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New Approaches to Defense Inflation and Discounting

Kathryn Connor, James Dryden

RAND CORPORATION

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New Approaches to Defense Inflation and Discounting

Kathryn Connor, James Dryden

Prepared for the Office of the Secretary of Defense

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Preface

The cost of operating and sustaining ground vehicles appears to be growing over time, and for new acquisitions there is concern that maintenance costs will exceed expectations. The RAND Corporation is assisting the Office of the Secretary of Defense Cost Assessment and Program Evaluation (CAPE) in determining whether existing Army inflation indices for operations and sustainment are appropriate for future cost estimates. This information will inform CAPE's review of future ground systems. The study reported here also addresses discounting, since the treatment of the time value of money in decisionmaking diminishes the importance of the operating and support costs of a system. Alternative ways to deal with this bias are addressed.

This research was sponsored by CAPE and conducted within the Acquisition Technology Policy Center of the RAND National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, the Unified Combatant Commands, the Navy, the Marine Corps, the defense agencies, and the defense Intelligence Community.

For more information on the RAND Acquisition and Technology Policy Center, see or contact the director (contact information is provided on the web page).

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Summary

Department of Defense (DoD) cost analysts must have correct information to generate operations and maintenance (O&M) estimates to support effective decisionmaking. Uniquely positioned under the 2009 Weapon Systems Acquisition Reform Act (WSARA) to improve and support DoD cost analysis, the Office of Cost Assessment and Program Evaluation (CAPE) within the Office of the Secretary of Defense asked RAND to assess O&M costs associated with several ground vehicles. The RAND researchers perceived a related question that also needed to be addressed: How well are current inflation indices and discount rates serving DoD weapon-system program management today?

Inflation indices and discount rates are necessary tools in DoD's acquisition process, as the final selection of a system is partially based on potential increases in sustainment costs (inflation) and the present value of future costs (discounting). This study assesses the accuracy of the inflation indices and the benefits of the policy guiding discounting and offers recommendations that may assist CAPE in supporting the work of weapon-system program cost analysts.

Inflation Indices Do Not Reflect All Sustainment Realities

Cost estimators rely on inflation indices to normalize data from disparate time periods. Inflation indices built for DoD use very broad categories that include O&M as well as manpower, procurement, and research and development. This study investigates inflation rates for parts for the Abrams tank, the Bradley armored personnel carrier (APC), the Stryker armored fighting vehicle, and the high-mobility multipurpose wheeled vehicle (HMMWV), using the Army's operations and support (O&S) cost system, the Operating and Support Management Information System (OSMIS), parts records, and other sources. For brevity this document presents results for two of these programs, the Abrams and Bradley. Different methods are used to generate inflation rates over the 2001–2010 time period, including the Marshall-Edgeworth inflation index, in which National Item Identification Numbers (NIINs) are weighted by the frequency with which parts are purchased, for those parts purchased in every year, over the entire period of interest. Another method is the geometric-mean index, in which a base-year

price share is created for each item in the period of interest. For both approaches, the indices we present include NIINs that are demanded in every year of the 10-year period. If an analyst picked a shorter period of interest, it is likely that more parts would be captured every year in the data, as some parts have an inconsistent demand history. The economists who designed the revised Consumer Price Index (CPI) in 1998 used the geometric-mean approach because it allows for the natural substitution of goods. However, this approach may lead to chronic underestimation of parts costs for programs if substitutions for less-expensive parts cannot be made as prices rise.

Figure S.1 compares the results of using the two indices to estimate inflation for the Bradley APC, using the Army Master Data File (AMDF) price, which considers primarily reparable parts, including track, sights/scopes, circuit cards, transmissions, and engines.

The figure illustrates the cumulative effect of building several years of inflation upon one another to show overall price changes. The estimates using the Marshall-Edgeworth (or "basket of goods") index are higher than those using the geometric-mean approach, as anticipated. The "basket of goods" approach is preferred for parts inflation, as DoD has limited ability to substitute parts. Figure S.1 also shows that the growth rates vary widely from year to year.

The Bradley inflation rates estimated using the Marshall-Edgeworth method are different from those outlined in the official Army O&M budget inflation in the Naval Center for Cost Analysis (NCCA) 2012 version of the inflation calculator and the published DoD National Defense Budget Estimates (Green Book) inflation index.

Figure S.1
Inflation of Bradley APC, Calculated with Marshall-Edgeworth and Geometric-Mean Inflation Indices

RAND *RR237-S.1*

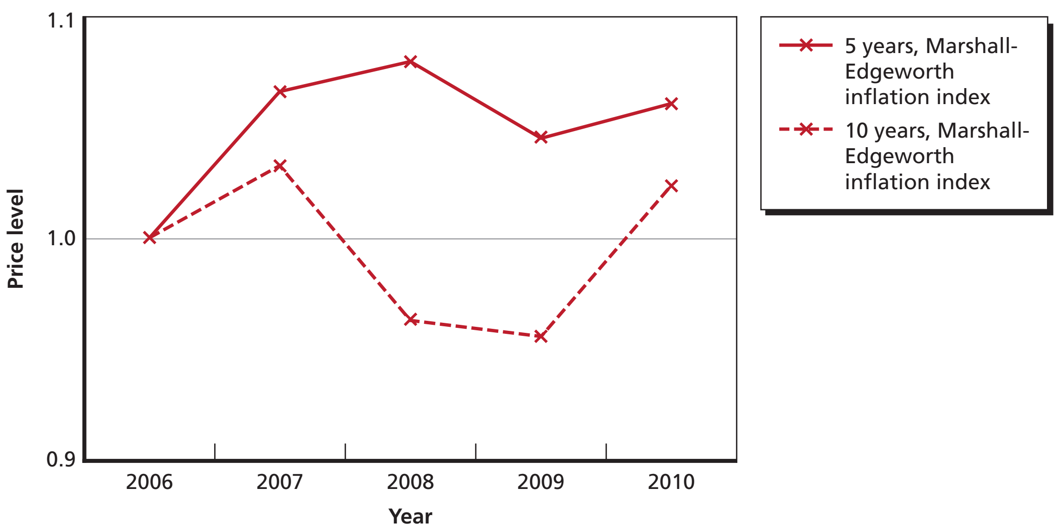
The estimates made using the geometric-mean index are close to the official inflation prediction.

The desire to capture more parts than are reflected in the 10-year indices and to show changes in parts as a result of obsolescence and modifications results from the expectation that parts used in every year of a shorter period of time might capture more variation of interest. Estimators may want to use information provided in the FEDLOG data system, which indicates when parts have been modified or upgraded.[1] The inflation picture changes when a constant basket of goods is observed over a shorter period of time, as shown in Figure S.2. The larger set of NIINs needed in a 5-year period results in a different view of inflation than that calculated with the 10-year indices. The 10-year-indices data are the same as those used in Figure S.1, but they have been rebaselined to 2006 for comparison with the 5-year data.

Inflation for more-recent parts shows a different pattern from that reflected in the 10-year index. The cumulative difference between the estimates from 2006 to 2010 is 3.5 percent. This result suggests that cost analysts should consider trends in recent parts usage on similar systems to improve future cost estimates.

The AMDF price is the cost of buying new parts from the industrial base (which includes working-capital fund cost recovery charges or surcharges), but program management offices are often interested in estimating the cost of purchasing a mix

Figure S.2
Inflation of Bradley APC Over 5 and 10 Years



RAND *RR237-S.2*

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1 Parts regularly become obsolete because of advances in technology, changes in supplier availability, and modifications to platforms over time. While this analysis did not focus on which parts are interchangeable, that information is available in the FEDLOG section on interchangeable and substitutable (I&S) parts.

of new and depot-repaired parts. For this purpose, inflation can be calculated with the Marshall-Edgeworth index, using the exchange price, also known in the Army's Operating and Support Management Information System (OSMIS) as the cost to the consumer. Figure S.3 contrasts inflation of the Bradley APC for the AMDF price and the exchange price, or cost to the consumer.

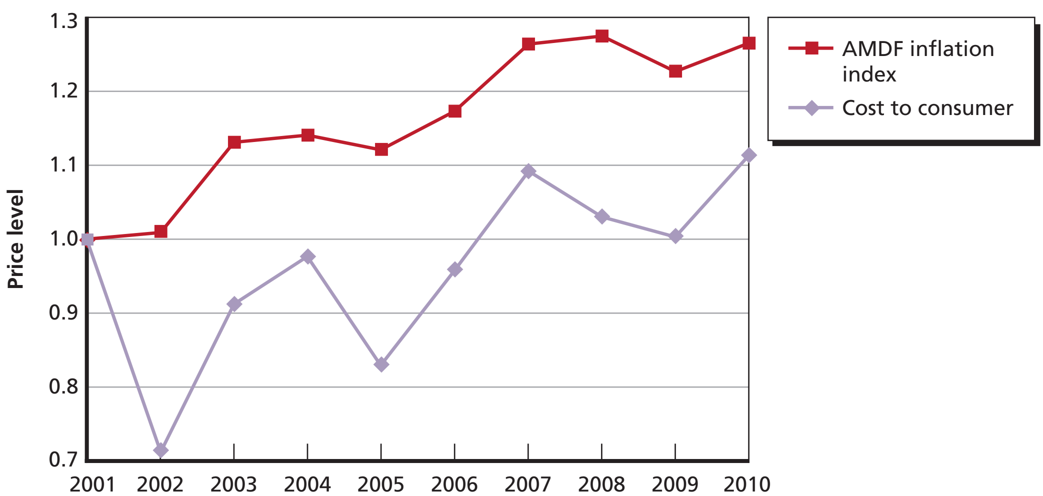
The exchange price shows much lower inflation than the AMDF price. In addition, the program experiences high variability in cost because of the variance in repaired-part prices.

The Defense Logistics Agency and the Army Materiel Command manage parts with a working-capital fund and add a surcharge to parts each year to cover costs; the surcharge is included in the indices presented here. It varies by up to 20 percentage points based on the overhead costs and sales (using lot average cost) forecast for a given year. Surcharge variation does play a role in parts costs inflation or deflation over time, and these price changes are very real for system operators. A major change in surcharges can significantly impact program and unit operations.

DoD Discounting Practices Do Not Deliver Least-Cost Decisions

Discounting is the process of taking into account the time value of money. Earlier expenditures carry more weight, and for DoD this means that acquisition costs are emphasized over sustainment costs. Discounting in the private sector typically balances near-term investment against future profits.

Figure S.3
Bradley APC Inflation, Calculated with the Exchange Price and AMDF Price



Government decisionmaking can also benefit from discounting. Government investments that impact the private economy are balanced against future societal costs and benefits. The discount rate in this case is the opportunity cost of private capital, which was set at 7 percent in 1992. For internal government investments, the discount rate is the Treasury's borrowing rate, which varies by the length of the obligation and currently has a "real" (no inflation component) value of 1.1 percent for a 10-year project. This rate reflects the market's preference for current consumption and the perception of the uncertainty in repayment due to risk of default. Inflation expectations also influence the market's rate setting, but inflation is excluded from the real rate.[2] When DoD decisions impact total federal borrowing, it makes sense to discount, but this is not always the case.[3]

Choices made using discounted cash flows are not always the least expensive for DoD. For example, the cost to modify a DoD system to save $2 million a year for 10 years could not equal $19 million given current discounting guidance. The opportunity to net an overall savings of $1 million is forgone, even though there is no compensating interest savings to DoD. And the Treasury would save on interest expense only if the decision impacted the DoD top-line budget, which is unlikely in day-to-day investment decisions. Normal financial programming activities result in funds released by one action being consumed by another.

Consider the choice among companies providing logistics support to a weapon system. One firm could have a higher bid, but if its costs were biased to the later years of the contract, its discounted cost could be less. Using discounted cash flow to select that firm would incur a greater real-dollar expense and would diminish the funds available for other activities.

Today's real 10-year rate is 1.1 percent, but as recently as 2007 it was 2.8 percent. Different discount rates will order alternative cash flows differently, impacting decisions. Likewise, discount rates during the execution of a program can be different, which would also impact a decision. To guard against selecting an incorrect alternative when discounting is used, the discount rate should be varied to determine the sensitivity of the choice to future market behavior.

When a significant program is canceled or retired early, or even extended past its originally planned lifespan, changes to the DoD top-line program can result. Cost estimators must provide decisionmakers with information on the range of costs and the range of risks to enable them to take into account the larger context for investment decisions. Discounted costs have often been portrayed as the clear line where investment decisions must be made. From a practical standpoint, however, lower discount rates place more weight on future costs, while higher discount rates place less weight

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2 See NYU Stern, undated.

3 See Office of Management and Budgeting (OMB) Circular A-94 and annual issuance of Appendix C for discussion of discount rates.

on the future. We conclude that reality is more subtle than a single discount rate and a sensitivity analysis is needed, because a range of reasonable courses of action exists for many DoD investment decisions.

Recommendations

We present the following recommendations for CAPE to consider when evaluating the inflation and discounting policies that impact the long-term affordability of DoD programs.

Revisit O&M costs annually with a 5-year moving-average inflation. The cost of repairing parts differs over time, sometimes dramatically, and DoD O&M estimating strategies should be reviewed to reflect changing repair and other costs. This analysis shows that two weapon systems, while both ground systems, experience inflation differently. Guidelines on how to develop individual system indices, posted online by CAPE or published in a handbook, could help the DoD acquisition community make more-accurate decisions for today's systems, as well as for future purchases. For future systems, variants that are most similar to the system should be selected. The uncertainty in using a variant to estimate a future system is indicated by the percentage of total NIINs they have in common.

Show variation in working-capital surcharges. The role of supply chain surcharges in parts costs should be highlighted in cost estimates and used to inform program financial analysis, as those surcharges have varied by up to 20 percentage points over the past two decades.

Expand analysis of investments to ensure consideration of least-cost outcomes. Discounting at the Treasury rates can result in more-costly programs. Further analysis is indicated to allow decisionmakers the opportunity to make strategic decisions about investment, as follows:

1. Discount the constant-dollar alternatives, using the appropriate Treasury rate from OMB Circular A-94, Appendix C.
2. Refer to the Table of Past Years Discount Rates in OMB Circular A-94 to develop a range of recent discount rates to use in sensitivity analyses.
3. Compare the undiscounted constant-dollar costs of the alternatives. This is the typical treatment of the cash-based federal budget (Kohyama, 2006).
4. Where these analyses point to a preference for different alternatives, the decisionmaker will be informed about the economic and cost impacts of a decision.

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Abbreviations

AMDF	Army Master Data File
APC	armored personnel carrier
CAPE	Office of Cost Assessment and Performance Evaluation
CPI	Consumer Price Index
CV	coefficient of variation
DLA	Defense Logistics Agency
DoD	Department of Defense
DoDI	Department of Defense Instruction
GDP	Gross Domestic Product
HMMWV	high-mobility multipurpose wheeled vehicle
I&S	interchangeable and substitutable
LAC	latest acquisition cost
NCCA	Naval Center for Cost Analysis
NIIN	National Item Identification Number
O&M	operations and maintenance
O&S	operations and support
OMB	Office of Management and Budget
OSMIS	Operating and Support Management Information System
PPI	Producer Price Index
WSARA	Weapon Systems Acquisition Reform Act

CHAPTER ONE

Introduction

The Department of Defense (DoD) has long recognized that cost estimates related to major weapon systems must take into account the total lifetime costs of the systems, from their initial development to their disposal. Once a weapon system is produced, its operation and maintenance (O&M) includes all programmatic aspects of system supportability, including maintenance, repair, modifications, upgrades if warranted, demilitarization, and safe disposal. Early in the acquisition process, DoD cost estimators use current inflation indices and discount rates to compare the sustainment (or support) costs of different systems. These tools are required in the final selection among alternatives, as they help identify potential increases in sustainment costs (inflation) and the present value of future costs (discounting).

In response to the Weapon Systems Acquisition Reform Act of 2009 (WSARA), the Office of Cost Assessment and Performance Evaluation (CAPE) has actively sought ways to reduce the cost of doing DoD business while maintaining ready, technologically advanced ground, air, sea, and cyber forces. CAPE, uniquely positioned under WSARA to improve and support DoD cost analysis, asked RAND to assess O&M costs associated with the Bradley ground combat vehicle and the Abrams joint light tactical vehicle. In conducting this assessment, the RAND team also confronted a broader but equally important question: How well are current inflation indices and discount rates serving DoD weapon-system program cost assessments and management today?

This report explores the accuracy of current inflation rates and discounting methods, using the experience of the Abrams tank, Bradley armored personnel carrier (APC), and—while not discussed in this report—high-mobility multipurpose wheeled vehicle (HMMWV) and Stryker programs. We used the Abrams and Bradley programs as representative cases of what cost estimators can do with existing O&M data. To address the broader question, we identify areas where CAPE could provide guidance to improve the information that cost estimators provide to DoD decisionmakers and offer actionable recommendations that CAPE could consider while discussing inflation and discounting policies that impact the long-term affordability of government programs with the Comptroller and the Office of Management and Budget (OMB).

Inflation Indices and Discounting Practices Enable Long-Term Estimating

Typical cost estimates for DoD rely on inflation indices and discount rates to provide clear information on the costs of new and existing programs. These tools are used to enable comparisons among a variety of weapon-system acquisition alternatives with different development timelines and expected useful lifetimes. Both are critical to cost estimators, as they help DoD understand how to apportion funds to systems over the long term. DoD, like the U.S. government, budgets according to annual appropriations. This makes budgeting an exercise in allocating limited funds across priorities. In contrast, privately owned commercial entities do longer-term capital budgeting, which accounts for the future obligations associated with buying a piece of machinery, including energy, maintenance, and depreciation. In the business world, this makes capital-purchase options A and B different in real-money terms. The focus is not only on the initial investment in technology but on the long-run costs of operating and replacing the system.

There are a few mechanisms that allow DoD to agree to multiple years of expenditures, such as multiyear purchases of aircraft. But generally, DoD does not do capital budgeting. This means that it does not feel the real consequences of a purchase of an aircraft or a tank from the first day of purchase, but rather focuses on the initial investment in technology. DoD experiences the O&M costs and eventual replacement costs gradually.

While there was considerable interest in capital budgeting between 1981 and 1998 based on U.S. Government Accountability Office reports (1981, 1983, 1986, 1987, 1988, 1989, 1998), there is no evidence that the federal budgeting or budget reporting will incorporate more capital components. The Government Accountability Office recommended in 1983 that the unified method of budgeting be retained so that overall spending could be controlled, but that capital elements be called out to allow for a thorough discussion of capital investment (U.S. Government Accountability Office, 1983). Therefore, we assume that DoD will continue to plan for systems with appropriation budgeting.

When the military acquires a system such as an armored ground vehicle, even though it does not do capital budgeting, it estimates the future costs of operating the system and maintaining it to ensure operational availability. The acquisition program then compares these costs across alternatives to understand which provide the most affordable option. To support these processes, cost estimators regularly apply standard inflation tables and discount rates, which are the primary concern of this report.

Terminology Captures Both Cost-Analytic Methods and DoD Specifications

Across organizations and in related literature, cost analysts generally agree upon the use of the terms *inflation* and *discounting*. In this report, each term has somewhat specific nuances in the unique context of DoD acquisition, so it is worth briefly reviewing the standard use of them. Subsequent chapters provide greater DoD-specific detail, as necessary.

Inflation is the increase in the price of an item over time (deflation reflects price reduction). Inflation could be caused by increases in the labor and material components of a price. It is important to know the amount of historical inflation, so that prices of items from different years can be compared in estimating the price of future acquisitions and in forecasting future inflation. The future inflation forecast is an important component of budgeting and is currently controlled by OMB and the Undersecretary of Defense Comptroller, in their capacities of preparing and presenting the President's budget. Existing processes are detailed in DoD's Financial Management Regulation. With the passage of WSARA, CAPE also now has a role in the development of inflation indices, but the exact allocation of duties has not been fully defined in current policy. Inflation at a constant annual rate is calculated as

Cost times ((1+ inflation rate) raised to the number of years)

Discounting is a process that accounts for the time value of money by adjusting future values into present values; it is best measured by the interest that money can earn. At 5-percent simple interest, a dollar promised next year is worth 95.24 cents today. The discount rates set by OMB reflect the government's cost of borrowing and are provided as real rates, used for cash flows adjusted to a single year, and nominal rates, which are applied to inflated cash flows. A discounted real value is calculated as

Cost times (1/(1 + real discount rate) raised to the number of years)

Table 1.1 shows how inflation and discounting affect cash flow. Nominal cost can be characterized by price times quantity. As price increases, the nominal cost increases unless quantity decreases. In Table 1.1, inflation is assumed to be 3 percent and the real discount rate is assumed to be 2 percent. The real discount rate is adjusted for economywide inflation rather than commodity-specific inflation indices.

The totals in Table 1.1 characterize the cash flow for comparison with other cash flows. The sum of the real cash flow, $400, would be used for a zero discount rate, and the sum of the real discounted cash flow, $381, would be compared to other discounted real cash flows. Note that this value does not equal the investment required to obtain the nominal cash flow, since inflation would not be paid to the investor.

Table 1.1
Example of Inflated, Real, and Discounted Year-End Cash Flows

	Cash Flow (dollars)				
Expenditure	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Total**
Nominal expenditures	103	106	109	113	431
Real expenditures	100	100	100	100	400
Discounted real expenditures[a]	98	96	94	92	381

[a] Discounted real expenditures do not add to the total due to rounding.

Organization of This Report

Chapter Two compares methods of preparing three inflation indices and explores how to make indices representative of current parts costs for Abrams and Bradley vehicles. Chapter Three takes a high-level view of the impact of discounting on DoD decision-making. In both of these chapters, we describe our analytic methods, which are specific to each of the tools. Chapter Four summarizes our findings and the near-term actions available to CAPE and cost analysts for improving O&M estimating with changes in inflation and discounting practices. The Appendix presents DoD budget authorization forecasts for 1992–2015, DoD outlay forecasts for 1992–2015, Gross Domestic Product (GDP) forecasts for 1992–2015, and Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W) forecasts for 1992–2015, taken from the current National Defense Budget Estimates (Green Book).

CHAPTER TWO

Cost Inflation of Ground-Vehicle Parts

This chapter assesses and compares three different methodologies used to calculate inflation costs related to weapon-system O&M. Cost estimators rely on inflation indices to normalize data from disparate time periods, but inflation indices are built for DoD on very broad categories that include system O&M as well as manpower, procurement, and research and development. These indices do take into account the effect inflation has on weapon-system and personnel budgets, but questions remain as to how well they reflect O&M realities at an individual system level. We focus upon ground-vehicle parts for the Bradley and Abrams vehicles to demonstrate this deficiency and conclude with general recommendations that may enable DoD to better account for the O&M requirements that are specific to individual weapon systems.

The Data Span a 10-Year Period

We collected information on parts costs and quantities from 2001 to 2010 in the Army's Operating and Support Management Information System (OSMIS). Within OSMIS, parts that are common to multiple systems are apportioned among the systems that contain them in proportion to the system quantities. The OSMIS-reported demands are not perfect indicators for reliability/demands for a part for a specific system, but they do constitute the best and most consistent data available for this effort. Parts unique to a system are apportioned only to that system.

From OSMIS, we obtained 471,885 records of parts-related costs for all of the Abrams and Bradley variants in the 10-year period. The dataset includes 25,161 unique National Item Identification Numbers (NIINs)—Abrams has 15,892 and Bradley has 12,214, with an overlap of almost 3,000 parts. While both of these vehicles have quite a few parts, only certain parts are consistently purchased every year. Notably, the OSMIS allocation system means that if there were any demand in a year for these parts by any Army Department of Defense Activity Code organization with an Abrams or

Bradley, it would appear in OSMIS for both vehicles proportional to the quantity of each owned by the organization.[1]

OSMIS includes two types of prices. The first is the Army Master Data File (AMDF) price, which consists of the purchase price of a new part from a supplier—i.e., the latest acquisition cost (LAC)—and a surcharge (or cost recovery charge) to cover working-capital fund overhead. This price is also called the standard price. The second type of price is the average cost to the consumer (the purchaser, such as an O&M customer or industrial operation, of an item from the supply management account of the Army Working Capital Fund), also known as the single stock fund price. It is a calculated value in OSMIS that uses the AMDF price: ((serviceable value * serviceable rate) + (unserviceable value * unserviceable rate)). This takes into account serviceable returns and the credit customers get for them and the exchange price paid for a depot-level reparable (or the credit received for a carcass). This cost is more representative of what users of the system pay for spare parts because it takes into account the value of parts that are reparable. We first look at the AMDF prices to see the changes in costs associated with the industrial base and then show inflation, including used parts that have been repaired by depots. The depot prices also reflect surcharges to cover overhead costs that are variable, based on demand for repair. We recognize that the repair requirements change over time. For future analysis, it would be important to select all the data from either before or after the policy change for consistency.

To calculate inflation rates, we isolated parts that were represented in every year. Abrams had 2,653 NIINs that were demanded for each of the 10 years, and Bradley had 2,174. The longer the time period analyzed, the fewer parts were purchased in every year of the data. This is to be expected, as some parts are used more frequently than others. Low-demand items are less likely to appear as a purchase in every year, especially as the time period of analysis increases. At the same time, both the Abrams and the Bradley have undergone modifications over the past 10 years that would change which parts they use. To reflect this, we also examined the 2006–2010 time period and found that Abrams had 3,290 NIINs required throughout and Bradley had 3,166. While not complete, these samples were representative of the overall inflation for the systems.

Three Index Methodologies Are Used in This Study to Assess Inflation

There are numerous index methodologies that can be used to calculate inflation. For this study, three different approaches were taken. The first method, which we call "one of each type," is a form of equal-weighted index (Bacon, 2008, p. 42). We took data

[1] We focused on data from OSMIS, which CAPE regularly accesses. In future analyses, it would be possible to use information from FEDLOG (the Defense Logistics Information Service) to obtain pricing for NIINs where there was no demand in a particular year.

from 2001 through 2010 and identified each NIIN that appeared in all 10 years for a weapon system. We summed the AMDF price for each NIIN in a year, then divided the sum for year N + 1 by the sum in year N. So 2002 was divided by 2001 to understand the inflation between 2001 and 2002. This method measures the underlying industrial price change but does not reflect the actual effects of inflation on a single weapon system because not all parts are used at the same rate.

Our second approach was the "basket of goods" method. Here, NIINs are weighted by the frequency with which the parts are purchased. The official name of this calculation is the Marshall-Edgeworth inflation index. It overcomes the overstatement of the Laspeyres price index (Stuvel, 1957), which uses the base year (in this case, 2001) as a basis for weighting frequency, and the understatement of the Paasche price index (Bacon, 2008, p. 42), which uses the index year as the basis for weighting frequency (in this case, 2002–2010, depending on which year of the index is calculated).

Why would one want to use Marshall-Edgeworth rather than an equal-weighted index? Consider an owner's spending on a personal vehicle over the course of a year. The owner buys multiples of oil filters and windshield wipers but probably would not replace the floor mats as often. He or she would want changes in the prices of filters and wipers to be more heavily weighted because they are paid for more frequently. Similarly, for the Abrams and Bradley vehicles, items such as track and light bulbs are replaced relatively frequently, while engines are replaced less often.

Consumer indices are typically based on the Laspeyres index, but it uses the base-year quantities of purchases, which may not be representative of the Abrams or Bradley because of high variance in demand for parts from one year to the next. To make the basket of goods have reasonable quantities, we took the average quantity of each NIIN over the 10-year period and used these averages for weighting the inflation index. Then for each year, we multiplied each average quantity by the AMDF price in that year. We then summed all of these products for the year and divided basket cost for year N + 1 by the cost in year N. As before, the total cost in each year is divided by the cost in the prior year, and 2001 becomes the base year for the index. The strength of this method is that it supports program cost estimating because it reflects the relative total cost of each part over the entire system.

The third and most complex technique is the geometric-mean approach. Instead of focusing on the quantity of items that are demanded, the geometric-mean approach keeps the "share of expenditures" for each category of good constant (Moulton, 1993). Typically, a geometric mean is characterized as the nth root of the product of n items. Applying that logic to an index proves to be complex, but it was covered in the *Department of Defense Inflation Handbook 2nd Edition* (Wise, Lochbryn, and Oprisu, 2011). The handbook suggests that analysts create a base-year price share for each item in the basket, which in this case would be the Bradley or Abrams baskets of parts that are used in all 10 years. The price share is the product of quantity and price for a single

NIIN in the base year divided by the product of the quantity and price for all NIINs in the base year, as follows:

$$\text{Price share of item J in base year} = (q_j * p_j)/(q_1 * p_1 + q_2 * p_2 + \ldots. + q_n * p_n)$$

Once the base-year price share has been calculated, we need to look at the change in price from one year to the next, while applying the base-year price share as a weight. So in the following inflation equation, X is the base year (2001) and Y is the following year (2002). This calculation is repeated for each pair of years through 2010:

$$\text{Inflation (geometric mean)} = (p_1(Y)/p_1(X))^{\text{Price share1(baseyear)}} * p_2(Y)/p_2(X))^{\text{Price share2(baseyear)}} \ldots * p_i(Y)/p_i(X))^{\text{Price sharei(baseyear)}} - 1$$

where P_1 is the price of the first NIIN in the basket, P_2 is the price of the second NIIN, and that continues for n NIINs.

The CPI did switch its calculation from the Laspeyres formula to the geometric-mean method in 1999, but for only 61 percent of the index (Dalton, Greenlees, and Stewart, 1998). Instead of keeping quantity weights constant as in the Laspeyres, Marshall-Edgeworth, and Paasche indices, the new method fixes expenditure proportions. The switch was made because the Bureau of Labor Statistics recognized that consumers would substitute goods within a narrow band when prices rise. Substitution, for the average consumer, captures a variety of activities. For instance, one may switch from buying three loaves of bread to buying only two if the price has risen, switching from the artisan loaf to the store brand, buying less bread and more rice, or even switching from the local grocery chain to a discount store. Notably, the CPI retained the quantity-weighted formula for its maintenance and utilities elements, because these items are difficult to substitute, subject to inelastic demand, or controlled by government providers/regulated monopolies.[2] DoD is unable to substitute the majority of its spare parts, and therefore the geometric-mean approach will likely underestimate the parts inflation. We do not recommend that this method be used to calculate inflation rates for spare parts.

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[2] The CPI is a calculation of the change in prices to the average urban consumer. DoD is not the average urban consumer, but the findings of economists that focus on creating indices are instructive here. The CPI retained an arithmetic mean for three main categories of expenditures: shelter, selected utilities and government charges, and selected medical-care services. Selected utilities and government charges are the most similar to DoD categories. They include electricity, maintenance of water and sewage, telephone services, natural gas service, cable television, and other related goods (Dalton, Greenlees, and Stewart, 1998). These items are calculated with the arithmetic mean because consumers of them are unable to freely alter their purchases due to slow changes in the housing stock, monopolistic provision of services, and generally low elasticities of demand. DoD experiences similarly low elasticities of demand and ability to substitute among goods. Goods that are calculated with the geometric mean include food, beverages, apparel, insurance, transportation, recreation, and education, along with communication, tobacco, personal services, and funeral services.

Methodological Limitations Relate to Information Availability

The current methods are unable to incorporate the full complement of consumables and reparables for ground vehicles, because pricing information is available in OSMIS only in years with recorded purchases. In addition, the prices in the OSMIS database incorporate surcharges for supply chain costs. Both the Defense Logistics Agency (DLA) and the Army Materiel Command manage parts with a working-capital fund, so this surcharge is added on to parts each year to cover costs. The surcharge varies based on the overhead costs and sales forecast (using LAC) for a given year, and rates have varied by up to 20 percentage points over the past two decades. It is possible to calculate inflation based on the LAC and leave out the surcharge, but we did not have access to full LAC data for this study.

The surcharge variation does play a role in inflation or deflation of parts costs over time, but it is difficult to exclude from the OSMIS dataset because the way in which it has been applied to units has changed over time. As these price changes are very real for operators of systems, keeping them in the calculation of indices will not have negative effects unless there is a major change in the way surcharges are handled in the future. If that occurs, the indices will need to be calibrated with the new information.

Calculations of Bradley Inflation

We developed annual growth rates for the Bradley APC, using each of the aforementioned methods, to show the incremental change in the cost of new parts from one year to the next. The results for each approach are summarized in Table 2.1.

Table 2.1
Calculated Bradley Annual Growth Rates

Year	Single Item	Marshall-Edgeworth	Geometric Mean
2001–2002	1.015	1.009	0.973
2002–2003	1.103	1.123	1.064
2003–2004	1.006	1.008	1.027
2004–2005	0.989	0.983	0.988
2005–2006	1.065	1.045	1.040
2006–2007	1.049	1.079	1.082
2007–2008	0.994	1.007	0.993
2008–2009	0.958	0.962	0.953
2009–2010	1.018	1.032	1.021
Average	1.021	1.027	1.015

The Marshall-Edgeworth and single-item growth rates switch back and forth from one year to the next, but in the end the Marshall-Edgeworth approach produces higher average growth than the single-item approach. This means that the price of some items that are bought more frequently increases at a faster rate than the price of items that are bought less often. The geometric mean shows lower average growth than either the Marshall-Edgeworth or single-item index, but it shows higher results in three years. As discussed earlier, this lower average growth rate is to be expected, because the geometric-mean calculation tends to be lower. This can be desirable in some situations where substitution between products is readily available, but we do not believe those conditions apply in DoD.

Our analysis included looking at the types of parts that have large price variation. For the Bradley, these are reparable rather than consumable parts, including track, sights/scopes, circuit cards, transmissions, and engines. These items appear to correlate with the modifications of the system over time and the challenges associated with obsolescence.

Figure 2.1 shows the growth rate from one year to the next and the cumulative effect when the products of several years of inflation build upon one another to show overall price changes, using all three indices. As expected, the Marshall-Edgeworth growth rate is higher than the geometric-mean growth rate. There is considerable variation from year to year.

Figure 2.1
Bradley Inflation Calculated Using the Three Methods

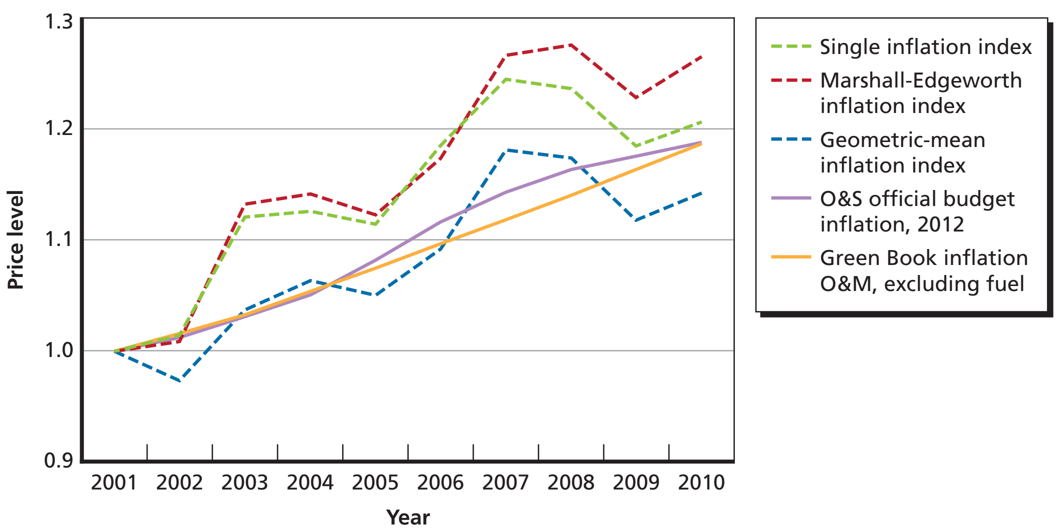
RAND *RR237-2.1*

The Bradley inflation rates estimated using the single-unit and Marshall-Edgeworth methods are different from those outlined in the official Army O&M budget inflation in the Naval Center for Cost Analysis (NCCA) 2012 version of the inflation calculator and the published Green Book inflation. The geometric-mean index result happens to be close to the official inflation in Figure 2.2. Using this index will ensure that inflation estimates are lower than those calculated with other indices, which may lead to chronic underestimation of parts costs if programs are unable to make substitutions for less-expensive parts as prices rise.

Bradley program officials mentioned regular upgrades and modifications to the platform. The original Bradley M2s came into service in the early 1980s, and there have been three subsequent major variants (M2A1, M2A2, and M2A3). In addition to the major variants, other parts were replaced because of obsolescence and other factors. This suggests that data for an average of 5 to 6 years would capture a large enough population of items and would reflect changes due to modifications and obsolescence over time.

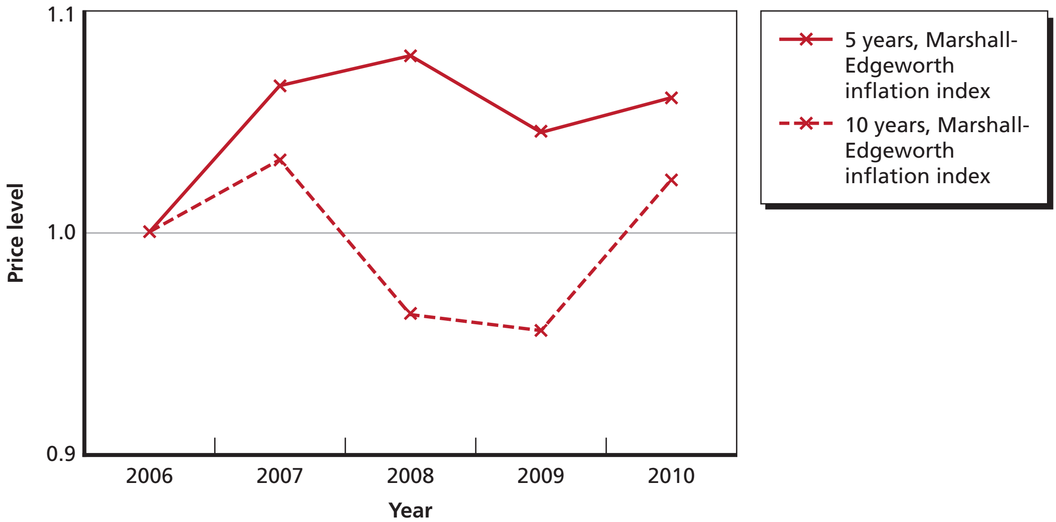
To assess how the inflation picture changes over a shorter period of time, we identified all of the NIINs that were purchased in all of the years from 2006 to 2010. With these NIINs, we used the Marshall-Edgeworth index to develop the 5-year curve in Figure 2.3. The larger set of NIINs results in a different view of inflation than the originally calculated 10-year indices (where we scaled the 2006 growth rate to 1.0 to

Figure 2.2
Comparison of Calculated Bradley Inflation Rates with Official Inflation Rates



RAND *RR237-2.2*

Figure 2.3
Comparison of Bradley Inflation Over 5 and 10 Years



RAND *RR237-2.3*

be able to compare the inflation side by side). More-recent parts appear to have slightly higher inflation than the parts from the 10-year index. Cost analysts should examine trends on new parts for similar systems to improve future cost estimates.

Calculations of Abrams Inflation

For the Abrams vehicle, we again created inflation-index estimates using the single-item (equal-weighted index), basket of goods (Marshall-Edgeworth), and geometric-mean approaches. The growth rate results for new parts estimated with each approach are summarized in Table 2.2.

The single-item and Marshall-Edgeworth estimates follow a similar trend, with the latter having a slightly higher average. The geometric-mean estimates tend to be lower than those calculated using either the Marshall-Edgeworth or single-item index. The inflation trends are shown in Figure 2.4.

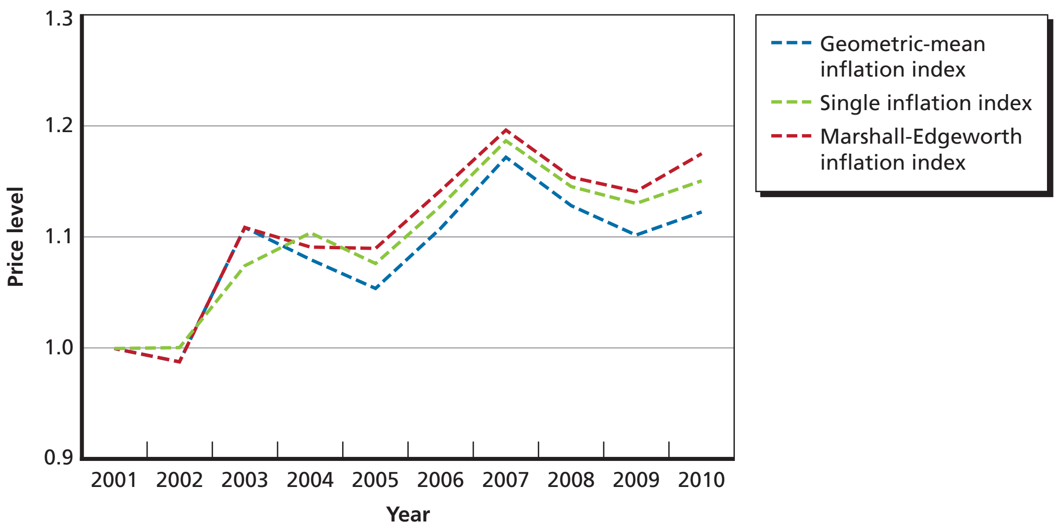
Abrams has fewer parts that exhibit large price swings, but parts that have changed greatly over time include portions of the engine, transmission, gun, and brakes. Once again, these seem in line with the upgrades and modifications the programs describe.

We compared the full 10-year index for Abrams with the official indices, as shown in Figure 2.5. Here, the single-item and Marshall-Edgeworth inflation calculations follow the trend of the official inflation. The geometric-mean calculation starts out higher but eventually ends up lower than the official inflation.

Table 2.2
Calculated Abrams Annual Growth Rates

Year	Single Item	Marshall-Edgeworth	Geometric Mean
2001–2002	1.001	0.990	0.988
2002–2003	1.073	1.118	1.123
2003–2004	1.027	0.986	0.973
2004–2005	0.976	0.998	0.977
2005–2006	1.048	1.049	1.052
2006-2007	1.052	1.047	1.057
2007–2008	0.965	0.964	0.963
2008–2009	0.987	0.990	0.977
2009–2010	1.019	1.029	1.018
Average	1.016	1.018	1.013

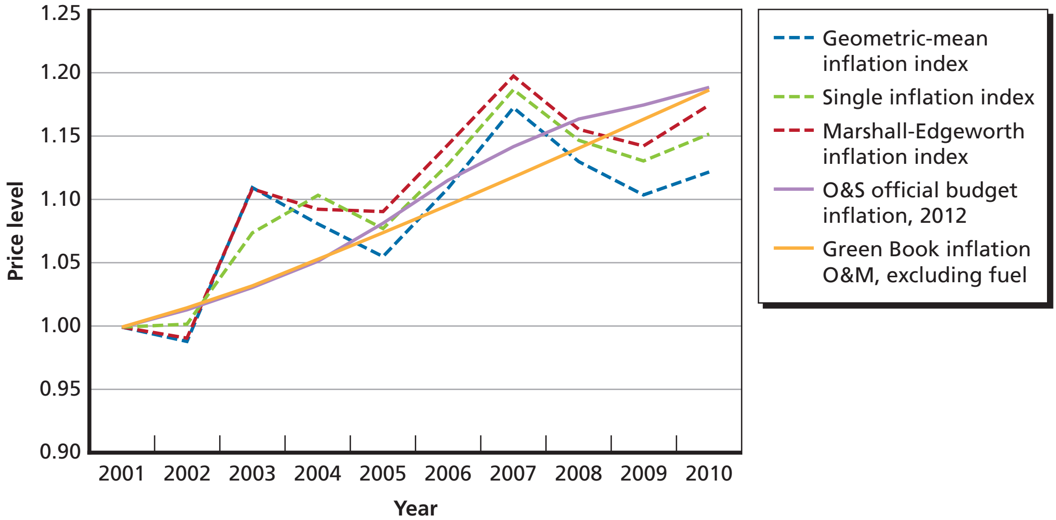
Figure 2.4
Abrams Inflation Calculated Using the Three Methods



RAND *RR237-2.4*

Like the Bradley, the Abrams has been in service for several decades and has gone through rounds of modification and upgrades. The M1 came out in the late 1970s, the M1A2 in the mid-1980s, and further upgrades in the late 1990s and 2000s. Our discussions with program officials and analysis of the number of NIINs purchased from year to year indicated that a shorter time period might more accurately capture the breadth of the parts catalog used to service current vehicles.

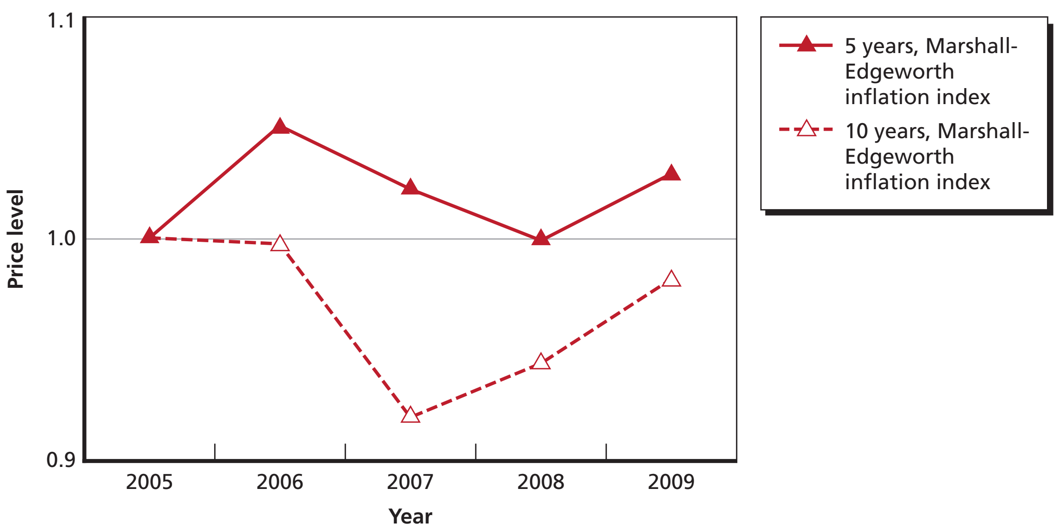
Figure 2.5
Comparison of Calculated Abrams Rates with Official Rates



RAND *RR237-2.5*

To compare the Abrams 5-year and 10-year inflation, as we did for the Bradley, we pulled all of the NIINS that were purchased in all the years from 2006 to 2010. Using these, we developed the dashed line in Figure 2.6. It appears that the newer Abrams parts are more subject to cost growth, similar to what we observed for the Bradley parts.

Figure 2.6
Comparison of Abrams Inflation Over 5 and 10 Years



RAND *RR237-2.6*

Impact of Depot-Repair Price Change on Inflation

In the analysis above, we used the AMDF price, i.e., the list or standard price for a new part. However, the Army often deals with reparables that are sent to the depot and repaired for less than the cost of buying new parts. Since many of the parts a weapon program will purchase involve depot-repaired parts, the exchange price (also known as the cost to consumer or single stock fund price) is more realistic for long-term program estimates.

Since depot-level repair is performed when it is more cost-effective than buying new parts, we examined the impact of depot-repair price changes on Bradley and Abrams inflation (Figures 2.7 and 2.8). Discussions with representatives from CAPE and Calibre Systems, which manages OSMIS, suggested that those prices may have increased over time because the scope of the repair work has increased. This would impact the unit budgets. We did not find a major shift in reparable pricing for the Bradley, but depot costs appear to be rising significantly for the Abrams. Depots need to recoup their costs over the repairs they perform, so variation in the level of depot activity means that overhead may significantly impact parts inflation for a program from year to year.

The OSMIS data field that showed consumable items versus reparable items had a lot of intra-item instability. That is, the same NIIN would occasionally switch back and forth between reparable and consumable status. OSMIS defines reparables on the basis of a series of codes in two fields within the AMDF file. This impacted our choice of method for considering changes in reparable costs. Our initial plan was to

Figure 2.7
Comparison of Bradley Inflation Based on AMDF and Exchange Price

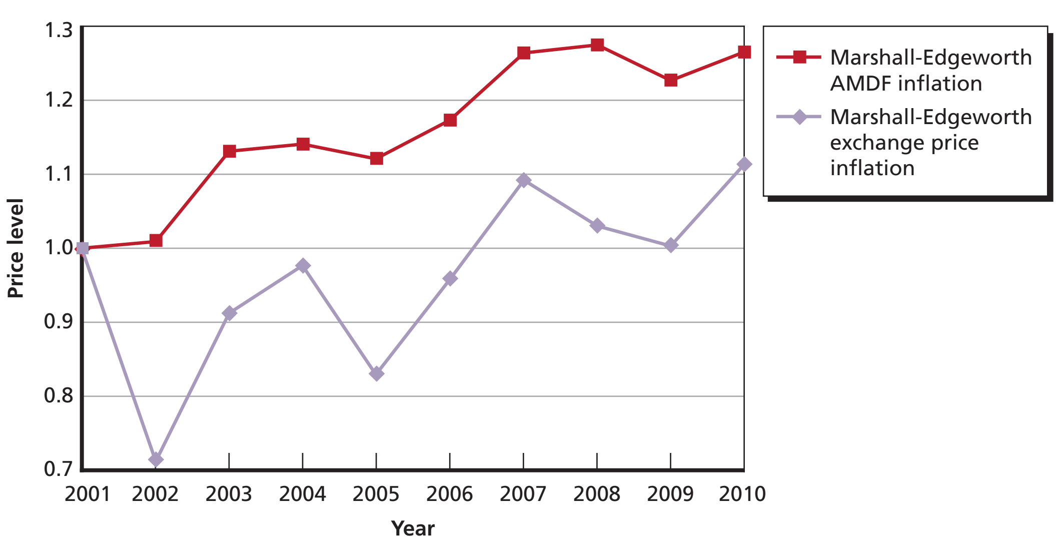
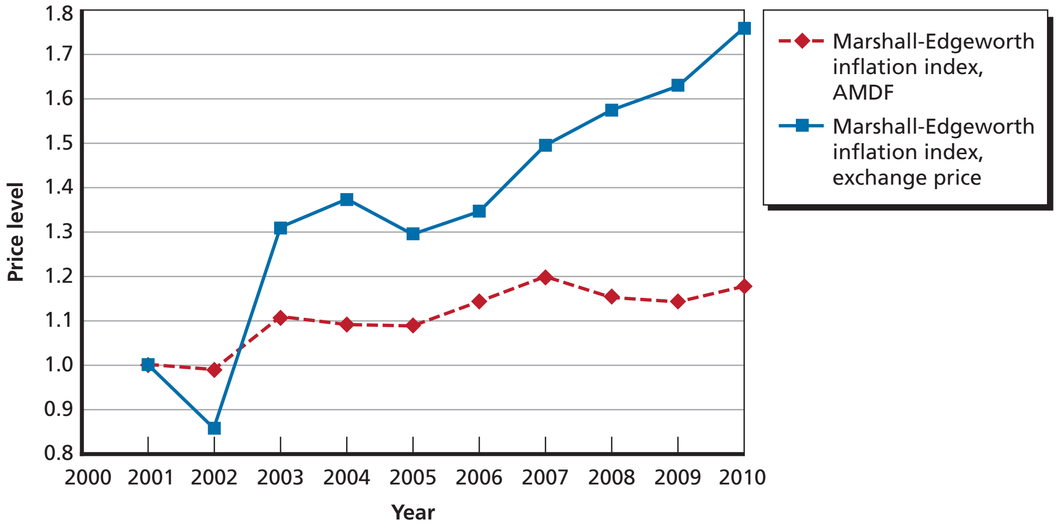


Figure 2.8
Comparison of Abrams Inflation Calculated Using AMDF and Exchange Price



RAND *RR237-2.8*

look at items purchased in all years and marked reparable in each year, which would result in a very small sample. Other logistics databases have consistent lists of reparable and consumable NIINs. Cost analysts who have access to these data sources, such as FEDLOG, can use them in combination with OSMIS to look at the impact of reparables, but we were unable to do that. Instead, we decided to look at all of the NIINs but focus on the exchange prices to see what, if any, impact this might have on inflation.

For the Bradley, we divided the total cost per year per NIIN of interest by the total quantity purchased of that NIIN to determine the average price to the consumer for each item in each year. Then we repeated the Marshall-Edgeworth index calculation.

This analysis showed wider year-to-year variability in inflation than in AMDF prices over 10 years. In our AMDF inflation calculations, prices fell by a little over 4 percent and rose by about 10 percent. In the reparables calculation, prices in some years fell by 29 percent, while in others it rose by 30 percent. Overall, however, the inflation over the 10 years comes out a bit lower than the inflation on list prices, at 1.12.

For the Abrams, the impact of changing reparables costs appears to be much more substantial. Prior to this excursion, we saw Abrams prices fall by about 3 percent in one year and increase by up to 12 percent in another. In the exchange-price excursion, prices fell by 15 percent in some years, while in others it rose by over 50 percent. Overall, the annualized inflation over the 10 years was a little more than 6 percent, which is significantly higher than the inflation on list prices alone. In this case, we did run into some major outliers in 2009 that were cause for concern.

Discussions with representatives from Calibre Systems indicated that the method of paying for reparables has changed significantly over the past 10 years. The single-item fund method was put in place after the combination of wholesale and retail inventories in 2001 transitioned to exchange price in October 2008 ("Exchange Pricing Improves Reparable Item Management," 2008). In addition, customers in Iraq and Afghanistan were paying the AMDF price until October 2012 rather than the exchange price, which inflated their costs (Department of the Army Office of the Assistant Secretary of the Army Financial Management and Comptroller, 2012). In developing future exchange-price-based inflation indices, cost analysts should try to limit their index to years that follow the same reimbursement method, but for consistency with the AMDF inflation estimates, we maintained the 10-year time frame. Estimators should also check whether depot repair prices over time appear to be shifting. We suggest that understanding the root cause of these shifts could improve estimation in the future. Using the exchange prices for calculating inflation most accurately reflects the costs from a weapon-system program perspective.

Accounting for Outliers

We examined the outliers associated with AMDF pricing, using two methods. First, we looked at histograms of the price change between 2001 and 2002 to see where the mode of price change was located. For both the Abrams and the Bradley, the spike in price changes was between 0.9 and 1.0, but there were a few NIINs that had price changes at 0.5 or less, or 2 or more. Once we knew there were going to be some outliers in the data, we decided to use the coefficient of variation (CV) for each NIIN to identify those particular items that have changed significantly over the 10-year period. The CV is calculated by dividing the standard deviation of each NIIN by the mean of that NIIN. This method has the added benefit of being unitless, so we could easily identify outliers regardless of the relative price of the item. Abrams had less than 1 percent of NIINs with a CV equal to or greater than 1 over 10 years. Bradley had less than 1.7 percent equal to or greater than 1. Depending on the type of indices in use, the number of outlier NIINs that have impact varies. For instance, in the geometric-mean indices, about 1 percent of the NIINs for both Abrams and Bradley appeared to be important outliers because of the combination of quantity and price over the years. But after further analysis, the indices seemed robust to their inclusion or exclusion because of the large quantity of items.

Future Inflation May Be Underestimated

In the Green Book, the Comptroller presents current estimates for inflation by appropriation and compares DoD inflation to GDP inflation and the CPI-W. A selection of these inflation exhibits is given in the Appendix. The documents also track prior estimates of inflation and how they have changed over time. The current estimates for inflation in the out years range from 1.4 percent to 1.8 percent. These seem optimistic given the current estimates for GDP and CPI and our analysis of the recent experiences of the Bradley and Abrams programs. In recent years, the estimates for DoD outlays and DoD budget authority have been slightly higher than those for the CPI-W. The current out-year estimates for the CPI-W range from 2.0 percent to 2.1 percent. This suggests that using the current DoD broad inflation index could underestimate the O&M cost of certain weapon systems.

The Producer Price Index (PPI) may also be valuable for comparison with DoD future inflation estimates. The PPI is a leading indicator, whereas the CPI tends to lag slightly in capturing cost trends. The PPI is not traditionally presented in the Green Book, but it could be a valuable addition. Several versions of the PPI tables could be appropriate. These include the broad "intermediate material, supplies and components," "finished goods," and more-specific tables under "intermediate or finished," such as "07 rubber and plastic products," "10 metal and metal products," "11 machinery and equipment," and "14 transportation equipment." Determining the most appropriate PPI comparisons requires future analysis.

Discussion

The large differences in inflation calculations based on inclusion of the additional NIINs from shorter time periods make it clear that systems with a lot of change in the NIINs over time need inflation indexes calculated over shorter time periods. Using a moving average of 5-year baskets should ensure that the baskets are relevant to the current system. Longer time frames can be used for systems with longer cycles of upgrades and modifications.

Unlike the typical American consumer, DoD cannot, under most circumstances, reap the benefits of an open, competitive market; there is no "store brand" of the parts needed on the Bradley and the Abrams that can be substituted when suppliers raise their prices. Because of readiness requirements, DoD cannot buy fewer parts just because prices go up. Many of the suppliers of these parts are monopolies because of the intellectual property wrapped up in the items. The CPI excludes government monopoly and maintenance costs from the geometric-mean calculations in favor of the original Laspeyres method. As DoD O&M indices are by definition focused on maintenance costs, using an index based on quantity weights is the logical option.

If a program is trying to develop inflation estimates specifically for maintenance costs, the exchange prices for several years should be used, to ensure that any changes in how the cost-to-consumer field is calculated in OSMIS are understood. The cost of repairing parts differs over time, sometimes dramatically. We recommend that analysts revisit these costs annually with a 5-year moving-average inflation to ensure that the existing support strategy continues to make sense in light of changing depot repair costs. This spiral approach to estimating O&M costs will inform the ongoing affordability of programs and can impact important decisions between life-extension programs and replacement.

CHAPTER THREE

The Value of Discounting

This chapter discusses the use of discounting to address the time value of money in DoD decisionmaking. Government discounting applications are reviewed and recent OMB discounting guidance used in making decisions related to O&M is presented. We then specifically address the use of discounting in DoD decisionmaking, which may sometimes lead to decisions that do not benefit DoD. We are particularly interested in how discounting may impact the decision to invest in an additional program or weapon system. Programs often compete for limited funds, and decisions may change the allocation of funding but may not change the DOD "top line" and may not impact federal borrowing and interest expense. If discounted costs are used to compare alternatives, there is a mismatch between the theoretical rate published by OMB and the actual rate, which is zero when borrowing does not change. We compare the purpose of DoD practices with the purposes of those used in private sector businesses and conclude with recommendations for assessing the financial aspects of alternatives under review by DoD cost analysts.

Discounting Is Used in a Wide Range of Cost Analyses

As noted in Chapter One, discounting is the process of taking into account the time value of money. It is basically the inverse of interest being accrued over time. Capital, C, invested today at interest rate r will be worth $C * (1 + r)$ after one year. After two years it will be worth $C * (1 + r) * (1 + r)$, or $C * (1 + r)^2$. Discounting allows future values to be put into a common time reference. At a discount rate R, a payment P_1 in year 1 is worth $P_1/(1 + R)$ today. A payment P_2 in year 2 is worth $P_2/(1 + R)^2$ today. Discounting converts future values into present values. The present value can be interpreted as the amount that needs to be invested today at rate R to yield the future values. Discounting can be applied to inflated or constant-dollar (real) future values by using the appropriate nominal (which includes an inflation component), or real, discount rate.

Discounting is a relatively straightforward process, but the choice of rates requires sophisticated analysis. This is especially true as higher rates diminish the influence of future values on current decisionmaking.[1] Discounting is used in cost-benefit analysis, where benefits can be evaluated in dollar terms. Where benefits cannot be converted into dollars—for example, in the case of number of targets killed—the cost streams of alternatives are discounted in a cost-effectiveness analysis so they can be compared.

Discounting in federal decisionmaking is governed by OMB Circular A-94 and contrasts cases in which federal decisions impact the general economy and those in which they affect only federal funds, such as DoD's programming decisions. For these latter cases, the discount rate is the Treasury's cost of borrowing.

Choices made using discounted cash flows are not always the least expensive. For example, the cost to modify a DoD system to save $2 million a year for 10 years could not exceed $19 million given current discounting guidance.[2] The opportunity to net an overall savings of $1 million is forgone, even though there is no compensating interest savings to DoD or the Treasury. The $1 million in savings would not be a reduction in the federal debt; it would be applied to other DoD requirements. At a 4-percent real discount rate for 10 years, the value for year 2000, no more than $16 million could be spent to save $20 million; $4 million in savings would be forgone. Therefore, the impact of discounting and its components should be part of the risk analysis used in making a decision.

Discounting Practices Differ in Private Sector and Government Decisionmaking

Businesses make investment decisions frequently, from purchases of tooling to maintain or expand production to developing new products. The measure of merit of these investments is the expected profit that will be earned. Investments occur early and profits are received later, so the time value of these cash flows must be addressed to make alternative investments comparable. There are many techniques to account for time value of money, ranging from the number of years of profit required to pay back the investment to the discounted net present value of the investment and the profits, which is preferred (Graham and Harvey, 2002). Business decisionmaking is an example of cost-benefit analysis where both costs and benefits can be monetized.

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1 Economists have for decades explored how to measure well-being across time to improve decisions made today, with Ramsey, Rawls, Koopman, and Mishan proposing methodologies (Dasgupta, 2005). The debate associated with discount rates is particularly active in the discussion of climate change and health care and how much to spend today to prevent future negative impacts on people, the environment, and the economy. In 1975, Mishan proposed a zero discount rate for items whose costs and benefits cross generations. In *The Economics of Global Warming*, Cline (1992) discussed using a 2-percent discount rate, while OMB was using a 10-percent real discount rate. Shishko (1976) presented a defense of the 10-percent rate as the social opportunity cost of capital. Krahn and Gafni (1993) argued that the discount rate should be specific to the perspective of the analysis. Shepard and Thompson (1979) recommended performing a sensitivity analysis around the chosen discount rate.

2 Current guidance calls for a real discount rate of 1.1 percent for a 10-year program (see Table 3.1).

The discount rate used in business is generally the firm's cost of capital. This is a combination of the rate at which funds are borrowed and the return that shareholders expect. It is a weighted average of interest on debt (less the tax-deduction effect) and the percentage costs associated with preferred and common stock. Preferred stock tends to receive constant dividends, and its cost is relatively straightforward. Dividends vary for common stock. Further complicating the evaluation, growth expectations of future dividends and the movement of the price of a stock relative to the market as a whole are taken into account. Interestingly, the cost of retained earnings is the same as the cost of common stock, because if the earnings were distributed to the stockholders they could invest them at a similar level of risk and expect a similar return (Drake, undated).

In general, government does not invest to make a profit. It cannot easily monetize all the benefits of its programs and therefore typically conducts cost-effectiveness analyses. Discounting is used to compare alternative investments or to assess the impact of rules, such as clean-air regulations. Some benefits can be monetized, for example, health benefits being equal to the cost avoided due to fewer medical complaints. Monetized benefits enable direct cost-benefit analyses. These analyses may require the use of two discount rates, because investment and consumer benefits have different impacts. First, discounting investments requires the use of an opportunity cost of capital. This is basically the return that could be earned on the next best investment. Second, consumer benefits are discounted using the consumption discount rate, which reflects the reduced utility to the consumer of deferred benefits. In general, the opportunity cost of capital will be greater than the consumption discount rate.[3]

The discount rates used by governments reflect their respective economies. Developing countries tend to use higher discount rates, reflecting the higher opportunity cost of capital of their firms. For example, the Philippines use a 15-percent discount rate (Zhuang et al., 2007). The United Kingdom uses the Social Time Preference Rate, based on "the rate at which individuals discount future consumption over present consumption" and "an additional element, if per capita consumption is expected to grow over time." A rate of 3.5 percent was established in 2003 for projects with durations of up to 30 years. Beyond that, the discount rate decreases "because of uncertainty about the future" (United Kingdom HM Treasury, 2011). This form of uncertainty impacts the U.S. Treasury and the U.S. taxpayer, but U.S. discount rates are set two ways: (1) as the marginal pretax rate of return on an average investment, which is a real discount rate of 7 percent and is used for cost-benefit analysis; and (2) by the bond market, where bonds are found to have higher yields if they span a greater period of time. The bond rate of return reflects the market's preference for current consumption and perception of the uncertainty in repayment due to risk of default. Inflation expectations also influence the market's rate setting, but inflation is excluded from the real rate (Damodaran, undated).

[3] This paragraph is adapted from U.S. Environmental Protection Agency, 1999..

OMB Offers Discounting Guidelines

For the U.S. government, OMB performs the analysis and publishes discount rates to be used in cost-benefit and cost-effectiveness analyses. These guidelines are intended to lead to cost-effective decisionmaking that benefits taxpayers. Two types of rates are established:

1. For government investment or regulations that affect the private economy, the "marginal pre-tax rate of return on an average investment in the private sector" is the basis for the discount rate (Office of Management and Budget, 1992). This was established at a real rate of 7 percent in 1992. It is a starting point for analysis. Alternative rates reflecting the particular industries affected are encouraged by OMB.
2. For "cost effectiveness, lease-purchase, internal government investment and asset sales analysis the Treasury's borrowing rate should be used as the discount rate" (Office of Management and Budget, 1992). These rates are published annually in Appendix C to OMB Circular A-94. Table 3.1 shows the real and nominal rates published in December 2011.

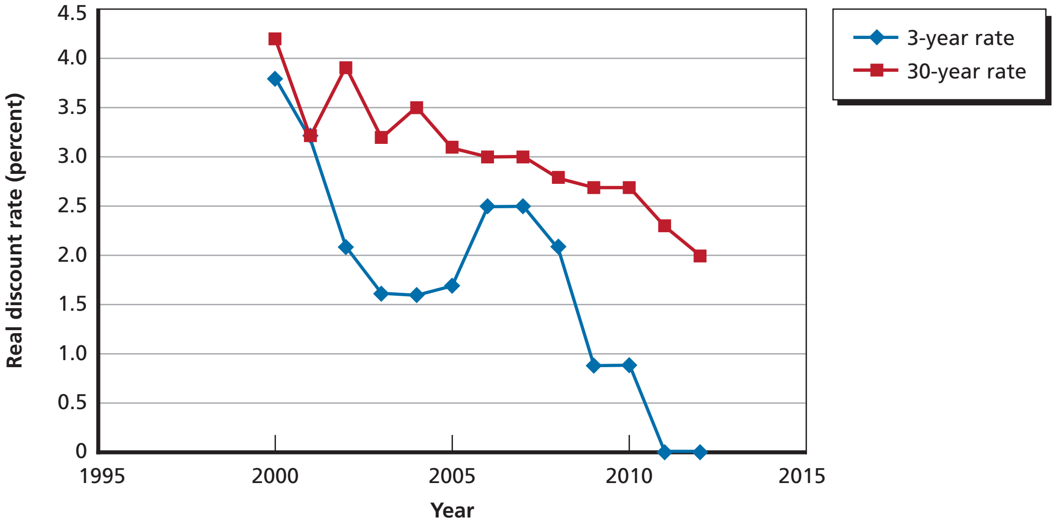
The difference between the real and nominal rates is the rate of inflation in the national economy. In cases where inflation for a particular commodity was different from inflation in the national economy, the real rates may be applied to cash flows, using the incremental difference in inflation rates. The rates are higher for longer-duration projects because buyers demand higher interest for long-term Treasury bonds. Cost analysts select the discount rate from the OMB charts based on the expected length of the program, which is often determined by the expected service life of a technology. Analyses of programs with project durations different from those presented in OMB charts may use a linear interpolation. For example, a 6-year project can be evaluated with a rate equal to the average of the 5-year and 7-year rates. Concepts with durations longer than 30 years use the 30-year interest rate. The Treasury borrowing rate changes from year to year, impacting the discount rates. Figure 3.1 shows the track of the 3-year and 30-year real rates from 2000 to 2012.

Table 3.1
Real and Nominal OMB Discount Rates for FY 2012 (percent)

	Project Duration					
Rate	**3 years**	**5 years**	**7 years**	**10 years**	**20 years**	**30 years**
Real	0.0	0.4	0.7	1.1	1.7	2.0
Nominal	1.6	2.1	2.5	2.8	3.5	3.8

SOURCE: OMB Circular A94, Appendix C, December 2011.

Figure 3.1
Real 3-Year and 30-Year Discount Rates from 2000 to 2012



SOURCE: OMB Circular A-94 Revised, Appendix C, revised December 2012.
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Thirty-year rates have been decreasing steadily, but there are large swings in 3-year rates. The 30-year rate stays at or above the 3-year rate over time.

The Treasury rates on which the discount rate is based are set at auction. As such, they reflect the market's investment demands. In 2001, the rate was 3.2 percent for all durations. In 2004 and 2005, demand for the 3-year bond drove rates down—the Treasury could sell these bonds easily. In 2006 and 2007, short-term rates increased, while long-term rates held steady. In general, long-term rates show less volatility in this downward trend. Cost-effectiveness analysis of government programs would not reflect this volatility in discount rates, and decisions reached may not be sustained within the scope of the program. It is apparent that the point in time at which the analysis is made can lead to different choices based on discounted cash flows.

DoD Discounting Guidance May Not Reflect Financial Realities

Department of Defense Instruction (DoDI) 7041.3, Economic Analysis for Decision Making, November 7, 1995, implements OMB Circular A-94. This instruction applies only to internal government costs, such as real property lease or purchase, automated information systems, or weapon systems and their support, so the discount rates based on the Treasury's borrowing rate are used. An exception is made for the analysis of commercial activities that may be performed by DoD personnel or contractor personnel, where costs are calculated and compared without discounting.[4]

The following are examples of DoD economic analyses: (1) during system acquisition, trading the acquisition cost of a modification to the O&M cost impact; (2) performing an analysis of alternatives in advance of system acquisition; and (3) during the O&M phase, conducting a business-case analysis to select a source of supply and maintenance.

Spending on near-term development and production to yield long-term O&M savings is an example of using a cost-benefit analysis. Since both the costs and the savings are measured in dollars, they can be discounted and a net present value calculated (the costs are treated as negative numbers). If the net present value is positive, the modification is a positive investment and current policy indicates that it should be pursued.

If the span of the project were 20 years, the OMB discount rate in 2012 would be 1.7 percent for constant-dollar (uninflated) costs. Since this is the Treasury's cost of borrowing, the implication of this choice is that the Treasury would have to borrow less (Krahn and Gafni, 1993). This is not always a realistic assumption, since DoD funds are programmed within high-level constraints such as the Defense Planning and Programming Guidance and related service constraints. Changes in the distribution of funds due to the decision on whether or not to pursue an individual system modification are often compensated with changes to funding distributions for other defense activities during the development of the Services' Program Objective Memorandums. This results in some areas within DoD operating with a cost of capital that is essentially 0 percent. Discounting makes sense where decisions affect total department funding. An example of this would be deciding which of several programs to cancel. Canceling the program with the highest present-value cost would save the government the most money overall. The decisionmakers would, of course, also have to consider the distribution of appropriated funds and the relative nonmonetary benefits of the alternatives.

Discussion

Current policy calls for using the Treasury's cost of borrowing as a discount rate in performing economic analyses. Since this rate varies, decisions made early in a program's life cycle might in the end have been wrong. The majority of decisions address cash flows that are completely within the financial envelope of DoD operations. Regardless of the choice, Treasury borrowing is not affected, indicating that a zero discount rate would reflect the financial impact on DoD. Where decisionmakers using discounted cash flows choose an alternative that has a higher undiscounted cost, there will be less funds available for other programs within the department's financial constraints.

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[4] See U.S. Department of Defense, 1995.

Discounting DoD cash flows makes sense where decisions are made at the margin of the financial program and where real change to Treasury borrowing can be affected. The uncertainty of those cash flows should be addressed, as should the uncertainty in the discount rate.

CHAPTER FOUR

New Approaches to Inflation and Discounting

Escalating for inflation and analyzing net present value (discounting) are second nature for weapon programs and cost estimators, but they currently rely on aggregate measures rather than system-specific measures. We propose that using a more nuanced approach to inflation and discounting will ensure that estimates more accurately reflect the costs that future programs will experience. We offer some recommendations to help cost estimators inform program decisionmakers, as well as future policy and guidance that CAPE can encourage.

Next Steps for Inflation

Comparisons of the specific indices for the Abrams and Bradley vehicles with the official index show that the experience of each system with inflation can be underestimated using the official escalation factors. Therefore, analysts need to develop their own inflation indices for consumables and reparables to inform estimates for existing and new systems that are based on analogous systems. For studies where cost analysts are examining the industrial base, the AMDF price is most applicable. For inflation indices to be used in program maintenance budgeting, the exchange price is more appropriate. While these are not official indices, they can provide additional information for decisionmakers in DoD's acquisition community.

Our efforts to build an index of this nature for a tactical vehicle indicated that not all variants experience inflation equally. Therefore, analysts should pick variants that are most similar to the future system. This selection must ensure that a sufficient percentage of the total NIINs in the analogous systems is represented. The best way to increase the number of NIINs represented is to examine inflation over short periods of time, such as 5-year increments, since modifications over time decrease the number of common NIINs. The increment of time should be short enough to capture changes caused by obsolescence and major modifications to the platform. That way, the cost estimates will be less affected by low-demand items not being demanded in some years and the changing selection of parts on a platform over time.

As these are unofficial indices, cost analysts can apply them to constant-year dollars to create a realistic then-year outlook. Then estimates can be adjusted into base-year dollars using the broader O&M indices to yield system-specific inflation-adjusted base-year estimates that will inform future resource allocation and affordability discussions. This allows the entire budgeting system to continue to use common inflation indices for uniform budget policy while capturing system-specific risk in the estimates.

Additionally, the development of system-specific indices is valuable for existing programs. These indices highlight areas where a program may be having issues with maintainability and reliability that are worth investment. They can also improve the updated O&M estimates that the program occasionally develops.

At the guidance and policy level, the role of supply chain surcharges in parts-cost inflation should be highlighted. CAPE should instruct cost estimators to show variation in working-capital surcharges and use that variation to inform program risk analysis. In addition, CAPE should enable calculation of system-specific indices through an online tool in O&S cost reporting systems or provide a handbook on how to implement system-specific indices at the program level.

Next Steps for Discounting

Cost estimators should provide program decisionmakers with enough information to understand the resource-allocation alternatives available. We recommend that program cost estimators perform the following steps for each life-cycle cost-effectiveness or cost-benefit analysis:

1. Calculate the net present values of the constant-dollar alternatives, using the appropriate Treasury rate from OMB Circular A-94, Appendix C.
2. Refer to the Table of Past Years Discount Rates in OMB Circular A-94 to develop a range of recent discount rates to use in a sensitivity analysis.
3. Compare the undiscounted constant-dollar costs of the alternatives. This is the typical treatment of the cash-based federal budget (Kohyama, 2006).

These actions should enable estimators to discuss the risk of extending the life of the program, increased modifications to the initial system, changes in discount rates, and other considerations that may change the outcome of the analysis. The process would allow decisionmakers to fully consider the costs of signing up DoD to more-expensive ongoing O&S budgets and would give programs the ability to justify up-front investment if it would result in lower ongoing maintenance costs.

At the policy level, there are multiple paths forward. There is a current disconnect among the incentives of the government as a whole and those of DoD in analyzing alternative courses of action. To perfectly align incentives, DoD would need to experience the time value of money. This could be done if DoD had the ability to invest a portion of its funds for later use, but legislative constraints and the current funding environment likely preclude such solutions.

Another alternative would be to shift the discounting requirement from a single discount rate to a range of rates that account for a more comprehensive treatment of the possible financial outcomes. This would allow decisionmakers to see the impact the discount rate is or is not having on the long-term affordability of a program. This alternative would require revising the existing DoD Instructions.

It is obviously important to escalate dollars for inflation and to acknowledge the time value of money for the U.S. government, but existing blanket approaches could be made more useful with the information cost analysts have at their disposal today. By ensuring that inflation indices are relevant and the risk associated with discounting future maintenance costs is appropriately highlighted, programs can work toward being more affordable for the military in the future.

APPENDIX

Inflation Estimates over Time

To support our analysis of future inflation predictions, we collected data from the DoD budget (the Green Book) on inflation indices through time. The tables in the budget show not only current-year estimates and predictions for future inflation but also prior-year estimates and predictions for four different indices. The first is the DoD budget authorization (Table A.1). Table A.2 shows DoD outlay, where the index accounts for the actual spending rates of the budget, rather than all spending occurring in the year of obligation. Table A.3 shows the change in GDP over time plus future predictions. Table A.4 shows forecasts using the CPI-W.

The variation in future inflation predictions in each chart is highlighted by conditional formatting. The lowest values appear in deep blue, and the highest values appear in deep rose. Values that are at the 50th percentile are unshaded. All others are shaded according to their percentile.

Table A.1
DoD Budget Authorization

Forecast Date	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jan-87	2.9																									
Jan-88	2.9	2.9																								
Jan-89	2.5	2.3	2.1																							
Jan-90	3.7	3.5	3.3	3.1																						
Jan-91	2.9	4	3.8	3.7	3.6																					
Jan-92	2.4	3.7	3.8	3.8	3.8	3.4																				
Mar-93	1.9	3.1	2	2	2.1	2	2.2																			
Jan-94	2	3.3	2.3	2.2	2.6	2.8	2.9	2.9																		
Jan-95	2	3.2	2.7	2.5	2.8	2.9	2.9	2.9	2.7																	
Jan-96	2	3.2	2.7	2	2.3	2.5	2.5	2.4	2.4	2.4																
Jan-97	2	3	2.4	2	2.3	2.5	2.6	2.2	2.3	2.4	2.4															
Jan-98	1.9	2.9	2.3	1.9	2.1	2.2	2.2	2.1	2.2	2.2	2.3	2.4														
Jan-99	1.9	2.9	2.3	2	2.1	2.1	2	2	2.3	2.5	2.5	2.6	2.7													
Jan-00	2.1	2.9	2.2	2	2.1	2.1	2.1	2	2.2	2.8	2.2	2.2	2.4	2.4												
Jan-01	2.2	2.9	2.2	2	2.2	2.2	2.3	2.2	2.5	2.8	2.9	2.4	2.6	2.7	2.7											
Jan-02	2.2	2.4	2.2	2	2.2	2.2	2.4	2.4	2.6	3	3	2.2	2.4	2.5	2.5	2.5										
Jan-03	2.2	2.2	2.2	2.1	2.2	2.2	2.5	2.5	2.6	2.9	2.7	2.1	2.3	2.3	2.4	2.4	2.4									
Jan-04	2.3	2	2.1	2.1	2.2	2.2	2.6	2.6	2.6	2.9	2.8	2.6	2.3	2	2.4	2.5	2.6	2.6								
Jan-05	2.6	2	2.2	2.1	2.2	2.3	2.5	2.4	2.6	2.9	2.7	2.8	2.8	2.9	2.3	2.4	2.5	2.5	2.6							
Jan-06	2.6	1.9	2.1	2.1	2.2	2.3	2.5	2.6	2.6	3	2.7	2.9	3.1	3.2	2.9	2.4	2.5	2.4	2.5	2.5						
Jan-07	2.7	1.8	2.1	2.1	2.2	2.3	2.6	2.6	2.5	3	2.6	3	3.2	3.4	3.8	2.7	2.6	2.6	2.5	2.5	2.5	2.5				
Jan-08	2.9	1.1	2	2.3	2.3	2.5	2.7	2.6	2.6	3.2	2.7	3.2	3.3	4.1	3.3	2.6	3	2.4	2.4	2.4	2.5	2.5				
Feb-09	2.6	0.9	2	2.3	2.3	2.4	2.8	2.7	2.6	3.1	2.8	3.4	3.1	4	3.4	2.6	2.7	1.6	1.9	2.5	2.5	2.5	2.5	2.5		
Feb-10	2.9	0.9	2	2.3	2.3	2.5	2.9	2.8	2.6	3.2	2.7	3.5	3.3	4.1	3.3	2.7	2.9	1.3	2.1	1.6	2	2	2.1	2.1		
Feb-11	2.9	0.8	2	2.3	2.3	2.5	2.8	2.7	2.6	3.2	2.7	3.4	3.3	4.2	3.3	2.7	2.9	1.3	2.1	1.5	1.5	2	2.1	2.1	2.1	
Feb-12	3	0.8	2	2.3	2.4	2.5	2.8	2.7	2.6	3.2	2.6	3.3	3.3	4.2	3.3	2.7	3	1.3	2.3	2.1	1.9	1.6	1.5	1.5	1.7	1.8

Table A.2
DoD Outlay

Forecast Date	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jan-87	3																									
Jan-88	3.2	3.2																								
Jan-89	2.9	2.5	2.1																							
Jan-90	4	3.7	3.4	3.1																						
Jan-91	3.1	4	3.9	3.7	3.6																					
Jan-92	2.2	3.7	3.8	3.9	3.8	3.4																				
Mar-93	2.1	3.1	2	2	2.1	1.9	2.2																			
Jan-94	2.1	3.3	2.2	2.2	2.6	2.8	2.8	2.8																		
Jan-95	2.1	3.3	2.4	2.4	2.8	3	2.9	2.9	2.7																	
Jan-96	2.1	3.3	2.4	1.9	2.2	2.5	2.5	2.5	2.4	2.4																
Jan-97	2.1	3.3	2.4	1.9	2.2	2.5	2.6	2.2	2.3	2.3	2.3															
Jan-98	2.1	3.3	2.4	1.9	2.2	2.3	2.2	2	2.2	2.2	2.2	2.1														
Jan-99	2.1	3.3	2.4	1.9	2.2	2.3	1.9	1.8	2.2	2.6	2.4	2.4	2.7													
Jan-00	2.1	3.3	2.4	1.9	2.2	2.3	1.9	1.8	2.2	2.8	2.1	2	2.4	2.4												
Jan-01	2.1	3.3	2.4	1.9	2.2	2.3	1.9	1.8	2.6	2.8	2.9	2.3	2.7	2.7	2.7											
Jan-02	2.1	3.3	2.4	1.9	2.2	2.3	1.9	1.8	2.6	3	3.2	2.1	2.4	2.4	2.5	2.6										
Jan-03	2.1	3.3	2.4	1.9	2.2	2.3	1.9	1.8	2.6	3	2.8	1.9	2.3	2.3	2.4	2.4	2.4									
Jan-04	2.1	3.3	2.4	1.9	2.2	2.3	1.9	1.8	2.6	3	2.8	2.3	2.5	1.9	2.3	2.4	2.5	2.6								
Jan-05	2.1	3.3	2.4	1.9	2.2	2.3	1.9	1.8	2.6	3	2.8	2.3	2.9	2.9	2.2	2.5	2.5	2.5	2.6							
Jan-06	2.1	3.3	2.4	1.9	2.2	2.3	1.9	1.8	2.6	3	2.8	2.3	2.9	3.5	3	2.4	2.5	2.4	2.5	2.5						
Jan-07	2.1	3.3	2.4	1.9	2.2	2.3	1.9	1.8	2.6	3	2.8	2.3	2.9	3.5	4	2.7	2.6	2.7	2.5	2.5	2.5	2.5				
Jan-08	2.1	3.3	2.4	1.9	2.2	2.3	1.9	1.8	2.6	3	2.8	2.3	2.9	3.5	4	2.8	3	2.4	2.4	2.4	2.5	2.5				
Feb-09	2.1	3.3	2.4	1.9	2.2	2.3	1.9	1.8	2.6	3	2.8	2.3	2.9	3.5	4	2.8	3.2	1.8	1.6	2.3	2.4	2.5	2.5	2.5		
Feb-10	2.1	3.3	2.4	1.9	2.2	2.3	1.9	1.8	2.6	3	2.8	2.3	2.9	3.5	4	2.8	3.2	1.6	2	1.4	2	2	2.1	2.1		
Feb-11	2.1	3.3	2.4	1.9	2.2	2.3	1.9	1.8	2.6	3	2.8	2.3	2.9	3.5	4	2.8	3.2	1.6	2	1.5	1.4	2	2.1	2.1	2.1	
Feb-12	2.1	3.3	2.4	1.9	2.2	2.3	1.9	1.8	2.6	3	2.8	2.3	2.9	3.5	4	2.8	3.2	1.6	2	2.1	2	1.6	1.4	1.5	1.7	3.5

Table A.3
GDP

Forecast Date	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jan-87	2.5																									
Jan-88	2.8	2.3																								
Jan-89	2.8	2.3	1.8																							
Jan-90	4	3.7	3.4	3.1																						
Jan-91	4.1	3.7	3.6	3.5	3.4																					
Jan-92	3.1	3.3	3.3	3.3	3.2	3.2																				
Mar-93	2.8	2.4	2.4	2.3	2.3	2.2	2.2																			
Jan-94	3	2.7	2.5	2.8	2.9	3	3	3																		
Jan-95	3	2.4	2	2.7	3	3	3	3	3																	
Jan-96	3	2.4	2	1.9	2	2.2	2.2	2.3	2.2	2.2																
Jan-97	2.9	2.6	2.3	2.5	2.2	2.5	2.6	2.6	2.6	2.6	2.6															
Jan-98	2.9	2.6	2.4	2.6	2.3	2.2	1.9	2	2.1	2.2	2.2	2.2														
Jan-99	2.9	2.6	2.4	2.4	2	1.9	1.2	1.3	2	2.1	2.1	2.1	2.1													
Jan-00	2.3	2.5	2.3	2.1	1.9	1.7	1.3	1.3	1.5	2	2	2	2	2												
Jan-01	2.6	2.4	2.2	2.2	2	2	1.4	1.4	1.9	2.1	2.1	2.1	2.1	2.1	2.1											
Jan-02	2.6	2.4	2.2	2.2	2	1.9	1.4	1.3	2.1	2.3	2.2	1.8	1.7	1.8	1.9	1.9										
Jan-03	2.6	2.4	2.2	2.2	2	2	1.4	1.3	1.9	2.4	1.3	1.3	1.5	1.5	1.6	1.7	1.8									
Jan-04	2.5	2.3	2.1	2.1	1.9	1.7	1.2	1.3	2	2.3	1.8	1.6	1.3	1.2	1.5	1.7	1.9	2								
Jan-05	2.5	2.3	2.1	2.1	1.9	1.7	1.2	1.3	2	2.4	1.9	1.8	2	2	2	2.1	2.1	2.1	2.1							
Jan-06	2.5	2.3	2.1	2.1	1.9	1.7	1.2	1.3	2	2.4	1.9	2	2.4	2.8	2.5	2.2	2.2	2.1	2.1	2.1						
Jan-07	2.5	2.3	2.1	2.1	1.9	1.8	1.2	1.3	2	2.4	1.9	2	2.6	3	3.1	2.5	2.4	2.3	2.2	2.1	2					
Jan-08	2.5	2.3	2.2	2.1	1.9	1.7	1.2	1.3	2	2.4	1.9	2	2.6	3.2	3.3	2.7	1.9	2	2	2	2	2				
Feb-09	2.5	2.3	2.1	2.1	1.9	1.8	1.2	1.3	2	2.4	1.9	2	2.6	3.2	3.4	2.7	2.4	1.5	1	1.4	1.7	1.8	1.8			
Feb-10	2.6	2.2	2.1	2.1	1.9	1.8	1.3	1.3	2	2.4	1.6	2.1	2.6	3.3	3.4	2.9	2.3	1.5	0.9	1.1	1.6	1.7	1.7	1.7		
Feb-11	2.6	2.2	2.1	2.1	1.9	1.8	1.3	1.3	2	2.4	1.6	2.1	2.6	3.3	3.4	3	2.3	1.3	0.8	1.3	1.4	1.6	1.7	1.7	1.7	
Feb-12	2.6	2.2	2.1	2.1	1.9	1.8	1.3	1.3	2	2.3	1.7	2	2.5	3.3	3.4	3	2.3	1.4	0.9	2	1.9	1.7	1.6	1.8	1.8	1.8

Table A.4
CPI-W

Forecast Date	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jan-87	2.4																									
Jan-88	2.8	2.3																								
Jan-89	2.8	2.3	1.8																							
Jan-90	3.9	3.7	3.4	3.1																						
Jan-91	4.1	3.8	3.6	3.5	3.4																					
Jan-92	2.8	3.2	3.2	3.2	3.2	3.2																				
Mar-93	2.8	3.1	2.7	2.7	2.7	2.7	2.7																			
Jan-94	2.8	2.9	2.7	3.1	3.3	3.3	3.4	3.4																		
Jan-95	2.8	2.9	2.5	3	3.2	3.2	3.2	3.2	3.1																	
Jan-96	2.8	2.9	2.5	2.9	2.6	3	2.9	2.8	2.8	2.8																
Jan-97	2.8	2.9	2.5	2.9	2.8	2.8	2.6	2.7	2.7	2.7	2.7															
Jan-98	3	3.1	2.6	2.8	2.8	2.7	2.1	2.2	2.2	2.3	2.3	2.3														
Jan-99	3	3.1	2.6	2.8	2.8	2.6	1.6	2	2.3	2.3	2.3	2.3	2.3													
Jan-00	2.8	2.9	2.5	2.9	2.8	2.6	1.4	1.9	2.7	2.4	2.5	2.6	2.6	2.6												
Jan-01	2.8	2.9	2.5	2.9	2.8	2.6	1.4	1.9	3.3	3.4	2.8	2.6	2.5	2.5	2.5											
Jan-02	2.8	2.9	2.5	2.9	2.8	2.6	1.4	1.9	3.3	3.2	1.7	2.3	2.3	2.3	2.4	2.4										
Jan-03	2.8	2.9	2.5	2.9	2.8	2.6	1.4	1.9	2.7	2.4	1.2	2.2	2	2.1	2.1	2.2	2.2									
Jan-04	2.8	2.9	2.5	2.9	2.8	2.6	1.4	1.9	2.7	2.4	1.2	2.3	1.5	1.4	1.7	2	2.3	2.5								
Jan-05	2.8	2.9	2.5	2.9	2.8	2.6	1.4	1.9	2.7	2.4	1.2	2.3	2.2	2.8	2.2	2.4	2.4	2.4	2.4							
Jan-06	2.8	2.9	2.5	2.9	2.8	2.6	1.4	1.9	2.7	2.4	1.2	2.3	2.2	3.4	3.5	2.4	2.4	2.4	2.4	2.4						
Jan-07	2.8	2.9	2.5	2.9	2.8	2.6	1.4	1.9	2.7	2.4	1.2	2.3	2.2	3.4	3.7	2	2.6	2.6	2.5	2.4	2.3	2.3				
Jan-08	2.8	2.9	2.5	2.9	2.8	2.6	1.4	1.9	2.7	2.4	1.2	2.3	2.2	3.4	3.8	2.2	3.2	2.1	2.3	2.3	2.3	2.3				
Feb-09	2.8	2.9	2.5	2.9	2.8	2.6	1.4	1.9	2.7	2.4	1.2	2.3	2.2	3.4	3.8	2.2	4.8	-0.9	1.4	1.7	2	2.1	2.1	2.1		
Feb-10	2.8	2.9	2.5	2.9	2.8	2.6	1.4	1.9	2.7	2.4	1.2	2.3	2.2	3.4	3.8	2.2	4.8	-0.8	2.2	1.4	1.9	2	2	2		
Feb-11	2.8	2.9	2.5	2.9	2.8	2.6	1.4	1.9	2.7	2.4	1.2	2.3	2.2	3.4	3.8	2.2	4.8	-0.8	2.2	1.4	1.7	1.9	2	2	2	
Feb-12	2.8	2.9	2.5	2.9	2.8	2.6	1.4	1.9	2.7	2.4	1.2	2.3	2.2	3.4	3.8	2.2	4.8	-0.8	2.2							

Glossary

AMDF unit price. The purchase price of a National Item Identification Number (NIIN) as identified by the Army Master Data File (AMDF). The AMDF unit price is equal to the latest acquisition cost plus a surcharge and is sometime known as the standard price.

Consumables. Any part that cannot be sent to the depot or any other special maintenance activity for repair. Any part that is not a reparable is a consumable. See *reparables* below.

Cost-benefit analysis. An analysis in which costs and benefits are monetized and compared. A concept or alternative can then be selected because it has positive benefits or the best cost-benefit ratio. Monetizing intangible benefits and performance characteristics can be difficult in the defense environment, so cost-effectiveness analysis is often used instead.

Cost-effectiveness analysis. An analysis in which costs are compared to metrics that measure the differing performance characteristics of alternative concepts or programs.

Discounting. The process of reducing a future amount of spending to present values. For DoD projects, the real and nominal discount rates are based on Treasury borrowing rates. The discount rate varies by the length and starting year of the project.

Exchange price. AMDF price – ((serviceable value * serviceable rate) + (unserviceable value * unserviceable rate)). The exchange price is also known as the as the single stock fund price.

Growth rate. A term used to highlight the difference in prices from one year to the next. Each growth rate is the change for one year. See *inflation index* for cumulative impact.

Inflation. The increase in the general level of prices in the economy. Prices may not rise evenly, and not all prices may be rising. Some prices may be constant, while others actually may fall over the period of interest.

Inflation index. A table or figure with a base year given a value of 1 that shows how prices have changed relative to that base year over time. The figures in this report show the cumulative impact of inflation over time. The difference from one year to the next is the *growth rate*.

Latest acquisition cost. The acquisition cost of an item that reflects the last time a representative quantity of the item was acquired from its vendor. It equals the total cost of purchased items divided by the total quantity purchased.

Nominal dollars. Dollars that have not been adjusted for inflation to a particular base year but rather refer to a value expressed in dollars of a specific day/month/year.

Outlay rates. The percentage distributions over several years in each budget category that are used to create weighted indices.

Raw indices. Inflation indices used for funding that is spent in one year.

Real dollars. Dollars that have been adjusted for inflation from the original year of expenditure to a specific year of interest.

Reparable. An item defined using two fields from the AMDF: the Maintenance Repair Code (MRC) and the Automatic Return Item (ARI) code. Records having an MRC of D or L are considered reparables; F, H, or O and an ARI of C, E, R, or S are also considered reparables. Typically, these parts must have a depot repair program. Many items are reparable in real life but do not have a formal depot program. All other codes are considered consumables.

Single stock fund price. A calculated value that takes the AMDF price ((serviceable value * serviceable rate) + (unserviceable value * unserviceable rate)). It is also known as the exchange price. When multiplied by quantity, it is the cost to the consumer.

Standard price. The latest acquisition cost plus a surcharge, also known as the AMDF price.

Weighted indices. Inflation indices that are used to adjust for funding that will be appropriated in one year but spent over two or more years.

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Inflation indices and discount rates are necessary tools in the Department of Defense's (DoD's) acquisition process, as the final selection of a system is partially based on potential increases in sustainment costs (inflation) and the present value of future costs (discounting). Inflation indices built for DoD use very broad categories that include operations and maintenance (O&M) as well as manpower, procurement, and research and development. This study addresses the question of how well current inflation indices and discount rates are serving DoD weapon-system program management. It investigates inflation rates for parts for the Abrams tank and the Bradley armored personnel carrier and shows that the two weapon systems, while both ground systems, experience inflation differently. Although government decisionmaking can benefit from discounting (taking into account the time value of money), choices made using discounted cash flows are not always the least expensive for DoD. Its O&M estimating strategies should be reviewed to reflect changing repair and other costs, since a range of reasonable courses of action exists for many DoD investment decisions. Recommendations for the Office of Cost Assessment and Program Evaluation to consider when evaluating the inflation and discounting policies that impact the long-term affordability of DoD programs include (1) revisiting O&M costs annually with a 5-year moving-average inflation, to reflect changing repair and other costs; (2) highlighting the role of supply chain surcharges in parts costs in cost estimates used to inform program financial analysis; (3) expanding analysis of investments to ensure consideration of least-cost outcomes.

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