. Technically speaking, they cannot be compared directly. However, if it is assumed that the baskets from the two eras are equally "typical" of consumer spending at their respective times, then it is possible to compare inflation over time of the typical basket, even if the particular items within the basket change.

Consider the same problem as the previous example, except that in FY 6, for whatever reason, the basket making up the CPI changes, eliminating "tourism" and adding "bicycles", as well as changing relative proportions. In Table 6-28, FY 6 is repeated with both the old basket and the new basket composition. This is because FY 6 is the base year for all years going forward, but to calculate the CPI relative to FY 5, it is necessary to have a common frame of reference with that year, that is it must have the same basket. Therefore, the first step in computing the CPI with a new basket is to calculate the CPI for that year with the old basket. Then the CPI can be reassigned the value of 100.0 as the new base year, and the values of the indices for previous years can be readjusted with the new base year the same way it was accomplished in the last example. For FY 7 and all subsequent years, the CPI is calculated using the new basket, with the FY 6 quantities and prices as the base. Note that the CPI and inflation rates for the new basket vary from those calculated in the previous example using the old basket, but not radically, since there is overlap between the two baskets.

	Qty	FY3	FY4	FY5	FY6	Qty	FY6	FY7	FY8	FY9	FY10
Bananas	10	1.40	1.35	1.85	1.70	150	1.70	1.50	1.55	1.60	1.65
Coconuts	8	2.15	2.20	2.40	2.35	150	2.35	2.20	2.30	2.35	2.45
Wood	2	5.50	5.40	5.50	5.60	40	5.60	6.00	5.75	6.00	6.30
Tourism	1	7.15	7.00	7.20	6.80						
Bicycles						3	160	170	175	190	200
Inflation Rate		4.7%	-0.9%	13.4%			-3.5%	-0.8%	2.2%	5.1%	4.5%
CPI, BY1		108.4	107.4	121.8			117.5	116.6	119.1	125.2	130.8
CPI, BY6		92.2	91.4	103.6			100.0	99.2	101.4	106.5	111.3

Table 6-28: Changing the CPI Basket

6.10.2 Gross Domestic Product

The Gross Domestic Product (GDP) and the GDP implicit price deflator (GDP deflator) in particular, have a greater impact than the CPI on overall inflation forecasts within DoD. The GDP is a measure of the size of the overall economy.

It is computed by multiplying all items produced in an economy by their prices, and adding all of the results together. There are two types of GDP that can be calculated. One is the nominal GDP, which is the sum of all products in the economy multiplied by their current price:

$$\text{Nominal GDP} = q_1(x) * p_1(x) + q_2(x) * p_2(x) + \ldots + q_i(x) * p_i(x)$$

where $q_j(x)$ is the quantity of item j in year x and $p_j(x)$ is the price of item j in year x.

The other is the "real" GDP, which is the sum of all products in the economy multiplied by their price in some base year, usually the previous year:

$$\text{Real GDP} = q_1(x) * p_1(x\text{-}1) + q_2(x) * p_2(x\text{-}1) + \ldots + q_i(x) * p_i(x\text{-}1)$$

where $q_j(x)$ is the quantity of item j in year x and $p_j(x\text{-}1)$ is the price of item j in year x-1.

In a sense, the real GDP is similar to the CPI in that it measures the change in price from one year to the next of the same set of goods, or "basket," but that basket is actually the entire economy and its composition changes every year. Table 6-29 shows the entire sample economy in FY 4, along with the prices for the same goods in FY 3. Nominal and real GDPs are calculated, along with another statistic known as the GDP implicit price deflator, and the CPI computed for the basket made up of four items for comparison.

	FY 3	FY 4			
	Unit Price	**Unit Price**	**Quantity**	**Nominal**	**Real, BY3**
Bananas	1.40	1.35	55000	74250	77000
Coconuts	2.15	2.20	44000	96800	94600
Wood	5.50	5.40	10500	56700	57750
Tourism	7.15	7.00	5750	40250	41112.5
Fuel	2.75	3.00	230000	690000	632500
Civilian Pay	11.00	12.00	180000	2160000	1980000
Military Pay	14.00	15.00	120000	1800000	1680000
Milk	2.30	2.25	18000	40500	41400
Medical Care	25.00	28.00	28000	784000	700000
Steel	15.00	13.00	2700	35100	40500
Radios	25.00	27.00	3600	97200	90000
Furniture	50.00	48.00	2400	115200	120000
Boats	n/a	950.00	100	95000	0
GDP				6,085,000	5,554,862.5
GDP Deflator					9.5%
CPI					-0.9%

Table 6-29: Nominal and Real GDP

The GDP implicit price deflator, otherwise known simply as the GDP deflator, is a measure of the overall inflation rate in the economy. It is expressed as a ratio between the nominal GDP and the real GDP, and shows the weighted change in price for all of the goods in the economy:

GDP Deflator =

$$\frac{\text{Nominal GDP}}{\text{Real GDP}} = \frac{\Sigma\text{Qty. (Year X) * Price (Year X)}}{\Sigma\text{Qty. (Year X) * Price (Year X – 1)}} = \frac{\text{Price (Year X)}}{\text{Price (Year X – 1)}}$$

For FY 4, the GDP deflator would be equal to the nominal GDP for FY 4 divided by the real GDP for FY 4, or 6,085,000/5,554,862.50 = 1.095, for a 9.5% increase in prices from FY 3 to FY 4 for the goods in the economy in FY 4. This statistic, however, does not capture the effects of substitution of items. Consider the two item economy in Table 6-30, containing steak and chicken. In FY 1, steak is five times more popular than chicken and two and a half times more expensive. In FY 2, possibly due to a disease outbreak among cattle, the relationship is reversed, with chicken five times more popular and two and a half times more expensive. The GDP is exactly the same for each year, and the economy looks very similar. But the GDP deflator depicts an inflation rate of 80%. Clearly this is an extreme example, with such large swings in prices rare and the number of goods in the U.S. economy diminishing the effects a few items can have on their own. Note that the price relationship in the example could have been reversed, which would have led to a GDP deflator of $3000/$5400 = 5/9 = .556, for an inflation rate of -44%.

	FY 7 Price	**FY 7 Quantity**	**FY 8 Price**	**FY 8 Quantity**
Steak	$5	1000	$2	200
Chicken	$2	200	$5	1000
Nominal GDP		$5400		$5400
Real GDP				$3000
GDP deflator				1.800
Inflation				80%

Table 6-30: Substitution Effect on GDP Deflator

Given inflation rates calculated by computing the GDP deflator, it is easy to create an index. Select a base year, such as FY 1, and set that to 100.0. The index for any year is the previous year's index multiplied by one plus the inflation rate for that year:

GDP Deflator index (Year X) = Index (Year X-1) * (1 + Inflation (Year X))

Plugging 9.5% in from Table 6-9 for the GDP deflator in FY4, and an index of 118.0 for FY3 from Table 6-11, makes it possible to compute the GDP deflator index for FY4:

$$\text{GDP Deflator index (FY4)} = 118.0 * (1 + 0.095) = 129.2$$

The analyst may face the task of converting budgets or expenditures between constant and then year dollars, which can be accomplished using the appropriate indices. Two conversion problems will use Table 6-31 as the source for historical inflation data in various sectors of the sample economy. The CPI-Medical index will be used for medical related costs, CPI-Fuel for fuel costs, CPI-Military Pay for military pay, CPI-Civilian Pay for civilian pay, CPI-Steel as an index for a program using a high proportion of steel, and the GDP deflator index for everything else.

	FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	FY9	FY10
GDP Deflator	100.0	111.4	118.0	129.3	143.0	157.8	232.7	246.6	267.0	284.6
CPI-Fuel	100.0	130.0	110.0	120.0	152.0	132.0	140.0	148.0	160.0	150.0
CPI-MilPay	100.0	108.3	116.7	125.0	133.3	137.5	141.7	150.0	158.3	166.7
CPI-CivPay	100.0	105.0	110.0	120.0	125.0	140.0	150.0	150.0	160.0	175.0
CPI-Med	100.0	110.0	125.0	140.0	160.0	175.0	185.0	200.0	225.0	240.0
CPI-Steel	100.0	120.0	150.0	130.0	140.0	160.0	170.0	150.0	200.0	180.0

Table 6-31: Inflation Indices, Sample Economy

7 Budget Analysis Applications and Examples

7.1 Background

The analyst's tasks extend beyond budget preparation to analyzing budget and expenditure trends over time, which necessitate adjustments for inflation. Examples of this include analyzing budget shares as they change over time, net present value (NPV) as a means of making budget choices, comparing contract proposals and past performance of vendors, and comparing actual expenditures to approved budgets. A 10-year sample economy, described in Appendix II, is used for the examples and problems in this chapter.

7.2 Trends over Time

7.2.1 Adjusting for Inflation

When making comparisons across multiple years it is important to adjust for inflation. This is often referred to as normalizing for inflation. The first step is to choose the appropriate index, as described in Section 5.6. The index will have a base year set to 100.0 and all other years reflecting a value proportional to the cost in the base year. For example, an index with FY 2004 as the base year and a value of 109.5 in FY 2006 indicates that items reflected in that index in FY 2006 will cost 9.5% more than items in FY 2004.

$$\text{Inflation, Year X to Year Y} = (\text{Index, Year Y} / \text{Index, Year X}) - 1$$

Table 7-1 displays the then year price of bananas and the CPI over 10 years in the sample economy. Other than a spike in prices in FY5 and drops in FY6-7, the table shows a steady increase in prices throughout the 10-year period. However, the CPI shows the same trend. By adjusting for inflation, it is possible to determine the trend in prices for bananas relative to other goods in the economy.

	FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	FY9	FY10
Bananas	$1.25	$1.30	$1.40	$1.35	$1.85	$1.70	$1.50	$1.55	$1.60	$1.65
CPI	100.0	103.6	108.4	107.4	121.8	117.5	116.6	119.1	125.2	130.8

Table 7-1: Then Year Price of Bananas

To adjust for inflation, it is necessary to multiply the then year price for each year by the CPI for the base year (FY1 = 100.0) divided by the CPI for the current year.

Adjusted (Constant) Price =
Then Year Price * (Base Year Index / Then Year Index)

For example, the price in FY4 adjusted for inflation is $1.35 * (100.0/107.4) = $1.26. Table 7-2 shows the raw and adjusted price for each year.

	FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	FY9	FY10
Raw	$1.25	$1.30	$1.40	$1.35	$1.85	$1.70	$1.50	$1.55	$1.60	$1.65
Adjusted	$1.25	$1.25	$1.29	$1.26	$1.52	$1.45	$1.29	$1.30	$1.28	$1.26

Table 7-2: Price of Bananas Adjusted for Inflation

The highest unadjusted price for bananas indeed occurs in the year with the highest adjusted price, in FY5, meaning that the growth in banana prices during the period leading up to FY5 was greater than inflation in the overall economy. However, it is frequently the case that the peaks in the raw and adjusted prices of a good do not fall in the same year. Even with bananas, notice the raw and adjusted prices for FY7-10. There is a steady increase in raw prices throughout the period. But the prices adjusted for inflation indicate that the highest price is actually in FY8, with FY10 registering the lowest adjusted price.

7.2.2 Budgets

The relative size of a budget over time is also affected by inflation. When comparing budgets in then year dollars from different years, they must be converted to constant dollars. After selecting an appropriate index and base year, multiply the then year budget by the base year index and divide by the then year index:

$$BY\$ = TY\$ * \frac{BYIndex}{TYIndex}$$

Table 7-3 takes the Military Pay expenditures from the sample economy from FY 1-5 in then year dollars and converts them to constant dollars, base year 1, using the GDP deflator as an index, as recommended by OMB. Since our interest is in comparing the growth in military pay to the increases in prices in the overall economy, the GDP deflator is an appropriate index. A military pay index would not have sufficed, as it would have exactly matched the increases in military pay.

	FY1	FY2	FY3	FY4	FY5
Then Year	1200	1485	1800	2145	2450
Base Year	1200	1296	1425	1525	1571
GDP Deflator	100.0	114.6	126.3	140.7	156.0

Table 7-3: Military Pay, FY1-10, $K

The constant dollar figures in Table 7-3 indicate that the budget for military pay increased in real terms by about 31% from FY1 to FY5, though it doesn't show how much of the increase came from higher salaries, and how much from a larger workforce. Since the growth in the GDP deflator was even greater during this period (56%), it does indicate that the bulk of the 104% increase in the budget in then year terms between FY1 and FY5 was due to inflation. This can be calculated as the increase due to inflation over the increase due to inflation added to the increase due to other causes:

Increase due to inflation (%) =
Increase due to Inflation/(Increase due to Inflation + Increase due to Purchases)

Where

Increase due to Inflation = ((CPI, Final)/(CPI, Base) – 1), and
Increase due to Purchases = ((BY$ Index, Final)/(BY$ Index, Base) – 1)

So we get:

Increase due to inflation (%) =
((156/100) – 1) / ((156/100) – 1 + (131/100) - 1) = 56/87 = 64.4%

Another question the analyst may need to answer is how much a budget changes relative to GDP. That is, what portion of the overall economy is spent on a particular budget? This can be indicative of the priority placed on that budget, though it can also be misleading, since a larger economy can support more programs, requiring a lower proportion for any one budget. Table 7-4 shows the military pay budget and the nominal GDP in then year dollars for each year in the sample economy. To find the relative size of the budget compared to the GDP, simply divide the budget by the GDP.

Budget as % of GDP = Budget/Nominal GDP

The proportion of the economy devoted to the military pay budget remains fairly constant from FY1-6, but steadily decreases afterwards despite continued overall growth in that budget, due to the much faster growth in GDP.

	FY1	**FY2**	**FY3**	**FY4**	**FY5**	**FY6**	**FY7**	**FY8**	**FY9**	**FY10**
MilPay Budget	1200	1485	1800	2145	2450	2610	2775	2945	2850	2900
GDP	3981	4893	5745	6790	7735	8451	12,666	14,997	16,642	18,004
%	30.1	30.3	31.3	31.6	31.7	30.9	21.9	19.6	17.1	16.1

Table 7-4: Military Pay Budget as a Percent of GDP, TY $K

7.3 Budget Shares

Different baskets of goods have different inflation rates associated with them, as reflected in the multiple inflation indices issued by OSD each year. If the relative proportion of goods purchased by the procurement category remains unchanged, the relative cost will change due to varying inflation rates. For example, consider the inflation indices in Table 7-5 for FY5 and FY8. All other things being equal, the higher inflation rates for Medical, for example, mean that it will take up a larger proportion of the overall budget in FY8. Similarly, the lower inflation rates for Fuel show that it will take up a lower proportion of the overall budget in FY8, assuming the amount of fuel purchased does not increase at a greater rate than the other purchases in the budget.

	FY5	FY8	FY8/FY5
Procurement	85.0	108.7	1.279
Military Pay	94.6	102.7	1.086
Civilian Pay	100.0	100.0	1.000
Fuel	94.9	104.4	1.100
Medical	79.2	112.2	1.417

Table 7-5: Inflation Indices, FY5, FY8, Base Year FY7

In order to project the budget shares that would result in the future due to inflation, it is necessary to know the proportion of each category in the base year and the inflation index in the target year relative to the base year. Starting with the FY5 budget distribution as shown in Figure 7-1, and the using the inflation indices calculated in Table 7-5, simply multiply the percent by the index for each category to arrive at a raw score for each category, as shown in Table 7-6.

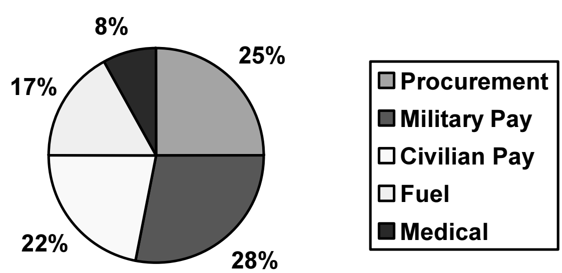


Figure 7-1: Budget Shares, FY5

Normalize the results so they add to 100 by multiplying each share by 100 and dividing by their sum.

Budget Share, Raw = Initial Budget Share * (Index Final)/(Index Base)
Budget Share, Normalized = (Budget Share, Raw)/(Sum of all Budgets)

e.g., Procurement Share, Raw, FY8 = 25% *(108.7/85.0) = 31.975
Procurement Share, Normalized, FY8 = 31.975 / 114.419 = 27.9%

	FY5 Share	FY8/FY5	FY8 Share	
			Raw	Normalized
Procurement	25	1.279	31.975	27.9
Military Pay	28	1.086	30.408	26.6
Civilian Pay	22	1.000	22.000	19.2
Fuel	17	1.100	18.700	16.3
Medical	8	1.417	11.336	9.9
Total	100		114.419	99.9

Table 7-6: FY6 Budget Shares

Civilian Pay and Procurement had the biggest changes, with Civilian Pay moving down almost 3% and Procurement up about 3%. As a proportion of its FY5 value, Medical had the largest change, increasing 1.9/8 = 24%:

% Change in Budget Share =
(Budget Share Final – Budget Share Base)/Budget Share Base

7.4 Evaluating Proposals and Past Performance

Many of the expenditures made by DoD are contracted out. In choosing vendors, it is necessary to evaluate their proposals and their past performance. Since the past performance frequently covers different time periods, it is again necessary to normalize all expenditures to a common base year to make comparisons.

Consider evaluating the past cost performance of two companies bidding on a proposal to be awarded in FY10. One performed similar work in a contract awarded in FY4, and the other performed similar work in a contract awarded in FY6. Table 7-7 provides outlay profiles for the appropriations of those two awards, along with the inflation indices and the total expenditures. With this information it is possible to determine which company performed the work more cost effectively.

Company X produced medical equipment, expending $600,000 from the FY4 appropriation. Company Y produced the same type and quantity of medical equipment, using the same process with the FY6 appropriation for $675,000. In addition, 60% of each appropriation used the CPI-Medical inflation rates, and 40% used the overall CPI from the sample economy. Unified outlay rates are provided, with the assumption that the proportion of CPI-Medical to CPI spending is constant over the life of the project.

	FY4	FY5	FY6	FY7	FY8	FY9
FY4 Outlay	45	30	15	10		
FY6 Outlay			50	20	15	15
CPI (40%)	107.4	121.8	117.5	116.6	119.1	125.2
CPI-Medical (60%)	140.0	160.0	175.0	185.0	200.0	225.0
Composite Index	127.0	144.7	152.0	157.6	167.6	185.1
FY4 = 1.000	1.000	1.139	1.197	1.241	1.320	1.457

Table 7-7: Outlays and Inflation, FY4 and FY6

The composite inflation index is computed by multiplying the CPI-Medical index for each year by 60% and adding it to the CPI index multiplied by 40%. Then set FY4 equal to 1.000, and adjust the remaining years accordingly.

Composite Index =
Proportion 1 * Index 1 + Prop. 2 * Index 2 + … + Prop. X * Index X

For example, the composite index for FY5 is computed:

Composite Index, FY5 = 40% * 121.8 + 60% * 160.0 = 48.7 +96.0 = 144.7

Then the base year is set to 1.000 as follows:

Setting Base Year = 1.000: TY Index/BY Index for each year

Next, compute the outlay weighted indices for each year. Recall that it is computed by taking the inverse of the sum of the outlays divided by the combined index for each year.

Weighted Index =
$1 / (E_1 / I_1 + E_2 / I_2 + \dots + E_i / I_i)$, where E_j is the expenditure proportion for year j and I_j is the Index for that year with the base year set to 1.000

First, for each outlay profile, divide the outlay percentage for each year by the FY4 base year combined inflation index. For the FY4 index (Company X), the FY5 component is computed as:

FY5 = .30/1.139 = .263

For the FY4 and FY6 Indices, sum up the yearly components and take the inverse to arrive at the outlay weighted indices. The results are shown in Table 7-8.

	Outlay FY4	**Outlay FY6**	**Med Eq. Index FY4=1.000**	**Company X Index**	**Company Y Index**
FY4	.45		1.000	.450	
FY5	.30		1.139	.263	
FY6	.15	.50	1.197	.125	.418
FY7	.10	.20	1.241	.081	.161
FY8		.15	1.320		.114
FY9		.15	1.457		.103
TOTAL	1.00	1.00		.919	.796
Index				1.088	1.256

Table 7-8: Outlay Weighted Indices, FY4 and FY6

To compare the performance of Company X to Company Y, take the cost incurred by each and divide by the appropriate outlay weighted index. Recall that to convert constant dollar budgets to then year budgets, it is necessary to multiply the constant dollar budgets by the weighted index:

TY$ = Budgets * CY Index

Conversely, to convert then year dollar expenditures to constant dollars, it is necessary to divide them by the weighted index:

CY$ = Expenditures / Weighted Index

Applying to this example, the constant dollar expenditures for the companies are as follows:

Company X = $600,000/1.088 = $551,471
Company Y = $675,000/1.256 = $537,420

This means that Company Y performed the same task more cheaply than Company X, adjusting for inflation and outlays.

7.5 Forecast vs. Actuals

7.5.1 Differences Between Forecasts and Actuals

The inflation guidance OSD issues is merely a forecast. Actual inflation for any given year will vary from the forecast. This means that the expenditures for any multiyear projects will vary from the budget forecasts, even if the quantities of all items purchased remain the same.

Table 7-9 displays a notional predicted and actual inflation for FY4-10, using the GDP Chain Weight Deflator as the measure of inflation. In this example, the differences between the predicted and actual are large enough to have significant consequences for any multiyear program budgeted with the forecast inflation figures. When inflation is lower than expected, there should be money left over in the budgets, since higher amounts of inflation would have been budgeted in. Conversely, when inflation is higher than expected, there should be budget short-falls, unless the risk of higher costs was accounted for in the budget.

	FY4	FY5	FY6	FY7	FY8	FY9	FY10
GDP Chain Weight Deflator	4.2%	12.0%	3.2%	20.9%	4.1%	6.6%	5.6%
Forecast	3.4%	7.8%	4.7%	9.5%	2.3%	8.9%	10.5%
Difference	+0.8%	+4.2%	-1.5%	+11.4%	+1.8%	-2.3%	-4.9%

Table 7-9: Inflation Forecast vs. Actual Inflation

7.5.2 Budget Shortfalls Due to Higher than Expected Inflation

If inflation is higher than forecast, all other factors being equal, there will be a budget shortfall. In order to calculate how much of a shortfall, merely recalculate the index for the appropriation using the adjusted inflation rates and same outlay profile, and subtract the original index.

For example, if the forecast inflation, actual inflation and outlay profile for a budget in FY4 are as shown in Table 7-10, it is possible to calculate the shortfall for a $10 million FY4 constant dollar program.

	FY4	FY5	FY6	FY7
Outlays	30	40	20	10
Forecast	4.5%	5.4%	3.7%	4.2%
Actual	4.8%	6.2%	5.5%	7.1%

Table 7-10: Outlays and Inflation Forecast, FY4 Procurement

Recall the formula for the weighted index:

Weighted Index =
$1 / (E_1 / I_1 + E_2 / I_2 + \ldots + E_i / I_i)$, where E_j is the expenditure proportion for year j and I_j is the Index for that year with the base year set to 1.000

All that is needed is to create an outlay weighted index for the program using the forecast inflation, another index using the actual inflation, and then compare the amount appropriated based on the forecast to what should have been appropriated to complete the program, as shown in Table 7-11.

Procurement Index	Outlay FY4	Forecast	FY4=1.000	Index	Actual Inflation	FY4=1.000	Actual Index
FY4	.30	4.5%	1.000	.300	4.8%	1.000	.300
FY5	.40	5.4%	1.054	.380	6.2%	1.062	.377
FY6	.20	3.7%	1.093	.183	5.5%	1.120	.179
FY7	.10	4.2%	1.139	.088	7.1%	1.200	.083
TOTAL	1.00			.951			.939
Index				1.052			1.065

Table 7-11: Forecast vs. Actual Index

The amount actually appropriated would have been \$10 million * 1.052 = \$10,520,000. The amount needed would be \$10 million * 1.065 = \$10,650,000. The shortfall is \$10,650,000 - \$10,520,000 = \$130,000.

7.5.3 Supplementals for Budget Shortfalls

If there is a budget shortfall, a supplemental appropriation may be needed to finish the program. For the previous example, the program ran out of money when \$10,520,000 had been spent out of \$10,650,000 needed. So 10,520,000/10,650,000 = 98.8% of the program. Assuming the original outlay profile, that is that the schedule did not slip, the remaining \$130,000 would be needed in the final year of the program, FY7.

7.6 Net Present Value

The Net Present Value (NPV) of an alternative is calculated by subtracting the cumulative discounted investment cost from the cumulative discounted savings associated with that alternative.

Net Present Value = (Investment / Index) – (Savings / Index), where investment and savings are the costs and the costs savings of a project as measured against an alternative, and the index represents the cost/return on money of an alternative, and could be an inflation index, or more likely an index based on interest rates.

Inflation is just one factor which can make the investment or savings from a project discounted over time. For example, the investment may simply have less utility in the future than in the present. More typically, it may be the rate of return on the next most attractive alternative investment for the money that would be invested in the project. However, inflation is one of the most easily quantifiable factors. NPV is a widely used and regarded capital budgeting method because:

- It considers all cash flows through the entire life cycle of a project.
- It considers the time value of money; that is, it reflects the fact that the costs and benefits realized earlier are more valuable than future costs and benefits.
- When the NPV method is used to select from a set of mutually exclusive projects, it allows decision makers to identify the project that has the greatest monetary return.

A positive NPV for an alternative indicates a favorable economic return, while a negative NPV indicates the opposite. An NPV of zero indicates an economic “tie” between alternatives. All else equal, the greater the NPV, the higher an alternative's economic viability. The concept clearly works better for projects that have a tangible economic return. An investment in a weapons system may have the benefit of providing security, but does not provide a cash flow, at least directly. An investment in a process improvement, however, may very well save money, and would be amenable to NPV analysis.

Department of Defense Instruction 7041.3, “Economic Analysis for Decisionmaking,” provides guidelines for the discount rate to be used for conducting economic analysis, including calculation of NPV. If costs and benefits are expressed in constant dollars, then a real discount rate that has been adjusted to exclude expected inflation should be used to calculate a net present value. If costs and benefits are measured in then year dollars, then a nominal discount rate which implicitly includes inflation should be used to calculate the net present value.

Each year, the Office of the Under Secretary of Defense (Comptroller), OUSD(C), issues guidance on the real and nominal discount rates to use, based on an estimate of the expected cost of borrowing for 3-, 5-, 7-, 10-, and longer-term securities.

Consider a project in FY3 running for four years with the following profile of expenditures (cost) and expected savings (benefit), as shown in Table 7-12:

Year	Cost, $TY	Benefit, TY$	Cost Discount Index	Benefit Discount Index	Discounted Investment	Discounted Savings
FY3	$100,000	$0	1.000	1.000	$100,000	$0
FY4	$300,000	$200,000	1.065	1.055	$281,690	$189,573
FY5	$400,000	$300,000	1.125	1.120	$355,556	$267,857
FY6	$200,000	$550,000	1.198	1.210	$166,945	$454,545
Total	$1,000,000	$1,050,000			$904,191	$911,975

Table 7-12: Net Present Value

Note that the discount rates need not be the same for the costs and the benefits, or uniformly the same over time. In then year dollars, savings outweigh investments by $50,000. When the value of the money is discounted to base year 3 dollars, the difference is down to below $8,000, still making it a profitable investment compared to not investing, though not necessarily compared to an alternative investment. The NPV is:

NPV = $911,975 - $904,191 = $7,784

7.7 Selected Acquisition Reports (SARs)

The U.S. Congress requires DoD to submit annual Selected Acquisition Reports (SARs) for major defense programs, which summarize the latest estimates of cost, schedule, and technical status. These reports are prepared annually in conjunction with the President's budget. Subsequent quarterly exception reports are required only for those programs experiencing unit cost increases of at least 15 percent or schedule delays of at least six months.

This requirement is part of an effort to keep control over costs. Part of that cost control comes in the form of Nunn-McCurdy breeches, which are the exception cases when unit costs have shown increases of greater than 15 percent. Calculating what comprises a 15% increase can prove a challenge, and has been open to different interpretations by DoD and the Government Accounting Office (GAO). For example, DoD has claimed exemption from reporting certain cases of what would otherwise be classified as Nunn-McCurdy breeches. When production runs of a system are smaller, the unit costs will be larger if costs stay the same or do not decrease proportionately. While DoD has chosen not to report cases involving significant decreases in production quantity, the analyst should be aware that the Government Accounting Office (GAO) has objected that this leads to an incomplete assessment of the costs of ongoing programs.[7]

Another point of contention with the SARs is that cumulative unit cost growth is reported in then year dollars, which include the cost of inflation. GAO has advocated changing the reporting to include reporting cumulative unit cost growth in constant dollars to better reflect changes and performance over the life of a program. Measuring the change in constant dollars would removes the effects of inflation to measure real program cost growth.

Another difficulty is what to do when programs are rebaselined. Due to the lack of a common frame of reference when there has been a program change between reporting periods, DoD has chosen to reset unit cost growth for the period in question to zero. But this can mask real growth in program costs over longer periods of time, and can effect the requirement to report a Nunn-McCurdy breech.

7.8 Advanced Topic: Accounting for Inflation Risk

Higher than predicted inflation poses a problem of how to budget enough to account for this risk. Consider Table 7-13, depicting again the forecast and actual inflation for FY4-10. Four times out of seven in the sample economy, the actual inflation as measured by the GDP chain weight deflator exceeded the forecast inflation, implying budget shortfalls for programs funded with the low forecasts. One task an analyst might face is budgeting sufficient resources to account for inflation risk based upon the historical data of actual vs. forecast inflation. For example, if a program office wanted to have an 80% certainty of budgeting sufficiently for inflation, there would be two possible approaches – one is a quick approximation, and the other is a more accurate fitting of a curve to the delta between the forecast and actual inflation.

7.8.1 Interpolation Between Two Data Points

The simple approach is to choose the difference between actual inflation and the forecast at the 80th percentile, which falls somewhere between the 5th highest out of seven data points and the sixth highest in Table 7-13.

[7] Defense Acquisitions: Information for Congress on Performance of Major Programs Can Be More Complete, Timely, and Accessible, GAO-05-182, March 2005.

	FY4	FY5	FY6	FY7	FY8	FY9	FY10
GDP Chain Weight Deflator	4.2%	12.0%	3.2%	20.9%	4.1%	6.6%	5.6%
Forecast	3.4%	7.8%	4.7%	9.5%	2.3%	8.9%	10.5%
Difference	+0.8%	+4.2%	-1.5%	+11.4%	+1.8%	-2.3%	-4.9%

Table 7-13: Forecast vs. Actual Inflation, FY4-10

To interpolate the value for a percentile rank that lies between any two data points, say the k^{th} highest and $(k+1)^{th}$ highest out of n, take the value for the k^{th} data point and add the quotient of the difference between the percentile and k/n and 1/n, all multiplied by the difference between the values of the k^{th} and $(k+1)^{th}$ points:

a^{th} percentile, n points =
value of k^{th} point + (((a*n)/100) – k) * (($(k+1)^{th}$ value - k^{th} value)

In the example:

80^{th} percentile: 1.8 + (((80*7)/100) – 5) * (4.2 – 1.8) =
1.8 + .6*2.4 = 1.8 + 1.44 = 3.24%

Where 1.8 is the 5^{th} highest data point and 4.2 is the 6^{th} highest out of seven (a = 80, k = 5, n = 7).

This implies, according to the historical record, that to have 80% confidence that the inflation accounted for in the budget is sufficient, that 3.24% should be added to the inflation forecast.

7.8.2 Fitting a Curve to the Data

A more accurate result would be to fit a line to all of the data points, not just between the 5^{th} and 6^{th} points. Since this line minimizes the distance of all data points to the curve, it doesn't necessarily pass through any of the points. The expected result should not vary to a large degree from the previous example and is more complicated, but should provide a more accurate gauge.

This analysis will be based on the sample mean. Sample mean is denoted as $\overline{X}$. All data is again taken from Table 7-13.

$$\overline{X} = \sum_{i=1}^{n} \frac{x_i}{n} = \sum_{i=1}^{7} \frac{x_i}{7} = \frac{\{0.8 + 4.2 + (-1.5) + 11.4 + 1.8 + (-2.3) + (-4.9)\}}{7} = \frac{9.5}{7} = 1.36$$

The variance of this sampling distribution is

$$s_{\overline{X}}^2 = Var\left(\sum_{i=1}^{n} \frac{x_i}{n}\right) = \frac{1}{n^2} Var\left(\sum_{i=1}^{n} x_i\right) = \frac{1}{n^2} nVar(x_i) = \frac{1}{n} Var(x_i) = \frac{s^2}{n}$$

Where $s^2 = \dfrac{1}{n-1} \sum_{i=1}^{n} (\overline{X} - x_i)^2$

A standard deviation is a measure of the variance from the mean, or average, of a set of points in a distribution. The sample standard deviation is defined as the square root of the quantity of the sum of the squares of the differences between each data point and the mean divided by one less than number of data points:

Standard deviation[8] = $\sqrt{s^2} = s = \left(\dfrac{\sum_{i=1}^{n} (\overline{X} - x_i)^2}{n-1} \right)^{\frac{1}{2}}$ for all x, where n is the number of data points.

In this case we get $s = \left(\dfrac{\sum_{i=1}^{7} (1.36 - x_i)^2}{6} \right)^{\frac{1}{2}} = \left(\dfrac{170.14}{6} \right)^{\frac{1}{2}} = (28.36)^{\frac{1}{2}} = 5.33$

Now we can calculate the standard deviation of the sampling distribution of the sample mean,

Standard deviation of the sample mean = $\dfrac{s}{\sqrt{n}} = \dfrac{5.33}{\sqrt{7}} = 2.01$

[8] The standard deviation can be calculated automatically with any statistical package or Excel.

By knowing the sample mean, the number of data points, and the sample standard deviation, it is possible to determine the percent confidence in a predicted value by looking up the number of z-statistics against that confidence level in a *z-distribution table*. The z is a standard normal distribution with mean zero and variance of one.

If the distribution of the population members is normal, then it can be shown that the distribution of the sample mean is also normal. Moreover, as a result of the central limit theorem, even if the population distribution is not normal, the distribution of the sample mean will typically be quite close to normal, provided the sample is of at least moderate size (usually 30 data points or more). Thus, in most applications, it suffices to take the sampling distribution of the sample mean to be normal (1.36 in our example), and sample standard deviation 2.01. It then follows that the random variable x (differences between forecast inflation and actual inflation rates in our example)

$$Z = \frac{\overline{X} - \mu}{s / \sqrt{n}}$$

(where μ is a population mean)

has a distribution that is approximately standard normal (with mean zero and variance of one). To elaborate this result, let's apply our example where the mean is 1.36 percent and the standard deviation of this mean is 2.01 percent. From the z-table we know that the probability is 0.80 that a standard normal random variable lays below 0.84 (that the forecast inflation rate is larger than the actual forecast). We therefore find:

$$0.80 = P(Z < 0.84)$$

$$0.80 = P\left(\frac{\overline{X} - \mu}{s / \sqrt{n}} < 0.84\right)$$

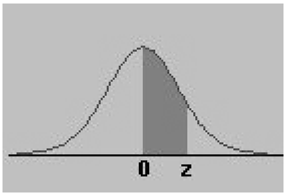
$$0.80 = P\left[\frac{\overline{X} - 1.36}{5.33 / \sqrt{7}} < 0.84\right]$$

$$0.80 = P\left[\overline{X} < 1.36 + 0.84(2.01)\right]$$

$$0.80 = P\left[\overline{X} < 3.05\right]$$

If, for example, the projected inflation for the following year is 5.3%, and we want to account for enough inflation to be 80% confident that the budget will not be overspent due to unforeseen inflation, the inflation rate to use would be 5.3% + 3.05% = 8.35%. Note that 3.05% is relatively close to the 3.24% figure derived by interpolating between the 5th and 6th data points, which was an easier calculation. Another item to be careful about is that the 1.36% representing the average deviation from the inflation forecast might indicate that the inflation forecasting model needs to be calibrated to remove the 1.36%. If the model is updated unbeknownst to the analyst, and the analyst incorporates the 1.36% into the estimate, the forecast inflation at the 80% confidence level will be 1.36% too high.

A portion of a *z distribution table* is reproduced in Table 7-10.



Area Between 0 and z

	0.00	**0.01**	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015

Table 7-14: Portion of z Table

The rows in the z table represent tenths of a standard error, and the columns hundredths of a standard error. So the value for 0.57 standard errors is 0.2157. The values represent the area between the mean of the normal distribution and the value of the standard error. In the case of 0.57, 21.57% of the cases in that distribution are within 0.57 standard errors on the positive side of the mean, or twice that amount, 43.14% within 0.57 errors in either direction of the mean.

8 Cost Estimation Applications and Examples

8.1 Background

Cost estimation drives the entire acquisition process in DoD. The cost estimate provides the decision maker with a forecast of resources required to acquire, operate, maintain, support, and dispose of a system. A proper estimate covers not only the total cost of a program, but the phasing of such costs, risk surrounding the factors that are a part of the estimate, and full documentation of the methodology and data collection and evaluation so that the estimate can be defended during the budget process and can be repeated at various stages or as the data changes. The cost estimate serves as the baseline for establishing the budget for a program. If the program runs over budget, the cost estimate can serve as a point of departure to identify the reasons, which can include the management of the program, unanticipated costs, inadequate budget, or risk factors outside of the predicted ranges. While there is debate over the degree cost estimating is an art or a science, it is clearly an integral part of the weapon system acquisition and budgeting process.

8.2 Cost Estimating Relationships (CERs)

A Cost Estimating Relationship (CER) is a mathematical expression relating cost as the dependent variable to one or more independent cost-driving variables. An example would be a formula to calculate the cost of a missile based on its dry mass. It makes sense that mass would be a cost driver, since not only does it imply more components, but also requires more to lift it into the air, and hence a more powerful, and presumably more costly, propulsion system. The CER can be developed from historical data on similar systems, plotting the independent variable or variables against the dependent variable, cost. A function most closely matching the data points can be derived within the range of the data points, and statistical tests run to verify the explanatory power of the CER.

While statistical techniques can be used to test for the correlation between two variables, for CERs to be valid and explain causation, the logic behind them must be thought through carefully. Two variables that are correlated can have causation in either direction, or there may be a third underlying variable causing both. Generally accepted theory can act as a guide, along with a dose of common sense about the direction of the relationship among two or more variables. Once the CERs have been established and accepted, data on the appropriate physical characteristics of the system being estimated will contribute to the overall cost estimate.

To continue with the example of a CER for a missile, consider the notional equation below, based on notional historical data from similar missiles with dry mass between 300 and 750 kg:

$$\text{Cost (FY7\$)} = 27 * M^{3/2} + \$93{,}000, \text{ where M is the dry mass in kg}$$

There are several things to notice about the equation. First, it is not linear. Second, the units are shown. Third, the base year for the dollars is shown, as the effects of inflation need to be removed from the historical costs during development of the CER. Finally, the range of the masses that went into developing the CER defines the valid range for the CER. It would not be valid to plug in higher or lower masses into the equation, as the CER has not been tested outside of the 300 kg to 750 kg range. In applying a CER, it is also a good idea to note the age of the data points – an older CER is less likely to be as accurate as a more recent CER. Note also that there is no generic form for a CER.

We now illustrate the use of the CER. First consider the production of a 500 kg missile in FY7. Since the mass is in the proper units, it is within the valid range, and the year matches the base year, this is the simplest possible case. Merely plug the weight into the equation:

$$\text{Cost} = 27 * 500^{3/2} + 93{,}000 = 27 * 11{,}180 + 93{,}000 = 394{,}860 \text{ FY7\$}$$

If we want the cost in FY9 dollars, take the result and multiply by the index in FY9 with FY7 as the base year, using the CPI shown in Table 8-1:

$$\text{Cost, FY9\$} =$$
$$\$394{,}860 * \text{FY9/FY7} = \$394{,}860 * (107.4/100.0) = \$424{,}080$$

Year	Base Year 1	Base Year 7
FY7	116.6	100.0
FY8	119.1	102.1
FY9	125.2	107.4

Table 8-1: CPI, FY7-9

To estimate the cost of an 800 pound missile in FY9$, it is necessary to first convert into kilograms, verify the mass is in the valid range, and then apply the formula.

$$\text{Mass (kg)} = \text{Weight (pounds)} / 2.2 \text{ (pound/kg)} = 800/2.2 = 364 \text{ kg}$$

The mass, 364 kg, is within the valid range of 300-750 kg.

$$\text{Cost} = (27 * 364^{3/2} + 93{,}000) * (107.4/100.0) = 301{,}264 \text{ FY9\$}$$

Next, we wish to estimate the cost in FY8$ of a missile with a dry mass of 800 kg, which is outside the valid range of the CER. One solution is to come up with a different mechanism for estimating the cost of the missile. But the CER still can serve to provide a minimum cost. By substituting in the maximum valid value, it is reasonable to assume that the 800 kg missile will not cost less than that:

$$\text{Cost} > (27 * 750^{3/2} + 93{,}000) * (102.1/100.0) = 661{,}168 \text{ FY8\$}$$

Similarly, a 250 kg missile (FY8) cannot be directly evaluated by this CER without introducing greater error, but a maximum cost can be established by substituting 300 kg into the formula:

$$\text{Cost} < (27 * 300^{3/2} + 93{,}000) * (102.1/100.0) = 238{,}195 \text{ FY8\$}$$

While it is recommended that the analyst find another means of estimating the cost of the missile in these two cases, the minimum and the maximum can serve as cross checks.

8.3 Constant and Then Year Dollar Conversions

As covered in Section 6.3, there are three main conversion problems involving then year and constant year dollars: 1) converting constant dollars in one year to then year dollars in another year; 2) converting then year dollars in one year to constant dollars in another year; and 3) converting then year dollars in one year to then year dollars in another year.

As a brief review, consider the CPI from the sample economy from FY2-FY6:

Year	Base Year (BY) 1	Base Year 3
FY2	103.6	95.6
FY3	108.4	100.0
FY4	107.4	99.1
FY5	121.8	112.4
FY6	117.5	108.4

Table 8-2: CPI, FY2-6

For converting constant dollars into then year dollars, it is necessary to set a base year equal to 100. In this case, FY3 is chosen. All other years in the range are divided by the old FY3 index and multiplied by 100 to arrive at indices relative to base year, FY3. Recall:

Budget, TY$ = Budget, CY$ * (TY Index / BY Index)

If we want to know what $1000 in constant FY3 dollars will be equal to in FY5 dollars, for example, it is necessary to multiply $1000 by the index level for FY5/100, 112.4/100:

$1000 constant dollars = $1000 * 112.4/100 = $1124 FY5 dollars

This means that $1124 in FY5 then year dollars will be needed to buy $1000 worth of goods in constant dollars. Conversely, to convert then year dollars to constant dollars, the formula is:

Budget, CY$ = Budget, TY$ * (BY Index / TY Index)

So, to find the value of $1000 FY5 dollars in constant FY3 dollars, divide $1000 by the index:

$1000 FY5, then year dollars = $1000 * (100/112.4) = $890 constant dollars

This means that $1000 in FY5 dollars will buy $890 worth of goods in constant year dollars. Finally, converting from then year dollars in one year to then year dollars in another year is merely a matter of multiplying by the ratio of the index of the target year to the originating year:

Budget, Year Y$ = Budget, Year X$ * (Year Y Index / Year X Index)

For example, $1000 in FY2 dollars is equivalent to:

$1000 FY2 = $1000 * FY6/FY2 = $1000 * 108.4/95.6 = $1134 FY6

In other words, to purchase the same market basket that would have cost $1000 in FY2, we would need $1134 in FY6.

8.4 Cost Risk

The next three sections cover various sources of uncertainty in the estimated cost of a program. Cost risk covers budget overruns or shortfalls independent of the schedule of the program, which also affects cost, and the risk that the inflation rate may differ from the forecast. Computer-aided simulations can provide a probability distribution of costs that would be too difficult to calculate by hand. A discrete approach to the problem assigns a finite set of distributions for variances of the costs compared to the budgeted amount. The distribution of variances could be gathered from historical data. To illustrate this approach, consider an FY7 procurement program extending four years for $5 million then year dollars that has a 30% chance of finishing at cost, a 10% chance of being 10% under budget, 30% chance of being 10% over budget and a 30% chance of being 20% over budget in constant dollars, according to the outlay profile and inflation index shown in Table 8-3.

	FY7	FY8	FY9	FY10
Outlays	30%	44%	17%	9%
Inflation Index	107.8	116.1	125.1	134.9

Table 8-3: FY7 Procurement Outlays and Inflation Forecast

Since outlays and inflation are held constant, it is sufficient to create one index for conversion between then year and constant dollars, as shown in Table 8-4, with again, the weighted index calculated as follows:

> Weighted Index = 1 / (E_1 / I_1 + E_2 / I_2 + … + E_i / I_i), where E_j is the expenditure proportion for year j and I_j is the Index for that year with the base year set to 1.000

Weapons Index	Outlay	Forecast Index	FY7 = 1.000	Index
FY7	.30	107.8	1.000	.300
FY8	.44	116.1	1.077	.409
FY9	.17	125.1	1.160	.147
FY10	.09	134.9	1.251	.072
TOTAL	1.00			.928
Index				1.078

Table 8-4: Index for FY7 Procurement Program

The minimum cost is the forecast cost ($5 million) minus 10% ($0.5million), or $4.5 million then year dollars. This in turn is $4.5 million / 1.078 = 4,174,397 FY7$. The maximum cost is the forecast plus 20% ($1 million) for a total of $6 million then year dollars, which is $6 million / 1.078 = 5,565,863 FY7$.

The expected value (EV) is the sum of the likelihoods of each outcome multiplied by the estimated cost of that outcome:

EV =
Probability 1 * Cost 1 + Probability 2 * Cost 2 + … + Probability X * Cost X

For this example:

EV = .1 * $4.5m + .3 * $5m + .3 * $5.5m + .3 * $6m = $5.4 million

$5.4 million then year dollars is equal to $5.4 million / 1.078 = 5,009,276 FY7$.

8.5 Schedule Risk

Another threat to the cost of a program is a slip in the schedule. Even if all of the budget items are procured according to their predicted constant dollar price, the effect of inflation will cause the cost to increase, because some items will be procured later in the program. Below is a simplified problem assuming all budget items are procured according to the predicted quantities, but on a delayed basis. In reality, extending the schedule generally means some items, such as labor and some of the overhead, need to be purchased in greater quantities.

Consider a $3 million procurement program appropriated in FY2 according to the outlay profile in Table 8-5. It has a 10% chance of finishing one year ahead of schedule, a 50% chance of finishing on time, a 30% chance of finishing one year late, and a 10% chance of finishing two years late. Finding the minimum, maximum and expected costs requires updating the outlay tables to account for inflation indices being applied to different portions of the expenditures. An assumption is made that compression or expansion of the schedule takes place uniformly throughout the life cycle of the program.

	FY2	FY3	FY4	FY5
Outlay Rates	25%	40%	20%	15%
Inflation Index	103.6	108.4	107.4	121.8

Table 8-5: FY2 Outlay Rates and Inflation

The earliest completion date is one year shorter than schedule, or three years. The latest completion date is two years behind schedule, for a total of 6 years. The expected completion date is equal to the sum of the probabilities of each completion date multiplied by the corresponding project length:

EV =
Probability 1 * Duration 1 + Prob. 2 * Duration 2 + … + Prob. X * Duration X

Therefore, we get:

Expected completion = .1 * 3 + .5 * 4 + .3 * 5 + .1 * 6 = 4.4 years

To reset the outlay rates to reflect the new schedules, it is necessary to overlay the original outlays over the new durations. Stretching four years out to 4.4 years implies that it will take 1.1 years to spend the outlay originally intended for one year, as shown in Table 8-6.

Furthermore, if it takes 4.4 years to spend 4 years of outlays, then in the first year it is possible to spend 4.0/4.4 of the first year's outlay. 0.4/4.4 remains to be spent in the second year. This leaves room for (4.0 – 0.4)/4.4 = 3.6/4.4 of the original 2nd-year outlay to be spent in the second year. So in the first year, the outlay is 25% * 4.0/4.4 = 22.7%. The new second year outlay is 25% * 0.4/4.4 + 40% * 3.6/4.4 = 35.0%.

Note that it is possible to spend only 40/44 of combined outlays in a given year (e.g., 8/44 + 32/44 in Year 3), but each of the original outlays is completely spent over multiple years (e.g. original Year 4 outlay, 28/44 + 16/44 in Years 4-5). The rest of the calculations are shown below the table.

Expected					**= 4.4 years**
40/44	4/44+36/44	8/44+32/44	12/44+28/44	16/44	
Min.					**= 3 years**
1+1/3	2/3+2/3	1/3+1			
Max.					**= 6 years**
4/6	2/6+2/6	4/6	4/6	2/6+2/6	4/6
1st year	**2nd year**	**3rd year**	**4th year**	**5th year**	**6th year**
1st 25%	2nd 40%		3rd 20%	4th 15%	

Table 8-6: Recalculating Outlay Rates due to Schedule Risk

For 4.4 years (expected duration):
Year 1 = .25 * 40/44 = 22.7%
Year 2 = .25 * 4/44 + .40 * 36/44 = 35.0%
Year 3 = .40 * 8/44 + .20 * 32/44 = 21.8%
Year 4 = .20 * 12/44 + .15 * 28/44 = 15.0%
Year 5 = .15 * 16/44 = 5.5%
Total = 100.0%

For 3 years (minimum duration):

Year 1 = .25 * 1 + .40 * 1/3 = 38.3%
Year 2 = .40 * 2/3 + .20 * 2/3 = 40.0%
Year 3 = .20 * 1/3 + .15 * 1 = 21.7%
Total = 100.0%

For 6 years (maximum duration):

Year 1 = .25 * 4/6 = 16.7%
Year 2 = .25 * 2/6 + .40 * 2/6 = 21.7%
Year 3 = .40 * 4/6 = 26.7%
Year 4 = .20 * 4/6 = 13.3%
Year 5 = .20 * 2/6 + .15 * 2/6 = 11.7%
Year 6 = .15 * 4/6 = 10.0%
Total = 100.0%

With new outlay rates it is possible to compute new indices, and thus the cost of the program according to the different schedules, as shown in Table 8-7.

Proc. Index	4.4-year Outlay	3-year Outlay	6-year Outlay	Forecast Index	FY2 = 1.000	4.4-year Index	3-year Index	6-year Index
FY2	.227	.383	.167	103.6	1.000	.227	.383	.167
FY3	.350	.400	.217	108.4	1.046	.335	.382	.207
FY4	.218	.217	.267	107.4	1.037	.210	.209	.257
FY5	.150		.133	121.8	1.176	.128		.113
FY6	.055		.117	117.5	1.134	.049		.103
FY7			.100	116.6	1.125			.089
TOTAL	1.000	1.000	1.001			.949	.974	.936
Index						1.054	1.027	1.068

Table 8-7: The Effect of Schedule Risk on Indices

Since the then year cost is the constant cost times the weighted index, simply multiply the cost of the program in constant dollars ($3 million) by the index for each expected duration to arrive at the cost to be incurred according to various schedule options:

Expected (4.4 years) = $3 million * 1.054 = $3.162 million
Low (3 years) = $3 million * 1.027 = $3.081 million
High (6 years) = $3 million * 1.068 = $3.204 million

8.6 Inflation Risk

Cost estimates incorporate inflation forecasts over the life of the program, which are themselves subject to variations from the actual forecast. While the risk to the fulfillment of the program is mitigated by the ability to request a supplemental due to higher than expected inflation, the program, nevertheless, costs a different amount than budgeted.

Section 7.6.2 gives an example of how to establish a level of confidence in the inflation estimate. Below is the simpler case of comparing budgeted to actual inflation, demonstrating the shortfall due to higher than expected inflation.

Consider a 3-year procurement program beginning in FY3 with the budget profile and projected inflation as shown in Table 8-8.

	FY3	FY4	FY5
Procurement	$150,000	$300,000	$250,000
Forecast Inflation	5.3%	4.2%	6.1%
Actual Inflation	5.1%	7.1%	8.6%

Table 8-8: FY3-5 Inflation Forecast Risk

To arrive at the difference between projected expenditures and actual expenditures, assuming all other factors remain the same, merely create indices for projected and for actual inflation, using FY3 as the base year, as shown in Table 8-9.

Procurement Index	Outlay	Projected Inflation	FY3 = 1.000	Actual Inflation	FY3 = 1.000	Projected Index	Actual Index
FY3	.214	5.3%	1.000	5.1%	1.000	.214	.214
FY4	.429	4.2%	1.042	7.1%	1.071	.412	.401
FY5	.357	6.1%	1.106	8.6%	1.163	.323	.307
TOTAL	1.000					.949	.922
Index						1.054	1.085

Table 8-9: Projected vs. Actual Procurement Index, FY3

For a $700,000 constant dollar program, the projected and actual then dollar costs are:

Actual	= $700,000 * 1.085	= $759,500
Projected	= $700,000 * 1.054	= $737,800
Shortfall		= $21,700

8.7 Complex Risk

In a cost estimate there is not just cost risk, schedule risk, or inflation risk (which is actually a special case of cost risk), but all three together. However, accounting for all three can require so many cases that a manual computation is nearly impossible. A simplification of the problem is to calculate minimum and maximum costs projected to be within a specified confidence level, assume a normal distribution between the extremes and estimate a standard deviation in order to calculate a distribution establishing a cost for any confidence level. This requires several assumptions, but with sufficient historical data, a rough estimate can be derived. Section 8.7.1 covers techniques for enumeration and ordering the cases with the aid of a spreadsheet.

Among the assumptions that need to be made to solve the problem is that the cost risk, schedule risk, and inflation risk are independent of each other. This allows application of the central limit theorem, stating that a large number of independent, identically distributed random variables approaches a normal distribution.

To illustrate, we will solve for a 3-year program appropriated for FY5 for $1.5 million constant dollars, with the outlay profile and inflation rates as shown in Table 8-10. Also shown are the risk that inflation will be different than forecast, the risk to the schedule of the program, and the risk to the planned cost.

	FY5	**FY6**	**FY7**	**FY8**	**FY9**
Outlays	$400,000	$500,000	$600,000		
Forecast Inflation	10.4%	10.3%	9.8%	9.7%	9.7%
Inflation Risk (%)		(-3)-0-(+5)	(-3)-0-(+5)	(-2)-0-(+4)	(-3)-0-(+3)
Infl. Risk Probs. (%)		30-40-30	30-30-40	20-50-30	30-40-30
Schedule Risk		20% (2.5yrs)	40%	30%	10%
Cost Risk (%)	-10%	Even	+10%	+25%	
Cost Risk Probs. (%)	15%	30%	45%	10%	

Table 8-10: Complex Risk Problem

To establish various confidence levels for the cost, we need to estimate the standard deviation. To estimate the standard deviation, assume a normal distribution about the mean, calculate the minimum case and its probability, and use a *z table* to determine the number of standard deviations from the mean to the minimum, which can then be used to calculate the value of the standard deviation, based upon the values for the mean and the minimum.

First calculate the mean. This is determined by finding the expected values for cost risk, schedule risk, and inflation risk, and use those values to adjust the inputs for finding the index for the program. Remember the general formula for finding the expected value, applicable to all three risks:

EV =
Probability 1 * Outcome 1 + Prob. 2 * Outcome 2 + … + Prob X * Outcome X

The cost risk is found by multiplying each outcome by its probability and adding the results:

Cost risk = (-10% * 15%) + (0% * 30%) + (10% * 45%) + (25% * 10%) = +5.5%

The schedule risk is the sum of the outcomes multiplied by their probabilities:

Schedule risk = (2.5 * 20%) + (3 * 40%) + (4 * 30%) + (5 * 10%) = 3.4 years

The inflation risk is the sum of the possible outcomes multiplied by their probabilities for each year:

FY6 = (-3% * 30%) + (0% * 40%) + (5% * 30%) = +0.6%
FY7 = (-3% * 30%) + (0% * 30%) + (5% * 40%) = +1.1%
FY8 = (-2% * 20%) + (0% * 50%) + (4% * 30%) = +0.8%
FY9 = (-3% * 30%) + (0% * 40%) + (3% * 30%) = 0.0%

Adjust the outlay profile to reflect a 3.4 year schedule and a new program cost of $1.5 million times 1.055, equal to $1,582,500:

FY5 = ($400K/$1.5M = .267) * (3.0/3.4) = 23.6%
FY6 = .267 * (0.4/3.4) + ($500K/$1.5M = .333) * (2.6/3.4) = 28.6%
FY7 = .333 * (0.8/3.4) + ($600K/$1.5M = .400) * (2.2/3.4) = 33.7%
FY8 = .400 * (1.2/3.4) = 14.1%

The weighted index can be computed by plugging the preceding inputs into Table 8-11:

Index	Outlay	Projected Inflation	Risk	Adjusted Inflation	FY5 = 1.000	Weighted Index
FY5	.236	10.4%		10.4%	1.000	.236
FY6	.286	10.3%	+0.6%	10.9%	1.109	.258
FY7	.337	9.8%	+1.1%	10.9%	1.230	.274
FY8	.141	9.7%	+0.8%	10.5%	1.359	.104
TOTAL	1.000					.872
Index						1.147

Table 8-11: Weighted Index for Mean, Complex Cost Example

Since we have assumed a normal distribution, the mean cost estimate in then year dollars is the adjusted program cost ($1,582,500) multiplied by the index:

Mean cost = $1,582,500 * 1.147 = 1,815,128 TY$

The next task is to find the minimum cost, using the minimal cases for cost risk, schedule risk, and inflation risk. The best case for cost risk is -10%, yielding a new base of $1.35 million. The best case for schedule is 2.5 years, the best case for FY6 inflation is 7.3%, and the best case for FY7 inflation is 6.8%. The new outlay profile is as follows:

FY5 = .267 + .333 * (0.5/2.5) = .333
FY6 = .333 * (2.0/2.5) + .400 * (1.0/2.5) = .427
FY7 = .400 * (1.5/2.5) = .240

The weighted index for the minimum is computed in Table 8-12.

Index	**Outlay**	**Inflation**	**FY5 = 1.000**	**Weighted Index**
FY5	.333	10.4%	1.000	.333
FY6	.427	7.3%	1.073	.398
FY7	.240	6.8%	1.146	.209
TOTAL	1.000			.940
Index				1.064

Table 8-12: Weighted Index for Minimum, Complex Cost Example

The then year minimum cost is then calculated as by multiplying the constant dollar cost by the weighted index:

Minimum Cost = $1.35 million * 1.064 = $1,436,400 TY

Here another assumption is needed. One could try to calculate a minimum cost probability from the minimum probabilities of cost, schedule, and inflation, but due to the lack of independence of the variables, such a calculation cannot easily be performed without the aid of a computer and statistical packages. A reasonable assumption is that the minimum cost is within three standard deviations of the mean, which incorporates 99.74% of all cases in a normal distribution.

This provides enough information to derive a rough value for the standard deviation, by subtracting the minimum from the mean and dividing by the number of standard deviations between the minimum and mean:

Standard Deviation =
(Mean – Minimum)/(Standard Deviation btw Mean and Minimum)

In this case:

Standard Deviation = ($1,815,128 - $1,436,400) / 3 = $126,243

With this value, it is then possible to determine the cost estimate at any confidence level, again using a *z table*, and even derive the confidence level of the point estimate (the estimate without accounting for the risk factors).

For example, to find the 80% confidence level for the estimate requires 0.84 standard deviations above the mean:

Estimate, 80% confidence =
$1,815,128 + (0.84 * $126,243) = $1,921,172

To find the confidence level for the point estimate requires coming up with the weighted index of the forecast cost, schedule, and inflation, as shown in Table 8-13:

Index	Outlay	Inflation	FY5 = 1.000	Weighted Index
FY5	.267	10.4%	1.000	.267
FY6	.333	10.3%	1.103	.302
FY7	.400	9.8%	1.211	.330
TOTAL	1.000			.899
Index				1.112

Table 8-13: Point Estimate Weighted Index, Complex Cost Example

So the point estimate is the constant dollar cost, $1.5 million, times the weighted index:

Point Estimate = $1.5 million * 1.112 = $1,668,000

The next task is to find the number of standard deviations away from the mean represented by the point estimate:

Standard Deviations =
($1,815,128 - $1,668,000) / $126,243 = 1.166 below the mean

Using the *z table*, this puts the point estimate at about 38% below the mean, or at the 12% confidence level.

8.7.1 Using Spreadsheets

To manually solve the preceding problem, avoiding the statistical assumptions made about the distribution would require 504 cases involving 126 different weighted indices. While it would be possible to manually perform all of the calculations over several days or weeks, the use of a spreadsheet can cut the task down to a more manageable several hours.

To derive a distribution of all of the combinations of cost risk, schedule risk, and inflation risk in the example requires not only determining what possibilities exist, but also their probabilities. This allows for determining the confidence level of any particular estimate, or conversely, an estimate for any specified confidence level.

The first step is to enumerate all possible combinations. At first glance it appears there are four cases of cost risk multiplied by four cases of schedule risk multiplied by 3 * 3 * 3 * 3 = 81 cases of inflation risk, for a grand total of 1296 cases. It turns out, however, that some cases are not applicable. For example, if the program finishes in three years, the inflation risks for the 4th and 5th years are not needed.

To simplify the problem, then, determine the number of cases for each schedule (2.5 years, 3 years, 4 years, 5 years) and add those up. The 2.5-year and 3-year schedules both require the 2nd and 3rd year inflation risks, or 9 cases each. The 4-year schedule adds the 4th year, for a total of 9 * 3 = 27 cases. The 5-year schedule adds the 5th year of inflation risk for 27 * 3 = 81 more cases. Hence, we have:

Cases = (9 + 9 + 27 + 81) * 4 (cost risk) = 126 * 4 = 504

The next step is to enter all of the cases into a spreadsheet so that the variables and formulas need to be entered a minimal number of times. Each of the four values and probabilities for the cost risk can be entered 126 times with the aid of copy and paste commands. Within each block of 126, the probabilities for nine 2.5-year schedules, nine 3-year schedules, 27 4-year schedules and 81 5-year schedules can be entered. For each year of possible inflation variance, the probabilities of occurrence can be entered in four separate columns, leaving blank the cells for which inflation is not a factor. This results in six columns with their associated probabilities, matching all possible cases. Multiplying the columns together yields the probability for each case. An additional column adding up the cumulative probability will be useful when the rest of the worksheet is filled out.

There are a total of four outlay profiles to consider, one for each schedule length. The profiles for the 2.5-year, and the 3-year schedule are already considered in the previous example. The other profiles are calculated in a similar manner in Table 8-14.

	FY5	FY6	FY7	FY8	FY9
2.5-year	.333	.427	.240		
3-year	.267	.333	.400		
4-year	.200	.233	.267	.300	
5-year	.160	.173	.200	.227	.240

Table 8-14: Outlay Profiles for Different Program Lengths

It is easy enough to match the outlay profile in five adjacent columns to the appropriate cases. This is followed by the projected inflation rates corresponding to the probabilities for those rates already entered. Inflation indices based on FY5 equal to 1.000 can then be constructed for each year for each case.

With all of these inputs, it is merely a matter of adding two additional columns – one for the weighted indices and one for the then year cost for each case. The weighted index is found by using a formula taking the inputs from the preceding columns as follows:

Weighted Index =
1 / (FY5 Outlay + (FY6 Outlay / FY6 Index) + (FY7 Outlay / FY7 Index) + (FY8 Outlay / FY8 Index) + (FY9 Outlay / FY9 Index))

The then year cost is the value associated with the cost risk multiplied by the weighted index. In order to determine confidence levels, it is then necessary to sort on the then year cost in ascending order. The column adding up the cumulative probabilities will give the confidence level for any particular case. Comparing the results of the previous section with an Excel spreadsheet going through these steps we get the statistics shown in Table 8-15.

	Manual	**Spreadsheet**
Mean	$1,815,128	$1,811,160
Minimum	$1,436,400	$1,435,589
80% Confidence	$1,921,172	$1,959,424
Point Estimate	12% Confidence	25% Confidence

Table 8-15: Spreadsheet vs. Probabilistic Complex Risk

It is not surprising that the mean and minimum results should be similar, as the calculations are mostly the same, with differences due to rounding. It is also to be expected that the 80% confidence level produces a greater value with the spreadsheet, since the distribution is not the symmetrical normal distribution assumed for the manual calculation, but has a right tail of values greater than the mean that is longer than the curve for the values less than the mean. This is due to the application of the central limit theorem with a small number of cases.

I. Appendix I: Problems and Solutions

Chapter 6 Problems

For problems 1-2, refer to Table I-1:

	FY 6		FY 7		FY 8	
	Quantity	**Unit Cost**	**Quantity**	**Unit Cost**	**Quantity**	**Unit Cost**
Bananas	45000	1.70	44000	1.50	48000	1.55
Coconuts	45000	2.35	46000	2.20	45000	2.30
Wood	12000	5.60	12500	6.00	14000	5.75
Radios	4500	25.00	5000	27.00	6000	24.00
Boats	140	1050.00	150	1075.00	170	1025.00
Milk	17500	2.45	18000	2.50	19000	2.70

Table I-1: CPI Data for Problems 1-2

1) (a) CPI using Arithmetic Mean (method in use until 1999)
Construct a CPI based on bananas, wood, and radios for FY 6-8, with FY 6 as the base year using the arithmetic mean.

(b) CPI using Geometric Mean (method currently in use)
Use the geometric mean to derive the CPI for FY 7-8.

(c) Deriving Inflation Rates from the CPI
Find the inflation for FY 7-8 for parts (a) and (b) above, as well as the average annual inflation from FY 6 to FY 8 and overall inflation from FY 6 to FY 8.

(d) Changing the CPI Base Year
Using the results from part (b), change the base year to FY 7, and recalculate the CPI for FY 6 and FY 8.

2) (a) Using a Different CPI Basket
Recalculate the CPI based on coconuts, boats, and milk for FY 6-8, with FY 7 as the base year using the geometric mean.

(b) Changing the CPI Basket
Construct a unified CPI index, with FY 6 equal to 100.0, but the change in basket from bananas, wood, and radios to coconuts, boats and milk effective in FY 7.

3) For problem 3 refer to Table I-2

	FY 6		FY 7		FY 8	
	Quantity	**Unit Cost**	**Quantity**	**Unit Cost**	**Quantity**	**Unit Cost**
Bananas	45000	1.70	44000	1.50	48000	1.55
Wood	12000	5.60	12500	6.00	14000	5.75
Radios	4500	25.00	5000	27.00	6000	24.00
Coconuts	45000	2.35	46000	2.20	45000	2.30
Boats			150	1075.00	170	1025.00
Milk					19000	2.70

Table I-2: GDP Data for Problem 3

(a) Computing Nominal GDP
Compute the nominal GDP for each year.

(b) Computing Real GDP
Compute the real GDP for each year, using the previous year as the base year.

(c) Computing the GDP Implicit Price Deflator
Compute the GDP implicit price deflator for each year, based on the formula:

GDP implicit price deflator = nominal GDP / real GDP

4) For problem 4, refer to Table I-3

	FY2	FY3	FY4	FY5	FY6
GDP Deflator	111.4	118.0	129.3	143.0	157.8
Medical – Unit Cost	22	25	28	32	35

Table I-3: Data for Conversion Between Constant and Then Year Dollars

(a) Converting Current Dollars to Then Year Dollars
Convert a proposed budget of $100,000 in FY4 dollars into FY6 dollars.

(b) Converting Then Year Dollars to Current Dollars
What would the budget need to be in FY4 dollars to be $100,000 in FY6 dollars?

(c) Comparing Costs Over Time
What year was the unit cost for medical at its highest? What year was it at its highest adjusted for inflation? What year was it at its lowest adjusted for inflation?

5) Problem 5 refers to Table I-4.

Dec Y9	FY9	FY10	FY11	FY12
Procurement	8.2%	7.5%	14.0%	15.6%
Military Pay	5.6%	5.7%	5.2%	4.9%
Civilian Pay	6.7%	4.4%	4.5%	5.3%
Fuel	8.1%	7.3%	7.0%	4.9%
Medical	12.5%	11.0%	9.9%	9.5%
Steel	33.3%	18.3%	13.8%	12.5%

Table I-4: Inflation Forecasts for Construction of Composite Rates

(a) Calculating Composite Inflation Rates

Using the forecast inflation rates from Table I-4, show the corresponding forecast inflation rates for the following composite categories:

Composite	Component 1	Component 2	Component 3
Civilian Personnel	Civilian Pay – 70%	Procurement – 20%	Medical – 10%
O&M	Procurement – 65%	Fuel – 35%	
Shipbuilding	Procurement – 35%	Steel – 40%	Fuel – 25%

Table I-5: Composite Rate Composition

(b) Converting Budgets using Composite Rates

Convert the budget in Table I-6 from FY9 dollars to FY11 dollars.

Item	Budget, FY9$
O&M	$50,000
Civilian Personnel	$35,000
Military Pay	$40,000
Procurement	$75,000
TOTAL	$200,000

Table I-6: FY9 Budget

6) Problem 6 refers to Table I-7

FY6 Outlay Rates							
	FY6	FY7	FY8	FY9	FY10	FY11	FY12
Procurement	35	35	23	7			
Ships	11	29	20	10	13	9	8
Aircraft	16	40	29	5	6	4	
Weapons	30	32	15	13	7	3	
Vehicles	11	46	29	7	4	3	
Ammunition	20	47	20	6	7		
Military Pay	100						

Civilian Pay	100						
Fuel	100						
Medical	71	23	6				

Table I-7: FY6 Outlay Rates

(a) Applying Outlay Rates

If an appropriation for FY6 has $5000 for each line item (Procurement, Ships, Aircraft, Weapons, Vehicles, Ammunition, Military Pay, Civilian Pay, Fuel, Medical), how much of the budget will be spent in each year overall and for each line item?

(b) Deriving Composite Outlay Rates

Derive composite outlay rates for O&M, Military Personnel and Civilian Personnel based upon the following formulas:

O&M = 70% Procurement + 20% Fuel + 10% Medical
Military Personnel = 80% Military Pay + 20% Procurement
Civilian Personnel = 80% Civilian Pay + 20% Procurement

(c) Outlays Across Multiple Appropriations

Find the yearly O&M spending authority for FY6-11 based upon the FY6-8 appropriations for O&M and the outlay rates in Table I-8. For the FY6 appropriation, take the results from part (b).

O&M	**FY6**	**FY7**	**FY8**	**FY9**	**FY10**	**FY11**		**Total**
FY6 Appropriation								$5,000
FY7 Appropriation		49	32.4	12.3	6.3			$8,000
FY8 Appropriation			46.4	26.4	18.1	9.1		$7,000
Total								$20,000

Table I-8: FY6-9 Appropriations

7) For problem 7, refer to Table I-9

Procurement Index – FY4	**Outlay Rate**	**Inflation Index/100**
FY4	.35	1.000
FY5	.37	1.115
FY6	.21	1.242
FY7	.07	1.385
TOTAL	1.00	

Table I-9: Calculation of Indices

(a) Construction of Indices - Army

For an Army procurement program with the annual outlay rates and inflation indices as indicated in Table I-9, compute an inflation index for the whole program. Remember, that the method for computing the index is different from that used in the Navy and Air Force.

(b) Construction of Indices – Air Force/Navy

For a Navy procurement program with the annual outlay rates and inflation indices as indicated in Table I-9, compute an inflation index for the whole program. Remember, that the method for computing the index is different from that used in the Army, but the same as that use in the Air Force.

(c) Application of Indices

For a Procurement program that would cost $100,000 in constant dollars, how much should the Army budget? How much should the Air Force budget?

8) For problem 8 refer to Table I-10

	Military Pay	Civilian Pay
CY4	7.1	9.1
CY5	7.3	7.6
CY6	7.5	7.0

Table I-10: CY4-6 Pay Increases

(a) Converting Pay Raises - Simple

Recall there are two methods for converting calendar year pay increases to fiscal year pay increases. Compute the FY5 and FY6 pay increases for military pay and civilian pay using the data in Table I-10 according to the method of taking the average pay increase by quarter.

(b) Converting Pay Raises - Precise

Compute the FY5 and FY6 pay increases accounting for compounding the pay increase from the first three months of the fiscal year.

9) For problem 9 refer to Table I-11

Item	FY4 Budget
Procurement	$50,000
Food	$25,000
Office Supplies	$15,000
Uniforms	$10,000

Pay – Military	$20,000
Pay – Civilian	$15,000
Coal	$10,000
Gas	$25,000
Health Plan	$10,000
Aircraft	$20,000
TOTAL	$150,000

Table I-11: Sample Budget, Problem 4

(a) Budgets and Inflation Indices
List the appropriate inflation index for each budget item.

(b) Budgets and Outlay Rates
Using the outlay rates from Table I-12, determine the spending by budget line item and year for FY4-9.

	FY4	FY5	FY6	FY7	FY8	FY9
Procurement	35	37	21	7		
Aircraft	19	44	23	7	4	3
Military Pay	100					
Civilian Pay	100					
Fuel	100					
Medical	71	24	5			

Table I-12: FY4 Outlay Rates

(c) Converting Outlays to Constant Dollars
Use the forecast inflation indices in Table I-13 to convert the results from 9) (b) into constant dollars with a base year FY4.

	FY4	FY5	FY6	FY7	FY8	FY9
Procurement	86.1	92.8	100.0	107.8	116.1	125.1
Military Pay	85.9	92.7	100.0	107.9	116.4	125.6
Civilian Pay	91.0	95.4	100.0	104.8	109.9	115.2
Fuel	100.5	100.3	100.0	99.7	99.5	99.2
Medical	79.1	88.9	100.0	112.4	126.4	142.1

Table I-13: Inflation Index Forecast, FY4-9

(d) Planning a Budget over Multiple Appropriations
Using Table I-14, determine the then year budget required each year for the program covered by the table, encompassing three years of appropriations, based upon the FY4 costs.

Procurement	FY4	FY5	FY6	FY7	FY8	FY9		Budget
FY4 Appropriation	35	37	21	7				$50,000
FY5 Appropriation		27	45	15	13			$40,000
FY6 Appropriation			35	35	23	7		$30,000
Total								$120,000

Table I-14: FY4-6 Procurement Appropriations

10) For problem 10, refer to Table I-15

Category	In $FY8	Old FY8	Old FY10	New FY8	New FY10
Procurement	$50,000	100.0	119.7	90.7	109.7
Military Pay	$30,000	100.0	114.9	95.3	105.8
Civilian Pay	$25,000	100.0	112.0	91.8	107.9
Fuel	$29,000	100.0	128.4	96.3	104.5
Medical	$16,000	100.0	127.8	89.7	111.8
TOTAL	$150,000				

Table I-15: Changing Inflation Assumptions

(a) Converting Constant Dollars to Then Year Dollars

A program needs to purchase $150,000 of goods in FY8 dollars in FY10. Compute the budget needed in FY10 dollars.

(b) Updating Budget with Revised Assumptions

A year after the budget is submitted, new inflation forecasts are released (New FY8 and New FY10). Revise the budget to account for the change in assumptions.

Chapter 6 Solutions

1) (a) CPI using Arithmetic Mean (method in use until 1999)
The first step in constructing the CPI is to come up with the basket it is based on. The overall quantities for bananas, wood, and radio are large enough to make the calculations difficult, so it is easier to reduce them proportionately. Deriving the CPI using the arithmetic mean then involves simply comparing the price of the basket from year to year, setting the base year equal to 100.0. For example, the CPI for FY 7 is (174/170.80) * 100 = 101.9.

			FY 6		FY 7		FY 8	
	Qty	**Basket**	**Price**	**Total**	**Price**	**Total**	**Price**	**Total**
Bananas	45000	30	1.70	51.00	1.50	45.00	1.55	46.50
Wood	12000	8	5.60	44.80	6.00	48.00	5.75	46.00
Radios	4500	3	25.00	75.00	27.00	81.00	24.00	72.00
Basket Price				170.80		174.00		164.50
CPI				100.0		101.9		96.3

Table I-16: Computing CPI using Arithmetic Mean

(b) CPI using Geometric Mean (method currently in use)
The geometric mean method for calculating the CPI involves taking the change in price from year to year for each item in the basket, taking it to the power of its share in the base year basket, and multiplying the results for all basket items together. The first step is to compute the basket share for each item in the base year:

Bananas = 51.00/170.80 = .30
Wood = 44.80/170.80 = .26
Radios = 75.00/170.80 = .44

So the calculations for Year 7 and Year 8 are:

$$FY\ 7 = ((1.50/1.70)^{.30} * (6.00/5.60)^{.26} * (27.00/25.00)^{.44} - 1) * 100.0 = 101.4$$
$$FY\ 8 = ((1.55/1.50)^{.30} * (5.75/6.00)^{.26} * (24.00/27.00)^{.44} - 1) * 101.4 = 96.2$$

(c) Deriving Inflation Rates from the CPI
Inflation rates are derived by taking the proportion of the CPI of one year to that of another. To find an average inflation rate over multiple years, find the overall rate and take it to the power of the inverse of the number of years.

Arithmetic Mean:

FY 7	= 101.9/100.0 – 1	= 1.9%
FY 8	= 96.3/101.9 – 1	= -5.5%
FY 7-8 overall	= 96.3/100.0 – 1	= -3.7%
FY 7-8 average	$= (96.3/100.0)^{1/2} - 1$	= -1.9%

Geometric Mean:

FY 7	= 101.4/100.0 – 1	= 1.4%
FY 8	= 96.2/101.4 – 1	= -5.1%
FY 7-8 overall	= 96.2/100.0 – 1	= -3.8%
FY 7-8 average	$= (96.2/100.0)^{1/2} - 1$	= -1.9%

(d) Changing the CPI Base Year

Changing the base year entails setting the new base year equal to 100.0 and multiplying all other years by 100.0 divided by the old index level of the new base year.

FY 6 = 100.0 * (100.0/101.4) = 98.6
FY 7 = 100.0
FY 8 = 96.2 * (100.0/101.4) = 94.9

2) (a) Using a Different CPI Basket

The calculation is the same as for the other basket, using the new quantities and prices.

	Qty	Basket	Y6 Price	Total	Share	Y7 Price	Y8 Price
Coconuts	46000	920	2.35	2162	.35	2.20	2.30
Boats	150	3	1050	3150	.51	1075	1025
Milk	18000	360	2.45	882	.14	2.50	2.70
Total				6194	1.00		

Table I-17: New CPI Basket

So the calculations for FY 7 and FY 8 are:

$$FY\ 7 = ((2.20/2.35)^{.35} * (1075/1050)^{.51} * (2.50/2.45)^{.14}) * 100.0 = 99.2$$
$$FY\ 8 = ((2.30/2.20)^{.35} * (1025/1075)^{.51} * (2.70/2.50)^{.14}) * 99.2 = 99.4$$

(b) Changing the CPI Basket

Recall that in the year the basket changes, the CPI is calculated using the old basket, but the base year data is collected for the new basket. So FY 6 is set to

100.0, FY 7 is equal to the CPI using the old basket (101.4), and FY 8 uses the new basket, with a CPI equal to the ratio of the CPI in FY 8 to the CPI in FY 7, both using the new basket (showing the inflation rate between FY 7 and FY 8) multiplied by the CPI in FY 7 using the old basket:

CPI, FY 8 = (99.4/99.2) * 101.4 = 101.6

	FY 6	FY 7	FY 8
Basket 1	100.0	101.4	96.2
Basket 2	100.0	99.2	99.4
Combined	100.0	101.4	101.6

Table I-18: Unified CPI Covering Two Baskets

3) (a) Computing Nominal GDP

The nominal GDP is calculated by multiplying the quantity and unit cost of each item in the economy, and adding up the results.

FY 6 GDP =	45,000 * $1.70	=	$76,500
	12,000 * $5.60	=	$67,200
	4,500 * $25.00	=	$112,500
	45,000 * $2.35	=	$105,750
			$361,950
FY 7 GDP =	44,000 * $1.50	=	$66,000
	12,500 * $6.00	=	$75,000
	5,000 * $27.00	=	$135,000
	46,000 * $2.20	=	$101,200
	150 * $1075	=	$161,250
			$538,450
FY 8 GDP =	48,000 * $1.55	=	$74,400
	14,000 * $5.75	=	$80,500
	6,000 * $24.00	=	$144,000
	45,000 * $2.30	=	$103,500
	170 * $1025	=	$174,250
	19,000 * $2.70	=	$51,300
			$627,950

(b) Computing Real GDP

The real GDP is calculated by multiplying the quantity of each item in the economy by its unit cost in a base year, usually the previous year, and adding up the results.

FY 6 GDP = can't calculate without FY5 data

FY 7 GDP =	44,000 * $1.70	=	$74,800
	12,500 * $5.60	=	$70,000
	5,000 * $25.00	=	$125,000
	46,000 * $2.35	=	$108,100
	150 * $0	=	$0
			$377,900

FY 8 GDP =	48,000 * $1.50	=	$72,000
	14,000 * $6.00	=	$84,000
	6,000 * $27.00	=	$162,000
	45,000 * $2.20	=	$99,000
	170 * $1075	=	$182,750
	19,000 * $0	=	$0
			$599,750

(c) Computing the GDP Implicit Price Deflator

The GDP implicit price deflator is the nominal GDP divided by the real GDP. From parts (a) and (b) we get the following table:

	Nominal GDP	Real GDP	GDP Deflator
FY 6	$361,950	n/a	n/a
FY 7	$538,450	$377,900	1.425
FY 8	$627,950	$599,750	1.047

Table I-19: Computing the GDP Implicit Price Deflator

4) (a) Converting Constant Dollars to Then Year Dollars

Multiply the budget by the ratio of the then year dollar index to the constant dollar index:

$100,000 * (FY6/FY4) = $100,000 * (157.8/129.3) = $122,042

(b) Converting Then Year Dollars to Constant Dollars

Multiply the budget by the ratio of the constant dollar index to the then year dollar index:

$100,000 * (FY4/FY6) = $100,000 * (129.3/157.8) = $81,939

(c) Comparing Costs Over Time
The highest cost unadjusted for inflation is for FY6, at $32.

To compare costs adjusting for inflation, first convert the cost for all years to constant dollars (choose the first year in the series, FY2), by multiplying by the FY2 index and dividing by the then year index:

	FY2	FY3	FY4	FY5	FY6
Current Dollars	$22	$25	$28	$32	$35
Constant FY2 Dollars	$22.00	$23.60	$24.12	$24.93	$24.71

Table I-20: Medical Costs Adjusted for Inflation

So the year with the highest price adjusted for inflation is FY5. The year with the lowest price adjusted for inflation is FY2. The cost of medical care increased at a rate greater than general inflation in FY3-5, and less than general inflation in FY6.

5) (a) Calculating Composite Inflation Rates
For each composite category, multiply the percent for each component by the rate for that component, and add the results. For Civilian Personnel, FY9, the calculation is:

70% * 6.7% + 20% * 8.2% + 10% * 12.5% = 7.58%

Calculating the rates for all three budget categories for FY9-12 yields:

	FY9	FY10	FY11	FY12
Civilian Personnel	7.58%	5.68%	6.94%	7.78%
O&M	8.17%	7.43%	11.55%	11.86%
Shipbuilding	18.22%	11.77%	12.17%	11.69%

Table I-21: Composite Inflation Rates

(b) Converting Budgets using Composite Rates
Two approaches are acceptable for this problem. One would be to create indices with base year 9 from the inflation rates, and then divide the budget categories by the FY11 index. The second, shown here, is to divide the budget items by the corresponding FY 10 inflation rate and FY 11 inflation rate. For example:

O&M = $50,000 / (1.0743 * 1.1155) = $41,726

The rest of the budget items are calculated in a similar manner.

Item	Budget, $FY9	Budget, $FY11
O&M	$50,000	$41,726
Civilian Personnel	$35,000	$30,970
Military Pay	$40,000	$35,972
Procurement	$75,000	$61,200
TOTAL	$200,000	$169,868

Table I-22: Using Composite Rates to Convert Then Year to Constant Dollars

6) (a) Applying Outlay Rates
Multiply the budget by the outlay rate for each year for each item.

	FY6	FY7	FY8	FY9	FY10	FY11	FY12	Total
Procurement	$1750	$1750	$1150	$350				$5000
Ships	$550	$1450	$1000	$500	$650	$450	$400	$5000
Aircraft	$800	$2000	$1450	$250	$300	$200		$5000
Weapons	$1500	$1600	$750	$650	$350	$150		$5000
Vehicles	$550	$2300	$1450	$350	$200	$150		$5000
Ammunition	$1000	$2350	$1000	$300	$350			$5000
Military Pay	$5000							$5000
Civilian Pay	$5000							$5000
Fuel	$5000							$5000
Medical	$3550	$1150	$300					$5000
Total	$24,700	$12,600	$7100	$2400	$1850	$950	$400	$50,000

Table I-23: Outlays for FY6 Appropriation

(b) Deriving Composite Outlay Rates
For each budget category, multiply the percent allocated by component by the percent allocated by year. For example:

$$\text{O\&M, FY6} = 70\% * 35\% + 20\% * 100\% + 10\% * 71\% = 51.6\%$$

Performing this calculation for all three categories for all outlay years yields:

	FY6	FY7	FY8	FY9
O&M	51.6%	26.8%	16.7%	4.9%
Military Personnel	87.0%	7.0%	4.6%	1.4%
Civilian Personnel	87.0%	7.0%	4.6%	1.4%

Table I-24: Composite Outlay Rates

(c) Outlays Across Multiple Appropriations
Fill in the outlay rate for O&M, FY6 from part (b) and multiply the annual appropriation amounts by the outlay rates for the appropriate years.

O&M	FY6	FY7	FY8	FY9	FY10	FY11		Total
FY6 Appropriation	$2,580	$1,340	$835	$245				$5,000
FY7 Appropriation		$3,920	$2,592	$984	$504			$8,000
FY8 Appropriation			$3,248	$1,848	$1,267	$637		$7,000
Total	$2,580	$5,260	$6,675	$3,077	$1,771	$637		$20,000

Table I-25: FY6-8 O&M Appropriations and Outlays

7) (a) Construction of Indices - Army
The Army takes a weighted average of the annual outlays and indices:

Proc. Index, FY4 =
35 * 1.000 + .37 * 1.115 + .21 * 1.242 + .07 * 1.385 = 1.120

(b) Construction of Indices – Air Force/Navy
The Navy (and Air Force) divide the outlay rate for each year by that year's inflation index, with the first year of the appropriation as the base year. The inverse of the inflation weighted outlays is then taken to arrive at the index.

Procurement Index – FY4	Outlay Rate	Inflation Index/100	Outlay / Inflation Index
FY4	.35	1.000	.350
FY5	.37	1.115	.332
FY6	.21	1.242	.169
FY7	.07	1.385	.051
TOTAL	1.00		.902
Navy/Air Force			1.109 (=1/.902)

Table I-26: FY4 Procurement Index – Air Force/Navy

(c) Application of Indices
Multiply $100,000 by the appropriate index.

Army: $100,000 * 1.120 = $112,000
Air Force (and Navy): $100,000 * 1.109 = $110,900.

8) (a) Converting Pay Raises - Simple
To convert calendar year pay raises to fiscal years, a close approximation is to take one quarter of the pay raise from the first calendar year, corresponding to October-December, and three quarters of the pay raise from the second calendar

year, corresponding to January-September. For example, the military pay raise for FY5 is calculated:

$$FY5 = (CY4 + 3 * CY5) / 4 = (7.1 + 21.9) / 4 = 7.25\%$$

The rest of the fiscal year pay increases are shown in Table I-29.

	Military Pay	Civilian Pay
FY5	7.25%	7.98%
FY6	7.45%	7.15%

Table I-27: Pay Raise Conversion - Simple

(b) Converting Pay Raises – Precise

A more precise formula accounts for compounding the pay raise by comparing one fiscal year to the previous fiscal year. The military pay raise for FY5 according to this formula is:

$$FY5 = \frac{1 + 3 * CY5}{(1/CY4) + 3} = \frac{1 + 3 * 7.3}{(1/7.1) + 3} = 7.29\%$$

The rest of the fiscal year pay increases are shown in Table I-30.

	Military Pay	Civilian Pay
FY5	7.29%	7.65%
FY6	7.49%	7.03%

Table I-28: Pay Raise Conversion - Precise

9) (a) Budgets and Inflation Indices

The inflation indices in the sample economy are designed to mimic the indices used by OSD when it develops its inflation guidance. However, due to the limited size of the sample economy, there are some discrepancies. Military pay and civilian pay are loosely based on the Employment Cost Index (ECI) and government policy decisions, but is easier to depict in the sample economy through the CPI. Otherwise, the indices listed below are the original sources (CPI, GDP deflator, etc.), which have equivalents in the real economy. In addition, the fuel index used by OSD is based on crude oil, not including other fuels. Thus, though coal is listed under fuel here, an argument could be made for using the GDP deflator. The GDP deflator is used for aircraft, but given the high metal content, the CPI-steel index might be a candidate, or a composite including both the GDP deflator and CPI-steel.

Item	Index
Procurement	GDP Deflator
Food	GDP Deflator
Office Supplies	GDP Deflator
Uniforms	GDP Deflator
Pay – Military	CPI-Military Pay
Pay – Civilian	CPI-Civilian Pay
Coal	CPI-Fuel
Gas	CPI-Fuel
Health Plan	CPI-Medical
Aircraft	GDP Deflator

Table I-29: Matching Budget Items to Indices

(b) Budgets and Outlay Rates

Multiply the budgeted amount for each line item by the percent allocated to each year. Fuel includes both coal and gas. Food, office supplies, and uniforms all roll up into the procurement total and not counted separately. Aircraft in this example is counted in addition to procurement, having its own outlay, but using the same inflation index.

	FY4	FY5	FY6	FY7	FY8	FY9
Procurement	$17,500	$18,500	$10,500	$3,500		
Aircraft	$3,800	$8,800	$4,600	$1,400	$800	$600
Military Pay	$20,000					
Civilian Pay	$15,000					
Fuel	$35,000					
Medical	$7,100	$2,400	$500			
TOTAL	$98,400	$29,700	$15,600	$4,900	$800	$600

Table I-30: Matching Budget Items to Outlays

(c) Converting Outlays to Constant Dollars

Multiply each outlay amount from part (b) by the FY4 index divided by the index in the target year.

	FY4	FY5	FY6	FY7	FY8	FY9	TOTAL
Procurement	$17,500	$17,164	$9,041	$2,795			$46,500
Aircraft	$3,800	$8,165	$3,961	$1,118	$593	$413	$18,050
Military Pay	$20,000						$20,000
Civilian Pay	$15,000						$15,000
Fuel	$35,000						$35,000
Medical	$7,100	$2,135	$396				$9,631
TOTAL	$98,400	$27,464	$13,398	$3,913	$593	$413	$144,181

Table I-31: Constant Dollar Outlay Profile

(d) Planning a Budget over Multiple Appropriations

The first step is to create inflation indices for each appropriation. Set the index for FY4 to 1.00. The value for each succeeding year is its index from Table I-13 divided by the FY4 index from the same table (86.1). For example, the FY5 index is 92.8/86.1 = 1.078. Calculate inflation indices for each year's appropriation using their outlay rates and the annual indices as in problem 7)(b).

Procurement Index – FY4-6	Outlay Rates FY4	FY5	FY6	Inflation Index/100	Outlay / Inflation Index FY4	FY5	FY6
FY4	.35			1.000	.350		
FY5	.37	.27		1.078	.343	.250	
FY6	.21	.45	.35	1.161	.181	.388	.301
FY7	.07	.15	.35	1.252	.056	.120	.280
FY8		.13	.23	1.348		.096	.171
FY9			.07	1.453			.048
TOTAL	1.00				.930	.854	.800
Index					1.075	1.171	1.250

Table I-32: Procurement Indices for FY4-6

Next, take the indices calculated in Table I-32 and multiply them by the constant FY4 dollar amounts desired for the appropriation to arrive at then year dollar amounts over the outlay profile of the appropriation. Then multiply the then dollar budget by the outlay rates for each year.

Appropriation	$FY4	Index	$TY	FY4	FY5	FY6	FY7	FY8	FY9
FY4	$50,000	1.075	$53,750	$18,813	$19,888	$11,288	$3,763		
FY5	$40,000	1.171	$46,840		$12,647	$21,078	$7,026	$6,089	
FY6	$30,000	1.250	$37,500			$13,125	$13,125	$8,625	$2,625
Total	$120,000		$148,090	$18,813	$32,535	$45,491	$23,914	$14,714	$2,625

Table I-33: Procurement Outlays, FY4-6

10) (a) Converting Constant Dollars to Then Year Dollars

Multiply the constant dollars by the index value for each category for FY10 and divide by the value for FY8. For example, for procurement:

$$\$FY10 = \$50,000 * (119.7/100.0) = \$59,850.$$

Table I-34 shows the rest of the budget in FY10 dollars.

Category	$FY8	$FY10
Procurement	$50,000	$59,850
Military Pay	$30,000	$34,470
Civilian Pay	$25,000	$28,000
Fuel	$29,000	$37,236
Medical	$16,000	$20,448
TOTAL	$150,000	$180,004

Table I-34: Budget in FY10 Dollars

(b) Updating Budget with Revised Assumptions

Since we know the original budget in constant dollars, it is possible to merely apply the revised assumptions to the constant dollar budget. For example, for the procurement budget, we would have:

Revised = $50,000 * (109.7/90.7) = $60,474

However, if we did not know the constant dollar budget, but did know the inflation assumptions that went into the then year dollar budget, it would be possible to back out the old assumptions and apply the new assumptions. The steps can be combined by multiplying each budget line item as it stood with the old assumptions by the old base year index and the new then year index and divide by the new base year index and old then year index. For example, the revised procurement budget would be:

Revised = $59,850 * (100/90.7) * (109.7/119.7) = $60,474

The rest of the revised budget is shown in Table I-35:

Category	Old Budget	Revised Budget
Procurement	$59,850	$60,474
Military Pay	$34,470	$33,305
Civilian Pay	$28,000	$29,385
Fuel	$37,236	$31,469
Medical	$20,448	$19,942
TOTAL	$180,004	$174,575

Table I-35: Revised FY10 Budget

Chapter 7 Problems

1) Normalizing Historical Data to Analyze Trends

(a) Adjusting for Inflation

Consider Table I-36, showing the then year price of wood and the CPI over 10 years. Find the year with highest price adjusted for inflation. Find the year with the lowest price adjusted for inflation.

	FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	FY9	FY10
Wood	$5.00	$5.25	$5.50	$5.40	$5.50	$5.60	$6.00	$5.75	$6.00	$6.30
CPI	100.0	103.6	108.4	107.4	121.8	117.5	116.6	119.1	125.2	130.8

Table I-36: Then Year Price of Wood

(b) Budget Compared to GDP

Table I-37 shows the military budget in then year dollars compared to the nominal GDP for each year in the sample economy. Find the year with the highest proportion of military budget to GDP. Find the year with the lowest military budget relative to GDP.

	FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	FY9	FY10
Mil. Budget	1800	2250	2800	3150	3750	3950	5100	6250	6400	6900
Nominal GDP	3981	4893	5745	6790	7735	8451	12,666	14,997	16,642	18,004
GDP Deflator	100.0	114.6	126.3	140.7	156.0	161.4	234.0	246.5	264.2	281.7

Table I-37: Military Budget Relative to GDP, TY $K

(c) Adjusting Budgets for Inflation

Using the GDP deflator from Table I-37, how much of the change in military budget from FY1 to FY10 can be explained by inflation? What is the average growth rate of the military budget from FY1 to FY10, adjusted for inflation? What years had budget increases adjusted for inflation? What years had decreases?

2) Evaluating Budget Shares

Given the inflation forecasts in Table I-38, and the FY3 budget shares in Figure I-1, project the relative budget shares in FY6.

	FY3	FY6
Procurement	80.5	111.4
Military Pay	85.2	108.3
Civilian Pay	90.7	105.0
Energy	59.2	130.0
Medical	82.6	110.0

Table I-38: Inflation Indices, FY3, FY6, Base Year FY5

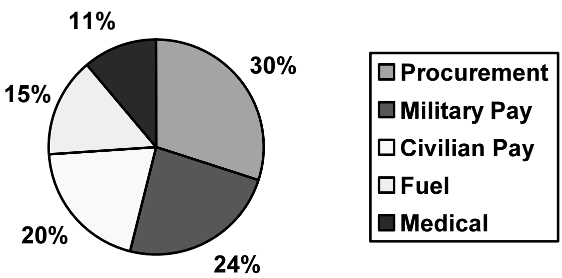


Figure I-1: Budget Shares, FY3

3) Comparing Productivity

(a) Comparing Expenditures with Outlay Weighted Indices

Company A produces ammunition expending $400,000 from an FY3 appropriation. Company B produces the same quantity using the same process with an FY5 appropriation for $450,000. Assuming the appropriations were spent according to the outlay profiles and actual inflation in Table I-39, which company was more efficient in its production of ammunition? Assume that the inflation rate for ammunition is a composite of 50% of the CPI and 50% of CPI-Steel.

	FY3	FY4	FY5	FY6	FY7	FY8	FY9	FY10
FY3 Outlay	15	50	25	5	5			
FY5 Outlay			11	50	28	5	6	
CPI	108.4	107.4	121.8	117.5	116.6	119.1	125.2	130.8
CPI-Steel	150.0	130.0	140.0	160.0	170.0	150.0	200.0	180.0

Table I-39: Outlays and Inflation, FY3 and FY5

(b) Adjusting Outlay Weighted Indices

If production on the FY5 appropriation were delayed a year at the beginning through no fault of Company B, and the cost were $450,000, which lot of ammunition was produced most efficiently? Use the same outlay rate from FY5, delayed by a year.

4) Comparing Forecasts and Actuals

(a) Differences between Forecasts and Actuals

Table I-40 displays the predicted and actual inflation for FY4-10. Find the difference between the forecast and actual inflation for each year. Find the minimum difference, maximum difference, and average difference.

	FY4	FY5	FY6	FY7	FY8	FY9	FY10
GDP Deflator	9.5%	10.6%	10.4%	47.5%	6.0%	8.2%	6.6%
Forecast	11.4%	7.8%	8.7%	9.5%	10.3%	28.9%	20.5%

Table I-40: Inflation Forecast vs. Actual Inflation

(b) Accounting for Inflation Risk

Three times out of seven in the sample economy, the actual inflation as measured by the GDP deflator exceeded the forecast inflation, implying budget shortfalls for programs funded with the low forecasts. Based upon this small data set, how much additional funding would be required to have an 80% confidence that there would not be any budget shortfalls due to actual inflation exceeding the forecast?

(c) Budget Shortfalls Due to Inflation Higher than Forecast

Given the forecast inflation and outlay profile for procurement in FY6 as shown in Table I-41, what is the shortfall for a 500,000 FY6$ program. Use the GDP deflator figures from Table I-40 as the actual inflation for FY6-9.

	FY6	FY7	FY8	FY9
Outlays	35%	35%	23%	7%
Forecast	8.7%	8.7%	8.7%	8.7%

Table I-41: Outlays and Inflation Forecast, FY6 Procurement

5) Net Present Value

A proposed project for FY7 would last four years with the following profile of expenditures (investment) and expected savings, along with the discount rates for FY7-10. An alternative project would have the same overall cost and benefit, but different yearly profiles and discount rates, as indicated. Find the NPV relative to the alternative investment. In other words, which course of action will be more cost efficient, the proposed project or the alternative?

Year	Cost 1 TY$	Benefit 1 TY$	Discount Rate 1	Cost 2 TY$	Benefit 2 TY$	Discount Rate 2
FY7	$300,000	$100,000		$400,000	$100,000	
FY8	$450,000	$300,000	5%	$300,000	$200,000	4%
FY9	$200,000	$500,000	3%	$300,000	$400,000	6%
FY10	$250,000	$600,000	7%	$200,000	$800,000	5%
Total	$1,200,000	$1,500,000		$1,200,000	$1,500,000	

Table I-42: Project 1 and 2 Costs and Benefits

Chapter 7 Solutions

1) Normalizing Historical Data to Analyze Trends

(a) Adjusting for Inflation

Multiply the then year price for each year by the CPI for the base year (FY1 = 100.0) divided by the CPI for the current year. For example, the price in FY2 adjusted for inflation is $5.25/1.036 = $5.07. The rest of the table:

	FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	FY9	FY10
Raw	$5.00	$5.25	$5.50	$5.40	$5.50	$5.60	$6.00	$5.75	$6.00	$6.30
Adjusted	$5.00	$5.07	$5.07	$5.03	$4.52	$4.77	$5.15	$4.83	$4.79	$4.82

Table I-43: Price of Wood Adjusted for Inflation

Hence, FY7 has the highest wood price adjusted for inflation, and FY5 has the lowest price.

(b) Budget Compared to GDP

Simply divide the budget by the GDP.

	FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	FY9	FY10
Mil. Budget	1800	2250	2800	3150	3750	3950	5100	6250	6400	6900
GDP	3981	4893	5745	6790	7735	8451	12,666	14,997	16,642	18,004
%	45.2%	46.0%	48.7%	46.4%	48.5%	46.7%	40.3%	41.7%	38.5%	38.3%

Table I-44: Military Budget as a Percent of GDP

The highest military budget relative to GDP is in FY3. The lowest is in FY10.

(c) Adjusting Budgets for Inflation

A significant portion of the increase is due to inflation. The FY1 budget of $1.8 million, adjusted for inflation to FY10 is $1.8m * 2.817 = $5.07m, for an increase of $3.27m. The proportion of the FY10 budget to the FY1 budget in FY10 dollars, $6.9m/$5.07m = 1.36 indicates that the budget increased during this period by 36% in constant dollars. The proportion of the increase due to inflation is 182% / (182% + 36%) = 83.5%.

The overall growth of the budget adjusted for inflation is $6.9m/(2.817 * 1.8m) – 1 = 36%. The average annual growth of the budget adjusted for inflation is $(\$6.9m/\$5.07m)^{1/9} - 1 = 3.5\%$.

	FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	FY9	FY10
Then Year	1800	2250	2800	3150	3750	3950	5100	6250	6400	6900
Constant	1800	1963	2217	2239	2404	2447	2179	2535	2422	2449
GDP Deflator	100.0	114.6	126.3	140.7	156.0	161.4	234.0	246.5	264.2	281.7

Table I-45: Military Budget Adjusted for Inflation

Increases occurred in FY2-6, FY8, and FY10.

Decreases occurred in FY7 and FY9.

2) Evaluating Budget Shares

First, take the FY3 budget shares and multiply them by the indices for FY6 and divide by the indices for FY3. Normalize the results so they add to 100 by multiplying each share by 100 and dividing by their sum.

	FY3 Share	FY6/FY3	FY6 Share	
			Raw	Normalized
Procurement	30	1.384	41.520	29.1
Military Pay	24	1.271	30.504	21.4
Civilian Pay	20	1.158	23.160	16.2
Energy	15	2.196	32.940	23.1
Medical	11	1.332	14.652	10.3
Total	100		142.776	100.1

Table I-46: FY6 Budget Shares

3) Comparing Productivity

(a) Comparing Expenditures with Outlay Weighted Indices

First, combine the CPI and Steel indices by adding them and dividing by two. Set FY3 = 1.000 and adjust all other years by taking the combined index level for each year and dividing it by the index level for FY3. For example:

$$FY4 = (107.4 + 130.0) / (108.4 + 150.0) = 0.919$$

For each outlay profile, divide the outlay percentage for each year by the FY3 base year inflation index. For the FY3 Ammunition Index, the FY4 component is computed as:

$$FY4 = .50/.919 = .544$$

For the FY3 and FY5 Ammunition Indices, sum up the yearly components and take the inverse to arrive at the outlay weighted indices. The results are shown in Table I-47.

Ammo Index	Outlay FY3	Outlay FY5	CPI	Steel Index	Ammo Index FY3=1.000	FY3 Index	FY5 Index	FY5 Delay Index
FY3	.15		108.4	150.0	1.000	.150		
FY4	.50		107.4	130.0	0.919	.544		
FY5	.25	.11	121.8	140.0	1.013	.247	.109	
FY6	.05	.50	117.5	160.0	1.074	.047	.466	.102
FY7	.05	.28	116.6	170.0	1.109	.045	.252	.451
FY8		.05	119.1	150.0	1.041		.048	.269
FY9		.06	125.2	200.0	1.259		.048	.040
FY10			130.8	180.0	1.203			.050
TOTAL	1.00	1.00				1.033	.923	.912
Index						.968	1.083	1.096

Table I-47: Outlay Weighted Ammunition Indices, FY3 and FY5

To compare the performance of Company A to Company B, take the cost incurred by each and divide by the appropriate outlay weighted index:

Company A = $400,000/.968 = $413,000
Company B = $450,000/1.083 = $416,000

Therefore, Company A performed the same task more cheaply, adjusting for inflation and outlays.

(b) Adjusting Outlay Weighted Indices
Given that the outlay profile is delayed by one year, the weighted index is computed by pushing each outlay rate back a year and calculating as before. In this case, the cost incurred by Company B adjusted for inflation and outlays is:

Company B (delayed) = $450,000/1.096 = $411,000

In this case, Company B provided the services at a lower cost adjusted for inflation and outlays.

4) Comparing Forecasts and Actuals

(a) Differences between Forecasts and Actuals

	FY4	FY5	FY6	FY7	FY8	FY9	FY10
GDP Deflator	9.5%	10.6%	10.4%	47.5%	6.0%	8.2%	6.6%
Forecast	11.4%	7.8%	8.7%	9.5%	10.3%	28.9%	20.5%
Difference	-1.9%	2.8%	1.7%	38.0%	-4.3%	-20.7%	-13.9%

Table I-48: Differences between Forecast and Actual Inflation

The smallest difference is in FY6, at 1.7%.
The largest difference is in FY7, at 38.0%.
The average, accounting for direction, is the sum divided by 7 = 1.7/7 = 0.2%.

(b) Accounting for Inflation Risk

There are two possible solutions. The "quick and dirty" way is to interpolate between the data points surrounding the 80th percentile. There are just seven data points in this example, making it an extremely small sample to make such extrapolations. With that caveat, an examination of the differences between actual inflation and forecast inflation shows that adding enough budget to account for 2.8% inflation would be sufficient in six out of the seven years, or 86%. To further pinpoint an amount sufficient for 80%, one could interpolate between the two adjacent points accounting for 71% certainty and 86% certainty, or between 1.7% and 2.8% inflation delta. 80% is located at (4/5 – 5/7) / (6/7 – 5/7) = (3/35) / (5/35) = .6 of the way from 5/7 to 6/7. So the amount of additional inflation to account for to increase the certainty of including enough inflation in the model 80% of the time is:

$$.6 * (2.8\% - 1.7\%) + 1.7\% = 0.66\% + 1.7\% = 2.36\%$$

The more complicated, but also more accurate, method is to fit a curve to the data points, and find the value for the 80th percentile. Recall that to come up with a curve that minimizes the sum of the squares of the errors from the data to the regression line, it is necessary to find the mean, the standard deviation, and the standard error, and look up the number of standard errors necessary to provide the level of desired confidence via a *z table*. Recall from part (a) that the mean is 0.24%. Further, recall the definition of standard deviation:

Standard deviation =
$(\Sigma(x - \text{mean})^2/(n-1))^{1/2}$ for all x, where n is the number of data points.

In this case we get $((\Sigma(x - 0.24)^2)/6)^{1/2} = (2098.12/6)^{1/2} = (349.69)^{½} = 18.70$

Next we find the standard error:

Standard error = standard deviation / $n^{1/2}$ = 18.70 / $7^{1/2}$ = 7.07

Previously in chapter 7 we looked up in a *z table* the number of standard errors away from the mean necessary to account for 80% of cases less than that level of inflation. That turned out to be 0.84 standard errors, equal to the 50% below the mean plus the 30% between the mean and the value z.

This provides the last piece of information needed to calculate the 80% value of the regression line fit to the seven data points:

Inflation @ 80% confidence – Inflation forecast = mean Inflation delta + (standard errors from mean to 30% from the mean) * (standard error)

= 0.24% + (0.84) * (7.07) = 0.24% + 5.94% = 6.18%

The reason for the significant level of difference between this calculation and the interpolation between the 5th and 6th data points is that the 1st, 2nd, and 7th data points force a much steeper curve than the 3rd-6th data points, which encompass the other method.

(c) Budget Shortfalls Due to Inflation Higher than Forecast
There are several ways to approach this problem, but the most straightforward is to create an outlay weighted index for the program using the forecast inflation, and then another index using the actual inflation, and compare the amount appropriated based on the forecast to what should have been appropriated to complete the program.

Procurement Index	Outlay FY6	Forecast	FY6=1.000	Index	GDP Deflator	FY6=1.000	Actual Index
FY6	.35	8.7%	1.000	.350	10.4%	1.000	.350
FY7	.35	8.7%	1.087	.322	47.5%	1.475	.237
FY8	.23	8.7%	1.161	.198	6.0%	1.564	.147
FY9	.07	8.7%	1.251	.056	8.2%	1.692	.041
TOTAL	1.00			.926			.775
Index				1.080			1.290

Table I-49: Forecast vs. Actual Index

The amount actually appropriated would have been $500,000 * 1.080 = $540,000. The amount needed would be $500,000 * 1.290 = $645,000. The shortfall is $645,000 - $540,000 = $105,000.

5) Net Present Value

The parameters for the problem were as follows:

Year	Cost 1 TY$	Benefit 1 TY$	Discount Rate 1	Cost 2 TY$	Benefit 2 TY$	Discount Rate 2
FY7	$300,000	$100,000		$400,000	$100,000	
FY8	$450,000	$300,000	5%	$300,000	$200,000	4%
FY9	$200,000	$500,000	3%	$300,000	$400,000	6%
FY10	$250,000	$600,000	7%	$200,000	$800,000	5%
Total	$1,200,000	$1,500,000		$1,200,000	$1,500,000	

Table I-50: Project 1 vs. Project 2 Costs and Benefits

The first task is to calculate the discount index for both projects, multiplying the preceding year's index by one plus the rate for each year. The results are reflected in the table below. Then for Project 1, the costs and benefits for each year are divided by the discount index for Project 1, and similar calculations are made for Project 2 using the discount index for Project 2.

Year	Disc. Cost 1 TY$	Disc. Ben. 1 TY$	Discount Index 1	Disc. Cost 2 TY$	Disc. Ben. 2 TY$	Discount Index 2
FY7	$300,000	$100,000		$400,000	$100,000	
FY8	$428,571	$285,714	1.050	$288,462	$192,308	1.040
FY9	$184,843	$462,107	1.082	$272,232	$362,976	1.102
FY10	$216,076	$518,583	1.157	$172,712	$690,846	1.158
Total	$1,129,490	$1,366,404		$1,133,406	$1,346,130	

Table I-51: Discounted Costs and Benefits, Project 1 vs. Project 2

Then the NPV for each project is merely the discounted benefits minus the discounted costs:

NPV (Project 1) = $1,366,404 - $1,129,490 = $236,914
NPV (Project 2) = $1,346,130 - $1,133,406 = $212,724

So Project 1 has the higher NPV, and thus is the better choice.

Chapter 8 Problems

1) Cost Estimating Relationships (CERs)

An analyst uses the following CER for the purchase of office space, valid for space between 1000-3000 square feet:

Cost = 120 * area (square feet) + 25,000, FY5$

From Table I-52, determine if the proposed purchases can be estimated using this CER and estimate the price for those that can. For any purchases for which this CER is not valid, suggest alternatives for providing an estimate.

Year	Sq. Ft.	Inflation Index
FY3	2300	118.0
FY4	800	129.3
FY5	1700	143.0
FY6	3200	157.8
FY7	1200	232.7

Table I-52: Purchases of Office Space

2) Then Year and Constant Dollars

	FY8	FY9	FY10
CPI	119.1	125.2	130.8

Table I-53: CPI, FY8-10

(a) Converting Constant Dollars to Then Year Dollars
Convert a proposed budget of $250,000 in FY8$ into FY10$.

(b) Converting Then Year Dollars to Constant Dollars
What would the budget need to be in FY8 dollars to be $250,000 in FY10 dollars?

3) Cost Risk

An FY5 weapons program extending six years for $1 million has a 50% chance of finishing at cost, a 10% chance of being 10% under budget, 20% chance of being 10% over budget, a 15% chance of being 20% over budget and a 5%

chance of being 50% over budget in constant dollars. What are the then year and constant dollar expenditures for the best, worst, and expected cases, assuming the project remains on schedule and actual inflation is the same as forecast?

	FY5	FY6	FY7	FY8	FY9	FY10
Outlays	28	34	24	8	3	3
Inflation Index	92.8	100.0	107.8	116.1	125.1	134.9

Table I-54: FY5 Weapons Outlays and Inflation Forecast

4) Schedule Risk

A $10 million procurement program is appropriated in FY4 according to the outlay profile in Table I-55. It has a 10% chance of finishing one year ahead of schedule, a 40% chance of finishing on time, a 20% chance of finishing one year late, a 15% chance of finishing two years late, a 10% chance of finishing three years late, and a 5% chance of finishing four years late. Find the expected completion time, as well as the expected expenditure in then year dollars. Also find the expenditure in then year dollars if the project is completed one year early, and if completed three years late, assuming that the compression or expansion of the schedule is uniform.

	FY4	FY5	FY6	FY7	FY8	FY9	FY10
Outlay Rates	35%	37%	21%	7%			
Inflation Index	89.7	100.0	114.1	124.2	138.4	154.2	171.8

Table I-55: FY4 Outlay Rates and Inflation

5) Inflation Forecast Risk

Cost estimates incorporate inflation forecasts over the life of the program, which are themselves subject to variations from the actual forecast. Given an estimate for a steel purchase of $500,000, distributed across three years according to the amounts and inflation forecast shown in Table I-56, along with the possible variances from the inflation forecasts, give the minimum and maximum possible expenditures, the expected expenditure, and the 20th and 80th percentiles.

	FY8	FY9	FY10
Steel	$100,000	$250,000	$150,000
Forecast Inflation	7.5%	7.9%	8.8%
Variance			
-5%		30%	20%
0%		50%	30%
+5%		20%	50%

Table I-56: FY8-10 Inflation Forecast Risk

6) Complex Risk Application

In a cost estimate there is not just cost risk, schedule risk, or inflation risk (which is actually a special case of cost risk), but all three together. Consider a 3-year program appropriated for FY7 for $1 million current dollars, with the outlay profile and inflation rates as shown in Table I-57. Also shown are the risk that inflation will be different than forecast, the risk to the schedule of the program, and the risk to the cost being as planned.

	FY7	FY8	FY9	FY10	FY11
Outlays	$300,000	$500,000	$200,000		
Forecast Inflation	5.2%	7.7%	6.5%	9.2%	3.7%
Inflation Risk (%)		(-2)-0-(+3)	(-4)-0-(+3)	(-3)-0-(+4)	(-1)-0-(+2)
Infl. Risk Probs. (%)		40-40-20	20-30-50	30-50-20	10-60-30
Schedule Risk		20% (2.5yrs)	30%	40%	10%
Cost Risk (%)	-10%	Even	+10%	+25%	
Cost Risk Probs. (%)	20%	50%	20%	10%	

Table I-57: Complex Risk Problem

Assuming that the inflation, schedule, and cost risks are independent of each other, find the following variances from the appropriation for completing the project:

(a) Find the expected cost of the program in then year dollars.
(b) Find the minimum cost of the program in then year dollars.
(c) Find the 80% confidence level of the cost of the program in then year dollars.

Chapter 8 Solutions

1) Cost Estimating Relationships (CERs)

FY3, FY5, and FY7 fall within the valid range of the CER. To estimate the price, perform the CER calculation and convert to FY5 dollars by multiplying by the value of the FY5 index and dividing by the value of the then year index:

FY3 = ($120 * 2,300 + $25,000) * (143.0/118.0) = $301,000 * 1.212 = $364,812
FY5 = ($120 * 1,700 + $25,000) * (143.0/143.0) = $229,000
FY7 = ($120 * 1,200 + $25,000) * (143.0/232.7) = $169,000 * 0.615 = $103,935

FY4 and FY6 fall outside the range of the CER. However, at least in the case of FY4, it is still possible to provide a rough estimate using the CER. Consider the case of renting 0 square feet. The CER yields an estimate of $25,000 for buying no office space at all, when we would expect the cost to be $0. Therefore, we can expect that this constant term in the CER varies between $0 and $25,000 between the values of 0 and 1000 square feet. It is not clear what the relationship is within this range. It could be linear, or the $25,000 could appear with the first square foot of office space. Assuming a linear relationship, the estimate for FY4 would be:

($120 * 800 + (800/1000) * $25,000) * (143.0/129.3) = ($96,000 + $20,000) * 1.106 = $128,296

FY6 is more difficult to estimate. Using the CER itself would yield $409,000 * (143.0/157.8) = $370,640. Larger office space might yield a discount, reducing the price, but it could also require extra infrastructure, increasing the price. Absent further data, the analyst could note the cost using the CER, with an explanatory note that the amount of office space is 7% greater than the upper bound of the valid range for the CER.

2) Then Year and Constant Dollars

(a) Converting Constant Dollars to Then Year Dollars

Multiply the budget by the ratio of the then year dollar index to the constant dollar index:

$250,000 * (FY10/FY8) = $250,000 * (130.8/119.1) = $274,559

(b) Converting Then Year Dollars to Constant Dollars
Multiply the budget by the ratio of the constant dollar index to the then year dollar index:

$250,000 * (FY8/FY10) = $250,000 * (119.1/130.8) = $227,638

3) Cost Risk

Since outlays and inflation are held constant, it is sufficient to create one index for conversion between then year and constant dollars.

Weapons Index	Outlay	Forecast Index	FY5 = 1.000	Index
FY5	.28	92.8	1.000	.280
FY6	.34	100.0	1.078	.315
FY7	.24	107.8	1.162	.207
FY8	.08	116.1	1.251	.064
FY9	.03	125.1	1.348	.022
FY10	.03	134.9	1.454	.021
TOTAL	1.00			.909
Index				1.100

Table I-58: Index for FY5 Weapons Program

The minimum cost is 900,000 TY$, which is 900,000 / 1.1 = 818,182 FY5$. The maximum cost is 1,500,000 TY$, which is 1,500,000 / 1.1 = 1,363,636 FY5$.

The expected value is the sum of the likelihoods of each outcome multiplied by the estimated cost of that outcome:

.1 * $900k + .5 * $1.0m + .2 * $1.1m + .15 * $1.2m + .05 * $1.5m = $1,065,000

1,065,000 TY$ is equal to 1,065,000 / 1.1 = 968,182 FY5$.

4) Schedule Risk

Compressing or expanding the schedule in effect changes the outlay rates and indices. The expected completion date is equal to the sum of the probabilities of each completion date multiplied by the corresponding project length:

Expected completion = .1 * 3 + .4 * 4 + .2 * 5 + .15 * 6 + .1 * 7 + .05 * 8
= 4.9 years

To reset the outlay rates to reflect the new schedules, be it the expected 4.9 years, the minimum 3 years, or longest example of 7 years, it is necessary to overlay the original outlays over the new duration. For example, stretching four years out to 4.9 years implies that it will take 1.225 years (4.9/4) to spend the outlay originally intended for one year, as shown in the table below. Furthermore, if it takes 4.9 years to spend 4 years of outlays, then in the first year it is possible to spend 4.0/4.9 of the first year's outlay. 0.9/4.9 remains to be spent in the second year. This leaves room for (4.0 – 0.9)/4.9 = 3.1/4.9 of the second year's outlay to be spent in the second year. So in the first year, the outlay is 35% * 4.0/4.9 = 28.6%. The new second year outlay is 35% * 0.9/4.9 + 37% * 3.1/4.9 = 29.8%. The rest of the calculations are shown below the table.

Expected						**= 4.9 yr**
40/49	9/49+31/49	18/49+22/49	27/49+13/49	36/49		
Min.						**= 3 yr**
1+1/3	2/3+2/3	1/3+1				
Max.						**= 7 yr**
4/7	3/7+1/7	4/7	2/7+2/7	4/7	1/7+3/7	4/7
1st year	2nd year	3rd year	4th year	5th year	6th year	7th year
1st 35%		2nd 37%	3rd 21%		4th 7%	

Table I-59: Recalculating Outlay Rates due to Schedule Risk

For 4.9 years:

Year 1 = .35 * 40/49 = 28.6%
Year 2 = .35 * 9/49 + .37 * 31/49 = 29.8%
Year 3 = .37 * 18/49 + .21 * 22/49 = 23.0%
Year 4 = .21 * 27/49 + .07 * 13/49 = 13.4%
Year 5 = .07 * 36/49 = 5.1%
Total = 100.0%

For 3 years:

Year 1 = .35 * 1 + .37 * 1/3 = 47.3%
Year 2 = .37 * 2/3 + .21 * 2/3 = 38.7%
Year 3 = .21 * 1/3 + .07 * 1 = 14.0%
Total = 100.0%

For 7 years:

Year 1 = .35 * 4/7 = 20.0%
Year 2 = .35 * 3/7 + .37 * 1/7 = 20.3%
Year 3 = .37 * 4/7 = 21.1%
Year 4 = .37 * 2/7 + .21 * 2/7 = 16.6%
Year 5 = .21 * 4/7 = 12.0%
Year 6 = .21 * 1/7 + .07 * 3/7 = 6.0%

Year 7 = .07 * 4/7 = 4.0%
Total = 100.0%

With new outlay rates it is possible to compute new indices, and thus the cost of the program according to the different schedules.

Proc. Index	4.9-year Outlay	3-year Outlay	7-year Outlay	Forecast Index	FY4 = 1.000	4.9-year Index	3-year Index	7-year Index
FY4	.286	.473	.200	89.7	1.000	.286	.473	.200
FY5	.298	.387	.203	100.0	1.115	.267	.347	.182
FY6	.230	.140	.211	111.4	1.242	.185	.113	.170
FY7	.134		.166	124.2	1.385	.097		.120
FY8	.051		.120	138.4	1.543	.033		.078
FY9			.060	154.2	1.719			.035
FY10			.040	171.8	1.915			.021
TOTAL	0.999	1.000	1.000			.868	.933	.806
Index						1.152	1.072	1.241

Table I-60: The Effect of Schedule Risk on Indices

Simply multiply the cost of the program in constant dollars ($10 million) by the index for each expected duration to arrive at the cost to be incurred according to various schedule options:

Expected (4.9 years) = $10 million * 1.152 = $11.52 million
Low (3 years) = $10 million * 1.072 = $10.72 million
High (7 years) = $10 million * 1.241 = $12.41 million

5) Inflation Forecast Risk

There are nine combinations of possible inflation outcomes according to the range of uncertainty for the FY9 and FY10 inflation forecasts. FY9 can be either 2.9%, 7.9%, or 12.9%, and FY10 can be either 3.8%, 8.8%, or 13.8%. The first step is to calculate an index for each possible combination. The combination of 2.9% in FY9 and 13.8% in FY10 is shown here, with the other combinations shown in Table I-62.

Steel Index	Outlay	Inflation	FY8 = 1.000	Index
FY8	.20		1.000	.200
FY9	.50	2.9%	1.029	.486
FY10	.30	13.8%	1.171	.256
TOTAL	1.00			.942
Index				1.062

Table I-61: Index for Steel, FY9=2.9%, FY10=13.8%

FY9	FY10	Index	Estimate	Probability	Percentile
2.9%	3.8%	1.034	$517,000	.06	.030
2.9%	8.8%	1.048	$524,000	.09	.105
2.9%	13.8%	1.062	$531,000	.15	.225
7.9%	3.8%	1.074	$537,000	.10	.350
7.9%	8.8%	1.088	$544,000	.15	.475
7.9%	13.8%	1.103	$551,500	.25	.675
12.9%	3.8%	1.112	$556,000	.04	.820
12.9%	8.8%	1.127	$563,500	.06	.870
12.9%	13.8%	1.142	$571,000	.10	.950

Table I-62: Inflation Risk Distribution

From the table, it can be seen that the minimum estimate is $517,000 and the maximum estimate is $571,000. The estimated value is determined by multiplying each possible estimate by its probability and adding the results:

Estimated value =
.06 * $517,000 + .09 * $524,000 + … + .10 * $571,000 = $544,155

Notice that the estimated value, measuring the weighted average of the estimates, is not the same as the most likely value ($551,500) or the median value ($544,000).

The percentile column in Table I-62 is taken as the midpoint for each possible outcome. In other words, it assumes a continuous distribution, with half of the estimates for a category above the mean estimate, and half below. To find the value for a particular percentile not on the table, interpolate between the percentiles above and below the target. For the 20^{th} percentile, take the value at 10.5^{th} percentile ($524,000) and the value at the 22.5^{th} percentile ($531,000) and find the amount that is proportionately as close to the upper value from the lower value as 20% is to 22.5% from 10.5%:

Proportion = (20 - 10.5) / (22.5 - 10.5) = 9.5/12 = 19/24 = .792
20^{th} Percentile = $524,000 + .792 * ($531,000 - $524,000) = $529,544

Similarly, for the 80^{th} percentile:

Proportion = (80 – 67.5) / (82 – 67.5) = 12.5/14.5 = 25/29 = .862
80^{th} percentile = $551,500 + .862 ($556,000 - $551,500) = $555,379

6) Complex Risk Application

(a) Find the expected cost of the program in then year dollars.
The expected value is determined by finding the expected values for cost risk, schedule risk, and inflation risk, and use those values to calculate the weighted index for the program.

The cost risk is found by multiplying each outcome by its probably and adding the results:

Cost risk =
(-10% * 20%) + (0% * 50%) + (10% * 20%) + (25% * 10%) = +2.5%

The schedule risk is the sum of the outcomes multiplied by their probabilities:

Schedule risk = (2.5 * 20%) + (3 * 30%) + (4 * 40%) + (5 * 10%) = 3.5 years

The inflation risk is the sum of the possible outcomes multiplied by their probabilities for each year:

FY8 = (-2% * 40%) + (0% * 40%) + (3% * 20%) = -0.2%
FY9 = (-4% * 20%) + (0% * 30%) + (3% * 50%) = +0.7%
FY10 = (-3% * 30%) + (0% * 50%) + (4% * 20%) = -0.1%
FY11 = (-1% * 10%) + (0% * 60%) + (2% * 30%) = +0.5%

Adjust the outlay profile to reflect a 3.5 year schedule and a new program cost of $1 million times 1.025, equal to $1,025,000:

FY7 = .3 * (3.0/3.5) = 25.7%
FY8 = .3 * (0.5/3.5) + .5 * (2.5/3.5) = 40.0%
FY9 = .5 * (1.0/3.5) + .2 * (2.0/3.5) = 25.7%
FY10 = .2 * (1.5/3.5) = 8.6%

The weighted index can be computed by plugging the preceding inputs into the table below:

Index	Outlay	Projected Inflation	Risk	Adjusted Inflation	FY5 = 1.000	Weighted Index
FY7	.257	5.2%		5.2%	1.000	.257
FY8	.400	7.7%	-0.2%	7.5%	1.075	.372
FY9	.257	6.5%	+0.7%	7.2%	1.152	.223
FY10	.086	9.2%	-0.1%	9.1%	1.257	.068
TOTAL	1.000					.920
Index						1.087

Table I-63: Weighted Index for Mean

The expected cost estimate in then year dollars is then the adjusted program cost ($1,025,000) multiplied by the index:

Expected cost = $1,025,000 * 1.087 = 1,114,175 TY$

(b) Find the minimum cost of the program in then year dollars.
To find the minimum cost, use the minimum cases for cost risk, schedule risk, and inflation risk. The best case for cost risk is -10%, yielding a new base of $900,000. The best case for schedule is 2.5 years, the best case for FY8 inflation is 5.7%, and the best case for FY9 inflation is 2.5%. The new outlay profile is as follows:

FY7 = .3 + .5 * (0.5/2.5) = .400
FY8 = .5 * (2.0/2.5) + .2 * (1.0/2.5) = .480
FY9 = .2 * (1.5/2.5) = .120

The weighted index for the minimum is computed in Table I-64.

Index	Outlay	Inflation	FY5 = 1.000	Weighted Index
FY7	.400	5.2%	1.000	.400
FY8	.480	5.7%	1.057	.454
FY9	.120	2.5%	1.083	.111
TOTAL	1.000			.965
Index				1.036

Table I-64: Weighted Index for Minimum, Complex Cost Example

The then year minimum cost is then calculated as:

Minimum Cost = $900,000 * 1.036 = $932,400 TY

(c) Find the 80% confidence level of the cost of the program in then year dollars.
To establish the 80% confidence level for the cost, the standard deviation is needed. To estimate the standard deviation, assume a normal distribution about the mean, take the minimum case and assume it is three standard deviations from the mean. For a normal distribution, the expected value and the mean will be the same.

This provides enough information to derive the value of the standard deviation, by subtracting the minimum from the mean and dividing by the number of standard deviations between the minimum and mean:

Standard Deviation = ($1,114,175 - $932,800) / 3 = $60,458

With this value, it is then possible to determine the cost estimate at any confidence level, again using a *z table*. The 80% confidence level for the estimate requires 0.84 standard deviations above the mean:

Estimate, 80% confidence = $1,114,175 + (0.84 * $60,458) = $1,164,960.

II. Appendix II: Sample Economy

The examples and problems in Chapters 6-8 are based on a simplified fictional future economy described here in full. The scenario is that some global catastrophe has greatly reduced the size of the U.S. economy to just 19 goods and services. But the U.S. Government and DoD structure, budget process, and inflation planning remain the same, allowing a detailed examination of all of the inflation related applications and calculations using a manageable amount of data.

The data in the tables that follow lists all of the goods and services produced in the sample economy for 10 years. During the first year there are 10 items, and every year an additional item is added, so that by year 10 there are 19 items. A subset of the 10 goods is used to compute an overall CPI, sector-specific CPI's, the GDP, and GDP deflator. Since the economy has grown and changed significantly during the first five years, the basket of goods making up the CPI is changed in FY 6, requiring a way to compare inflation between years with different baskets.

In addition to the statistics on this economy, annual forecasts of inflation are made based on the historical CPI and GDP data. The forecasts are similar to the actual inflation guidance provided by OMB and the Troika to OSD. Similarly, outlay rates were varied from year to year within a range and do not represent actual OSD rates. They mimic changes that occur from year to year in the OSD outlay rates.

Every attempt was made to make the sample economy internally consistent to provide material for examples within the text. There are idiosyncrasies introduced by having such a small sample size and increasing the relative size of the economy so quickly, including very large GDP deflator rates relative to the CPI. In addition, as sample problems created the necessity for alterations, the sample economy was not always updated, most likely leading to some mismatches among the tables. Nevertheless, the data contained herein largely corresponds with the data used in the examples and problems in the text.

Appendix II

	Year 1		Year 2		Year 3		Year 4		Year 5	
	Unit Cost	Quantity	Unit Cost	Quantity	Unit Cost	Quantity	Unit Cost	Quantity	Unit Cost	Quantity
Bananas	1.25	50000	1.30	52000	1.40	54000	1.35	55000	1.85	42000
Coconuts	2.00	40000	2.10	39000	2.15	41000	2.20	44000	2.40	47000
Wood	5.00	10000	5.25	9500	5.50	10000	5.40	10500	5.50	11000
Tourism	7.00	5000	6.85	5200	7.15	5500	7.00	5750	7.20	6000
Energy	2.50	200000	3.25	210000	2.75	220000	3.00	230000	3.80	180000
Civilian Pay	10.00	150000	11.00	160000	12.50	170000	14.00	180000	15.00	185000
Military Pay	12.00	100000	13.50	110000	15.00	120000	16.50	130000	17.50	140000
Milk	2.20	15000	2.25	17000	2.30	16000	2.25	18000	2.35	17000
Medical Care	20.00	25000	22.00	27000	25.00	28000	28.00	28000	32.00	30000
Steel	10.00	2000	12.00	2200	15.00	2500	13.00	2700	14.00	3000
Radios			24.00	3000	25.00	3300	27.00	3600	26.00	4000
Furniture					50.00	2000	48.00	2400	52.00	2700
Boats							950.00	100	1000.00	125
Bicycles									150.00	800
Roads										
Houses										
Eggs										
Bread										
Paper										

	Year 6		Year 7		Year 8		Year 9		Year 10	
	Unit Cost	Quantity	Unit Cost	Quantity	Unit Cost	Quantity	Unit Cost	Quantity	Unit Cost	Quantity
Bananas	1.70	45000	1.50	44000	1.55	48000	1.60	50000	1.65	52000
Coconuts	2.35	45000	2.20	46000	2.30	45000	2.35	47000	2.45	48000
Wood	5.60	12000	6.00	12500	5.75	14000	6.00	15000	6.30	16000
Tourism	6.80	6300	7.10	6600	7.40	6500	7.30	6750	7.50	7000
Energy	3.30	220000	3.50	240000	3.70	260000	4.00	270000	3.75	280000
Civilian Pay	14.00	190000	15.00	195000	15.00	200000	16.00	210000	17.50	200000
Military Pay	18.00	145000	18.50	150000	19.00	155000	19.00	150000	20.00	145000
Milk	2.45	17500	2.50	18000	2.70	19000	3.00	19500	3.20	20000
Medical Care	35.00	32000	37.00	33000	40.00	34000	45.00	35000	48.00	35000
Steel	16.00	3500	17.00	4000	15.00	4500	20.00	5200	18.00	6000
Radios	25.00	4500	27.00	5000	24.00	6000	22.00	7000	21.00	8000
Furniture	54.00	2600	55.00	2800	58.00	3000	60.00	3300	65.00	3500
Boats	1050.00	140	1075.00	150	1025.00	170	1000.00	160	1020.00	175
Bicycles	160.00	900	170.00	1250	165.00	1500	175.00	2000	200.00	2500
Roads	800.00	500	850.00	400	900.00	600	950.00	550	1000.00	500
Houses			5000.00	700	5500.00	900	6000.00	950	6300.00	1000
Eggs					2.50	30000	2.75	40000	3.00	50000
Bread							3.00	30000	2.75	35000
Paper									2.25	100000

Table II-1: Sample Economy Quantities and Prices

	Year 1 Quantity	Year 1 Unit Cost	Year 2 Unit Cost	Year 3 Unit Cost	Year 4 Unit Cost	Year 5 Unit Cost	Year 6 Quantity	Year 6 Unit Cost	Year 7 Unit Cost	Year 8 Unit Cost	Year 9 Unit Cost	Year 10 Unit Cost
Bananas	10	1.25	1.30	1.40	1.35	1.85	150	1.70	1.50	1.55	1.60	1.65
Coconuts	8	2.00	2.10	2.15	2.20	2.40	150	2.35	2.20	2.30	2.35	2.45
Wood	2	5.00	5.25	5.50	5.40	5.50	40	5.60	6.00	5.75	6.00	6.30
Tourism	1	7.00	6.85	7.15	7.00	7.20		6.80	7.10	7.40	7.30	7.50
Bicycles						150.00	3	160.00	170.00	175.00	190.00	200.00
	21						343					
							=Year 6 using Year 5 CPI					
Total		45.5	47.15	49.35	48.9	55.9	53.8	1311.5	1305	1332.5	1402.5	1467
CPI, AM		100.0	103.6	108.5	107.5	122.9	118.2	100.0	99.5	101.6	106.9	111.9
Inflation			3.6%	4.7%	-0.9%	14.3%	-3.8%	-3.8%	-0.5%	2.1%	5.3%	4.6%
CPI (AM), BY1		100.0	103.6	108.5	107.5	122.9		118.2	117.7	120.1	126.4	132.3
CPI (AM), BY6		84.6	87.6	91.7	90.9	103.9		100.0	99.5	101.6	106.9	111.9
CPI, GM		100.0	103.6	108.4	107.4	121.8		100.0	99.2	101.4	106.5	111.3
Inflation			3.6%	4.7%	-0.9%	13.4%		-3.5%	-0.8%	2.2%	5.1%	4.5%
Inflation w Y1 B									-3.5%	2.2%	2.4%	3.9%
CPI (GM), BY1		100.0	103.6	108.4	107.4	121.8		117.5	116.6	119.1	125.2	130.8
CPI (GM), BY6		85.1	88.1	92.2	91.4	103.6		100.0	99.2	101.4	106.5	111.3
Medical		20.00	22.00	25.00	28.00	32.00		35.00	37.00	40.00	45.00	48.00
Medical Index		100.0	110.0	125.0	140.0	160.0		175.0	185.0	200.0	225.0	240.0
Inflation			10.0%	13.6%	12.0%	14.3%		9.4%	5.7%	8.1%	12.5%	6.7%
Energy		2.50	3.25	2.75	3.00	3.80		3.30	3.50	3.70	4.00	3.75
Energy Index		100.0	130.0	110.0	120.0	152.0		132.0	140.0	148.0	160.0	150.0
Inflation			30.0%	-15.4%	9.1%	26.7%		-13.2%	6.1%	5.7%	8.1%	-6.3%
Civ. Pay		10.00	11.00	12.50	14.00	15.00		14.00	15.00	15.00	16.00	17.50
Civ. Pay Index		100.0	110.0	125.0	140.0	150.0		140.0	150.0	150.0	160.0	175.0
Inflation			10.0%	13.6%	12.0%	7.1%		-6.7%	7.1%	0.0%	6.7%	9.4%
Mil. Pay		12.00	13.50	15.00	16.50	17.50		18.00	18.50	19.00	19.00	20.00
Mil. Pay Index		100.0	112.5	125.0	137.5	145.8		150.0	154.2	158.3	158.3	166.7
Inflation			12.5%	11.1%	10.0%	6.1%		2.9%	2.8%	2.7%	0.0%	5.3%
Steel		10.00	12.00	15.00	13.00	14.00		16.00	17.00	15.00	20.00	18.00
Steel Index		100.0	120.0	150.0	130.0	140.0		160.0	170.0	150.0	200.0	180.0
Inflation			20.0%	25.0%	-13.3%	7.7%		14.3%	6.3%	-11.8%	33.3%	-10.0%

Table II-2: Sample Economy CPI

Appendix II

	Year 1				Year 2				Year 3			
	Unit Cost	**Quantity**	**Nominal**	**Real, BY1**	**Unit Cost**	**Quantity**	**Nominal**	**Real, BY1**	**Unit Cost**	**Quantity**	**Nominal**	**Real, BY2**
Bananas	1.25	50000	62500	62500	1.30	52000	67600	65000	1.40	54000	75600	70200
Coconuts	2.00	40000	80000	80000	2.10	39000	81900	78000	2.15	41000	88150	86100
Wood	5.00	10000	50000	50000	5.25	9500	49875	47500	5.50	10000	55000	52500
Tourism	7.00	5000	35000	35000	6.85	5200	35620	36400	7.15	5500	39325	37675
Energy	2.50	200000	500000	500000	3.25	210000	682500	525000	2.75	220000	605000	715000
Civilian Pay	10.00	150000	1500000	1500000	11.00	160000	1760000	1600000	12.50	170000	2125000	1870000
Military Pay	12.00	100000	1200000	1200000	13.50	110000	1485000	1320000	15.00	120000	1800000	1620000
Milk	2.20	15000	33000	33000	2.25	17000	38250	37400	2.30	16000	36800	36000
Medical Care	20.00	25000	500000	500000	22.00	27000	594000	540000	25.00	28000	700000	616000
Steel	10.00	2000	20000	20000	12.00	2200	26400	22000	15.00	2500	37500	30000
Radios			0	0	24.00	3000	72000	0	25.00	3300	82500	79200
Furniture			0	0			0	0	50.00	2000	100000	0
Boats			0	0			0	0			0	0
Bicycles			0	0			0	0			0	0
Roads			0	0			0	0			0	0
Houses			0	0			0	0			0	0
Eggs			0	0			0	0			0	0
Bread			0	0			0	0			0	0
Paper			0	0			0	0			0	0
GDP			3980500	3980500			4893145	4271300			5744875	5212675
GDP Deflator								14.6%				10.2%
CPI								3.6%				4.7%
GDP Deflator Index				100.0				114.6				126.3

	Year 4				Year 5				Year 6			
	Unit Cost	**Quantity**	**Nominal**	**Real, BY3**	**Unit Cost**	**Quantity**	**Nominal**	**Real, BY4**	**Unit Cost**	**Quantity**	**Nominal**	**Real, BY5**
Bananas	1.35	55000	74250	77000	1.85	42000	77700	56700	1.70	45000	76500	83250
Coconuts	2.20	44000	96800	94600	2.40	47000	112800	103400	2.35	45000	105750	108000
Wood	5.40	10500	56700	57750	5.50	11000	60500	59400	5.60	12000	67200	66000
Tourism	7.00	5750	40250	41112.5	7.20	6000	43200	42000	6.80	6300	42840	45360
Energy	3.00	230000	690000	632500	3.80	180000	684000	540000	3.30	220000	726000	836000
Civilian Pay	14.00	180000	2520000	2250000	15.00	185000	2775000	2590000	14.00	190000	2660000	2850000
Military Pay	16.50	130000	2145000	1950000	17.50	140000	2450000	2310000	18.00	145000	2610000	2537500
Milk	2.25	18000	40500	41400	2.35	17000	39950	38250	2.45	17500	42875	41125
Medical Care	28.00	28000	784000	700000	32.00	30000	960000	840000	35.00	32000	1120000	1024000
Steel	13.00	2700	35100	40500	14.00	3000	42000	39000	16.00	3500	56000	49000
Radios	27.00	3600	97200	90000	26.00	4000	104000	108000	25.00	4500	112500	117000
Furniture	48.00	2400	115200	120000	52.00	2700	140400	129600	54.00	2600	140400	135200
Boats	950.00	100	95000	0	1000.00	125	125000	118750	1050.00	140	147000	140000
Bicycles			0	0	150.00	800	120000	0	160.00	900	144000	135000
Roads			0	0			0	0	800.00	500	400000	0
Houses			0	0			0	0			0	0
Eggs			0	0			0	0			0	0
Bread			0	0			0	0			0	0
Paper			0	0			0	0			0	0
GDP			6790000	6094862.5			7734550	6975100			8451065	8167435
GDP Deflator				11.4%				10.9%				3.5%
CPI				-0.9%				13.4%				-3.5%
GDP Deflator Index				140.7				156.0				161.4

Table II-3: Sample Economy GDP, FY1-6

	Year 7				Year 8			
	Unit Cost	**Quantity**	**Nominal**	**Real, BY6**	**Unit Cost**	**Quantity**	**Nominal**	**Real, BY7**
Bananas	1.50	44000	66000	74800	1.55	48000	74400	72000
Coconuts	2.20	46000	101200	108100	2.30	45000	103500	99000
Wood	6.00	12500	75000	70000	5.75	14000	80500	84000
Tourism	7.10	6600	46860	44880	7.40	6500	48100	46150
Energy	3.50	240000	840000	792000	3.70	260000	962000	910000
Civilian Pay	15.00	195000	2925000	2730000	15.00	200000	3000000	3000000
Military Pay	18.50	150000	2775000	2700000	19.00	155000	2945000	2867500
Milk	2.50	18000	45000	44100	2.70	19000	51300	47500
Medical Care	37.00	33000	1221000	1155000	40.00	34000	1360000	1258000
Steel	17.00	4000	68000	64000	15.00	4500	67500	76500
Radios	27.00	5000	135000	125000	24.00	6000	144000	162000
Furniture	55.00	2800	154000	151200	58.00	3000	174000	165000
Boats	1075.00	150	161250	157500	1025.00	170	174250	182750
Bicycles	170.00	1250	212500	200000	165.00	1500	247500	255000
Roads	850.00	400	340000	320000	900.00	600	540000	510000
Houses	5000.00	700	3500000	0	5500.00	900	4950000	4500000
Eggs			0	0	2.50	30000	75000	0
Bread			0	0			0	0
Paper			0	0			0	0
GDP			12665810	8736580			14997050	14235400
GDP Deflator				45.0%				5.4%
CPI				-0.8%				2.2%
GDP Deflator Index				234.0				246.5

	Year 9				Year 10			
	Unit Cost	**Quantity**	**Nominal**	**Real, BY8**	**Unit Cost**	**Quantity**	**Nominal**	**Real, BY9**
Bananas	1.60	50000	80000	77500	1.65	52000	85800	83200
Coconuts	2.35	47000	110450	108100	2.45	48000	117600	112800
Wood	6.00	15000	90000	86250	6.30	16000	100800	96000
Tourism	7.30	6750	49275	49950	7.50	7000	52500	51100
Energy	4.00	270000	1080000	999000	3.75	280000	1050000	1120000
Civilian Pay	16.00	210000	3360000	3150000	17.50	200000	3500000	3200000
Military Pay	19.00	150000	2850000	2850000	20.00	145000	2900000	2755000
Milk	3.00	19500	58500	52650	3.20	20000	64000	60000
Medical Care	45.00	35000	1575000	1400000	48.00	35000	1680000	1575000
Steel	20.00	5200	104000	78000	18.00	6000	108000	120000
Radios	22.00	7000	154000	168000	21.00	8000	168000	176000
Furniture	60.00	3300	198000	191400	65.00	3500	227500	210000
Boats	1000.00	160	160000	164000	1020.00	175	178500	175000
Bicycles	175.00	2000	350000	330000	200.00	2500	500000	437500
Roads	950.00	550	522500	495000	1000.00	500	500000	475000
Houses	6000.00	950	5700000	5225000	6300.00	1000	6300000	6000000
Eggs	2.75	40000	110000	100000	3.00	50000	150000	137500
Bread	3.00	30000	90000	0	2.75	35000	96250	105000
Paper			0	0	2.25	100000	225000	0
GDP			16641725	15524850			18003950	16889100
GDP Deflator				7.2%				6.6%
CPI				5.1%				4.5%
GDP Deflator Index				264.2				281.7

Table II-4: Sample Economy GDP, FY7-10

	FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	FY9	FY10	FY11	FY12
Dec Y2												
Procurement		14.6%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%				
Index		70.3	80.5	89.7	100.0	111.4	124.2	138.4				
Military Pay		12.5%	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%				
Index		75.7	85.2	92.3	100.0	108.3	117.4	127.1				
Civilian Pay		10.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%				
Index		82.5	90.7	95.2	100.0	105.0	110.3	115.8				
Energy		30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%				
Index		45.5	59.2	76.9	100.0	130.0	169.0	219.7				
Medical		10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%				
Index		75.1	82.6	90.9	100.0	110.0	121.0	133.1				
Steel		20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%				
Index		57.9	69.4	83.3	100.0	120.0	144.0	172.8				
Dec Y3												
Procurement		11.4%	10.2%	10.6%	7.8%	7.8%	7.8%	7.8%	7.8%			
Index		68.3	76.1	83.9	92.8	100.0	107.8	116.1	125.1			
Military Pay		8.3%	11.1%	10.2%	7.9%	7.9%	7.9%	7.9%	7.9%			
Index		69.9	75.7	84.1	92.7	100.0	107.9	116.4	125.6			
Civilian Pay		5.0%	13.6%	10.8%	4.8%	4.8%	4.8%	4.8%	4.8%			
Index		72.2	75.8	86.1	95.4	100.0	104.8	109.9	115.2			
Energy		30.0%	-15.4%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%			
Index		91.4	118.8	100.5	100.3	100.0	99.7	99.5	99.2			
Medical		10.0%	13.6%	12.4%	12.4%	12.4%	12.4%	12.4%	12.4%			
Index		63.3	69.6	79.1	88.9	100.0	112.4	126.4	142.1			
Steel		20.0%	25.0%	23.3%	23.3%	23.3%	23.3%	23.3%	23.3%			
Index		43.8	52.6	65.7	81.1	100.0	123.3	152.1	187.6			
Dec Y4												
Procurement			5.9%	11.4%	9.6%	9.6%	8.7%	8.7%	8.7%	8.7%		
Index			70.6	74.8	83.3	91.3	100.0	108.7	118.1	128.3		
Military Pay			7.7%	10.0%	9.2%	9.0%	7.5%	7.5%	7.5%	7.5%		
Index			70.9	76.4	84.0	91.8	100.0	107.5	115.6	124.3		
Civilian Pay			4.8%	12.0%	9.6%	8.4%	7.0%	7.0%	7.0%	7.0%		
Index			71.7	75.1	84.2	92.2	100.0	107.0	114.4	122.4		
Energy			-15.4%	9.1%	0.9%	4.4%	4.4%	4.4%	4.4%	4.4%		
Index			102.8	87.0	94.9	95.8	100.0	104.4	109.0	113.8		
Medical			13.6%	12.0%	12.5%	12.2%	12.2%	12.2%	12.2%	12.2%		
Index			62.2	70.7	79.2	89.1	100.0	112.2	125.9	141.3		
Steel			25.0%	-13.3%	-0.6%	5.0%	5.0%	5.0%	5.0%	5.0%		
Index			88.4	110.5	95.8	95.2	100.0	105.0	110.3	115.8		
Dec Y5												
Procurement				9.5%	10.9%	10.4%	9.6%	9.5%	9.4%	9.4%	9.4%	
Index				68.0	74.5	82.6	91.2	100.0	109.4	119.7	131.0	
Military Pay				7.1%	6.1%	6.4%	6.7%	6.9%	7.2%	7.2%	7.2%	
Index				77.5	83.0	88.1	93.7	100.0	107.2	114.9	123.1	
Civilian Pay				9.1%	7.1%	7.8%	7.4%	7.0%	5.8%	5.8%	5.8%	
Index				73.9	80.6	86.4	93.1	100.0	105.8	112.0	118.6	
Energy				9.1%	26.7%	20.8%	13.8%	13.3%	13.3%	13.3%	13.3%	
Index				52.6	57.4	72.7	87.9	100.0	113.3	128.4	145.5	
Medical				12.0%	14.3%	13.5%	13.4%	13.0%	13.0%	13.0%	13.0%	
Index				60.7	68.0	77.7	88.2	100.0	113.0	127.8	144.4	
Steel				-13.3%	7.7%	0.7%	3.6%	6.1%	6.1%	6.1%	6.1%	
Index				102.7	89.0	95.9	96.6	100.0	106.1	112.5	119.4	
Dec Y6												
Procurement					10.6%	3.5%	5.8%	6.8%	7.1%	7.4%	9.7%	9.7%
Index					77.3	85.5	88.4	93.6	100.0	107.4	117.9	129.4
Military Pay					6.7%	2.9%	4.1%	4.8%	5.3%	5.7%	5.8%	5.8%
Index					83.5	89.1	91.6	95.4	100.0	105.7	111.9	118.4
Civilian Pay					4.2%	-6.7%	-3.1%	-0.4%	0.9%	1.7%	7.9%	7.9%
Index					106.6	111.0	103.6	100.4	100.0	101.7	109.7	118.4
Energy					26.7%	-13.2%	0.1%	3.8%	3.0%	4.5%	4.5%	4.5%
Index					87.5	110.8	96.2	96.3	100.0	104.5	109.2	114.1
Medical					14.3%	9.4%	11.0%	11.4%	11.8%	11.8%	11.8%	11.8%
Index					64.7	73.9	80.8	89.7	100.0	111.8	125.0	139.8
Steel					7.7%	14.3%	12.1%	7.5%	7.9%	8.8%	8.8%	8.8%
Index					67.4	72.6	83.0	93.0	100.0	108.8	118.4	128.8

Table II-5: Sample Economy Forecasts, Y2-Y6

FY5 Indices

	Method 1 (Navy, AF)	Method 2 (Army)
Procurement	1.1255	1.1377
Ships	1.2267	1.2461
Aircraft	1.1488	1.1638
Weapons	1.1370	1.1507
Vehicles	1.1701	1.1804
Ammunition	1.1579	1.1672
Military Pay	1.0000	1.0000
Civilian Pay	1.0000	1.0000
Energy	1.0000	1.0000
Medical	1.0229	1.0254
Military Personnel	1.0228	1.0275
Civilian Personnel	1.0228	1.0275
O&M	1.0873	1.0989
Steel	1.2130	1.2506

FY6 Indices

	Method 1 (Navy, AF)	Method 2 (Army)
Procurement	1.0766	1.0818
Ships	1.1481	1.1553
Aircraft	1.1101	1.1155
Weapons	1.0990	1.1068
Vehicles	1.1130	1.1176
Ammunition	1.0961	1.1014
Military Pay	1.0000	1.0000
Civilian Pay	1.0000	1.0000
Energy	1.0000	1.0000
Medical	1.0394	1.0444
Military Personnel	1.0144	1.0164
Civilian Personnel	1.0144	1.0164
O&M	1.0567	1.0617
Steel	1.2161	1.2628

FY7 Indices

	Method 1 (Navy, AF)	Method 2 (Army)
Procurement	1.0880	1.0942
Ships	1.1638	1.1757
Aircraft	1.1016	1.1078
Weapons	1.1171	1.1257
Vehicles	1.1250	1.1308
Ammunition	1.1163	1.1208
Military Pay	1.0000	1.0000
Civilian Pay	1.0000	1.0000
Energy	1.0000	1.0000
Medical	1.0263	1.0299
Military Personnel	1.0164	1.0188
Civilian Personnel	1.0164	1.0188
O&M	1.0629	1.0689
Steel	1.0515	1.0536

FY8 Indices

	Method 1 (Navy, AF)	Method 2 (Army)
Procurement	1.1137	1.1226
Ships	1.1783	1.1923
Aircraft	1.1162	1.1241
Weapons	1.1314	1.1434
Vehicles	1.1494	1.1563
Ammunition	1.1191	1.1272
Military Pay	1.0000	1.0000
Civilian Pay	1.0000	1.0000
Energy	1.0000	1.0000
Medical	1.0362	1.0414
Military Personnel	1.0208	1.0245
Civilian Personnel	1.0208	1.0245
O&M	1.0810	1.0899
Steel	1.0741	1.0777

FY9 Indices

	Method 1 (Navy, AF)	Method 2 (Army)
Procurement	1.0769	1.0831
Ships	1.1621	1.1752
Aircraft	1.0929	1.0997
Weapons	1.1148	1.1238
Vehicles	1.1245	1.1312
Ammunition	1.0992	1.1049
Military Pay	1.0000	1.0000
Civilian Pay	1.0000	1.0000
Energy	1.0000	1.0000
Medical	1.0388	1.0434
Military Personnel	1.0145	1.0166
Civilian Personnel	1.0145	1.0166
O&M	1.0568	1.0625
Steel	1.0833	1.0895

FY10 Indices

	Method 1 (Navy, AF)	Method 2 (Army)
Procurement	1.2026	1.2462
Ships	1.4284	1.4856
Aircraft	1.3065	1.3511
Weapons	1.2730	1.3167
Vehicles	1.3051	1.3400
Ammunition	1.2823	1.3104
Military Pay	1.0000	1.0000
Civilian Pay	1.0000	1.0000
Energy	1.0000	1.0000
Medical	1.0225	1.0251
Military Personnel	1.0349	1.0492
Civilian Personnel	1.0349	1.0492
O&M	1.1365	1.1749
Steel	1.0778	1.0840

Table II-6: Sample Economy Indices

FY3 Outlay Rates

	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Total
Procurement	30	40	20	10				100
Ships	15	25	15	15	10	10	10	100
Aircraft	20	40	25	5	5	5		100
Weapons	25	35	20	10	5	5		100
Vehicles	10	50	25	5	5	5		100
Ammunition	15	50	25	5	5			100
Military Pay	100							100
Civilian Pay	100							100
Energy	100							100
Medical	75	20	5					100
Military Personnel	86	8	4	2				100
Civilian Personnel	86	8	4	2				100
O&M	48.5	30	14.5	7				100

FY4 Outlay Rates

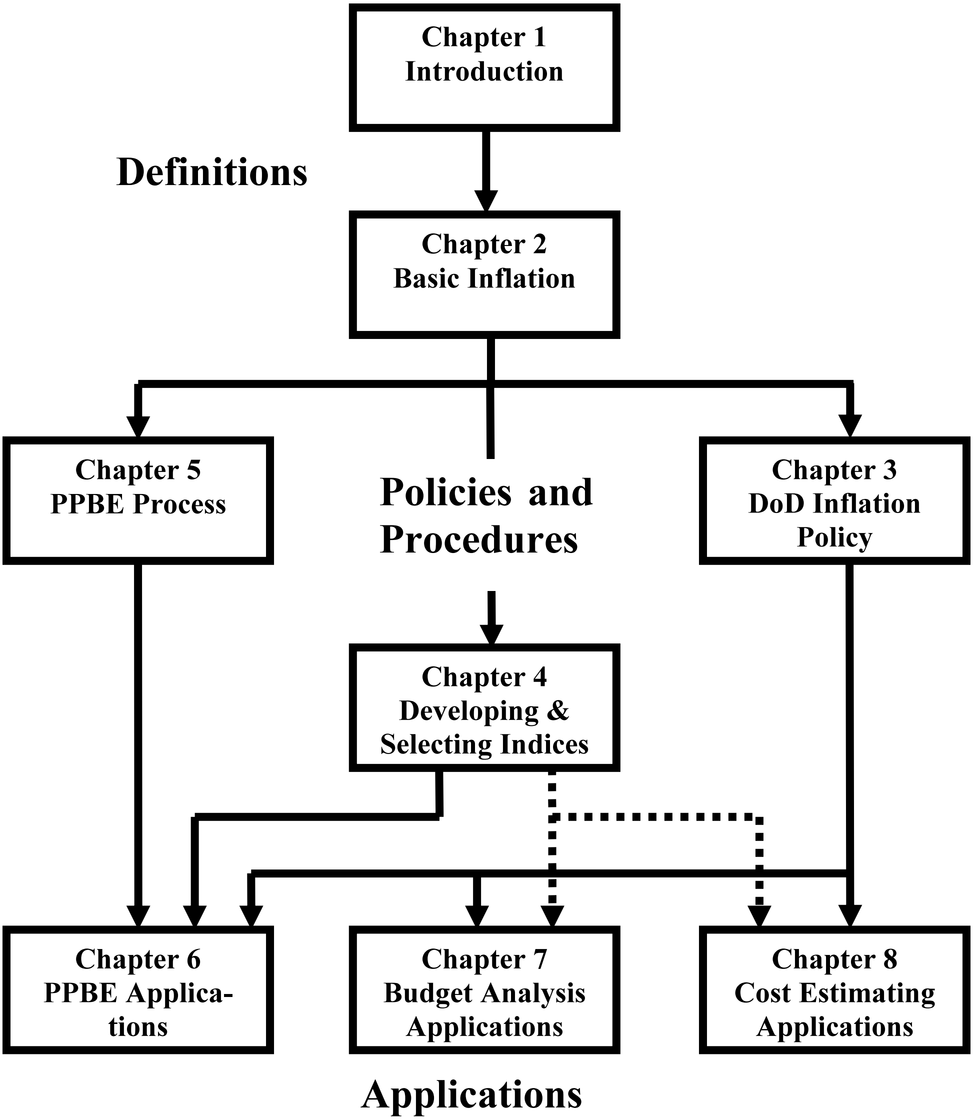
	Y4	Y5	Y6	Y7	Y8	Y9	Y10	
Procurement	35	37	21	7				100
Ships	10	27	11	15	13	13	11	100
Aircraft	19	44	23	7	4	3		100
Weapons	30	30	16	10	7	7		100
Vehicles	13	54	22	5	3	3		100
Ammunition	20	51	20	4	5			100
Military Pay	100							100
Civilian Pay	100							100
Energy	100							100
Medical	71	24	5					100
Military Personnel	87	7.4	4.2	1.4				100
Civilian Personnel	87	7.4	4.2	1.4				100
O&M	51.6	28.3	15.2	4.9				100

FY5 Outlay Rates

	Y5	Y6	Y7	Y8	Y9	Y10	Y11	
Procurement	27	45	15	13				100
Ships	16	21	14	19	7	11	12	100
Aircraft	25	35	21	6	7	6		100
Weapons	28	34	24	8	3	3		100
Vehicles	7	55	20	4	7	7		100
Ammunition	11	50	28	5	6			100
Military Pay	100							100
Civilian Pay	100							100
Energy	100							100
Medical	79	17	4					100
Military Personnel	85.4	9	3	2.6				100
Civilian Personnel	85.4	9	3	2.6				100
O&M	46.8	33.2	10.9	9.1				100

Table II-7: Sample Economy Outlay Rates, FY3-5

Guide to Using Handbook



Topic	**Equation**	Page
Inflation	Inflation = (P2*q/P1*q)-1	Pg. 9
Average Annual Inflation	AAI =$(\text{CPI (Year Y) / CPI (Year X)})^{(1/(Y-X))}$ - 1	Pg. 66
Purchasing Power of Then Year Dollars	TY$= (BY$)/(1 + Cumulative Inflation)	Pg. 12
Converting Constant Year Dollars to Then Year Dollars	TY$ = CY$ * (TY Index/CY Index)	Pg 45
Converting Then Year Dollars to Constant Year Dollars	CY$ = TY$ * (CY Index/TY Index)	pg 45
Composite Rate	CR = Rate 1 * Proportion 1 + Rate 2 * Proportion 2 + … + Rate i * Proportion i	Pg 54
Raw Index	$RI_{i+1} = RI_i$ * (1 + Inflation Rate, Year i)	Pg 9
Weighted Index	$WI = (1 / (E_1 / I_1 + E_2 / I_2 + \ldots + E_i / I_i))$	Pg 60
CPI(Arithmetic Mean)	CPI (Arithmetic Mean) = (Basket Price (Year i) / Basket Price (Year j))*100	Pg. 65
Inflation (Geometric Mean) (CPI)	Inflation (Geometric Mean) = $(p_1(Y)/p_1(X))^{\text{Price Share 1 (BY)}} * (p_2(Y)/p_2(X))^{\text{Price Share 2 (BY)}} * \ldots * (p_i(Y)/p_i(X))^{\text{Price Share i (BY)}}$ – 1	Pg. 67
Consumer Price Index (New Base Year) (Common Market Basket)	CPI (New Base Year) = $(CPI_{OLD}$ * 100) / CPI_{OLD} (New Base Year)	Pg. 70
Nominal GDP	Nominal GDP = $q_1(x) * p_1(x) + q_2(x) * p_2(x) + \ldots + q_i(x) * p_i(x)$	Pg. 73
Real GDP	Real GDP = $q_1(x) * p_1(x-1) + q_2(x) * p_2(x-1) + \ldots + q_i(x) * p_i(x-1)$	Pg. 73
GDP Deflator	Nominal GDP/ Real GDP	Pg. 74
Net Present Value	NPV= Σ(Benefits / Index) – Σ(Costs / Index)	Pg. 84

Typical Problems, Examples, and Concepts

Problem	Discussion/Example	Concept Introduction
Chapter 6		
Current Year / Then Year Dollar Conversions	Section 6.2, p. 44	Sections 2.1
Applying Indices and Outlays to Budgets	Section 6.3, p. 47	Section 5.2.3
Applying Revised Inflation Assumptions	Section 6.3, p. 47	Section 5.2.5
Pay Raise Conversions	Section 6.4, p. 51	Section 4.4
Composite Inflation Rates	Section 6.5, p. 53	Sections 3.2, 4.7
Outlay Rates	Section 6.6, p. 55	Section 2.5
Calculating Outlay Weighted Indices	Section 6.7, p. 58	Sections 2.5
Calculating CPI (Arithmetic Mean and Geometric Mean)	Section 6.10.1, p. 64	Sections 4.3
Changing the CPI Basket	Section 6.10.1, p. 64	Sections 4.3
Calculating GDP	Section 6.10.2, p. 72	Sections 4.2
Chapter 7		
Normalizing Historical Data	Section 7.2, p. 76	Section 2.1
Evaluating Budget Shares	Section 7.3, p. 79	Section 5.2
Comparing Productivity	Section 7.4, p. 80	Section 5.2.4
Comparing Forecasts and Actuals	Section 7.5, p. 83	Section 5.2.5
Net Present Value	Section 7.6, p. 84	Section 2.2.1
Chapter 8		
Cost Estimating Relationships	Section 8.2, p. 93	Section 5.1.1
Constant Year / Then Year Dollar Conversions	Section 8.3, p. 95	Section 2.1
Cost Risk	Section 8.4, p. 97	Section 3.1.2
Schedule Risk	Section 8.5, p. 98	Section 3.1.2
Inflation Forecast Risk	Section 8.6, p. 100	Section 3.1.2
Complex Risk	Section 8.7, p. 101	Section 3.1.2

Acronyms

Acronym	**Meaning**
AFMC/FM	Air Force Material Command Financial Management
APA	Procurement of Aircraft
AWRI	Average of Weighted Relatives Index
BA	Budget Authority
BEA	Bureau of Economic Analysis
BGM	Budget Guidance Memorandum
BLS	Bureau of Labor Statistics'
CEA	Council of Economic Advisers
CER	Cost Estimating Relationships
CES	Current Employment Statistics
CES	Consumer Expenditure Survey
COLA	Cost-of Living Adjustments
CPI	Consumer Price Index
DFARS	Defense Federal Acquisition Regulation Supplement
DHP	Defense Health Program
DoD	Department of Defense
DRU	Direct Reporting Units
ECI	Employment Cost Index
EIA	Energy Information Administration
EPA	Economic Price Adjustment
FAR	Federal Acquisition Regulation
FCCOM	Facilities Capital Cost of Money
FOA	Field Operating Agencies
FYDP	Future Years Defense Program
GDP	Gross Domestic Product
MAJCOM	Major Commands
MCA	Military Construction, Army
MIPA	Procurementt of Missiles
NPV	Net Present Value
O&M	Operations & Maintenance

OMA	Operation and Maintenance, Army
OMB	Office of Management and Budget
OUSD	Office of the Undersecretary of Defense
OUSDC	Office of the Under Secretary of Defense Comptroller
PA	Procurement Appropriations
PB	President's Budget
PBD	Program Budget Decisions
POL	petroleum, oil, lubricants
POM	Program Objective Memoranda
PPBE	Planning Programming Budgeting and Execution
PPI	Producer Price Index
RAC	Refiners' Acquisition Cost
RDT&E	Research, Development, Test and Evaluation
ROM	Rough Order of Magnitude
RWAI	Relative of Weighted Aggregates Index
SAF/FMC	Deputy Assistant Secretary of the Air Force, Cost and Economics
SAG	Subactivity Groups
SIC	Standard Industrial Classification
SPO	System Program Office
SPO	Air Force Material Command Financial Management
TOA	Total Obligation Authority
WTCV	Weapons and Tracked Combat Vehicles

Glossary

Term	Definition
Base Year	A specific year used as a benchmark in measuring financial or economic data.
Base Year Dollars	Dollars that are directly comparable to the Current Dollars for a given year. Base Year Dollars are also known as constant dollars.
Budget Authority	Authority provided by law to enter into obligations that will result in outlays of Federal funds
Constant Year Dollars	Dollars that are directly comparable to the Current Dollars for a given year. Constant Dollars are also known as Base Year dollars.
Consumer Price Index	An index of prices used to measure the change in the cost of basic goods and services in comparison with a fixed base period
Cost risk	Budget overruns or shortfalls independent of the schedule of the program, which also affects cost, and the risk that the inflation rate may differ from the forecast.
Current Year Dollars	The value of dollars that actually make the transaction. Also known as Then Year Dollars.
Deflation	A persistent fall in the general price level of goods and services
Depreciation	A noncash expense that reduces the value of an asset as a result of wear and tear, age, or obsolescence.
Discount Rate	The interest rate used in discounting future cash flows
Exchange Rates	Rate at which one currency may be converted into another.
Facilities Capital Cost of Money (FCCOM)	The fee directed by the Federal Acquisition Regulation (FAR) and Defense Federal Acquisition Regulation Supplement (DFARS) to compensate government contractors for investments in capital infrastructure that improve on the capability of the contractor.

Forecast	Estimated future trends produced examining and analyzing available information
Gross Domestic Product	The total market value of all final goods and services produced in a country in a given year, equal to total consumer, investment and government spending, plus the value of exports, minus the value of imports.
Gross Domestic Product Deflator	the GDP measured in current dollars divided by the GDP measured in constant dollars.
Inflation	A sustained rise in the general price level, or the proportionate rate of increase in the general price level per unit of time.
Inflation Index	Accounts for the change in prices over time
Inflation Risk	Additional cost attributed to the risk in a greater than forcasted inflation rate
Interest	The fee that someone will pay to borrow money over a period of time.
Interest Rates	A rate which is charged or paid for the use of money.
Mean	The average value of a set of numbers.
Net Present Value	The present value of an investment's future net cash flows minus the initial investment.
Nominal GDP	Measures the value of everything produced in an economy by adding up the value of all the goods and services at current prices. It is also known as current GDP.
Outlay Rate	The percent of the total cost of a program to be spent in a given year, with the corresponding inflation assumptions applied to that year
Outlays	A expenditure
Paasche index	Compares the cost of purchasing the current basket of goods and services with the cost of purchasing the same basket in an earlier period.

Real GDP	Measures the quantity of goods and services produced by holding prices constant from a base year and only adjusting for changes in the amount of goods and services produced.
Schedule Risk	Additional cost attributed to the risk in a slip in schedule
Standard Deviation	A measure of the dispersion or variation in a distribution, equal to the square root of the arithmetic mean of the squares of the deviations from the arithmetic mean
Standard Error	The standard deviations of the sample in a frequency distribution, obtained by dividing the standard deviation by the total number of cases in the frequency distribution.
Then Year Dollars	See Current Year Dollars
Total Obligation Authority	Is the amount that a DoD component can obligate (spend) during the year.
Troika	A cooperative effort of the Office of Management and Budget (OMB), the Council of Economic Advisors (CEA), and the Department of Treasury which produces a six-year economic forecast, which includes projected inflation.

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