The Cost of Instability in Defense Spending

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ABSTRACT

Budget instability like that seen in defense over the past 20 years costs defense about 15 percent of its force levels. This result derives from a dynamic simulation of the defense resource allocation process. The simulation assumes fiscal constraints, and uncertainty in planned future budgets. Inefficiencies depend on the severity of budget changes from budgets planned to those actually received. The effects of instability on the Army, Navy, and Air Force are shown to be quite different, with major determinants being the relative size of acquisition budgets and the life span of assets.

The Costs

Over the past 20 years the Navy received about 1.5 trillion dollars measured in 1988 terms. Annual budgets grew erratically, declining five percent, growing ten percent, declining six percent, etc. That's unstable funding.

If budgets had instead grown at a steady 1.5 percent per year, the same 1.5 trillion dollars would have yielded 15 percent more forces. The Navy would plan on 17 Carrier Battle Groups in the 1990's, instead of 15.

Budget instability has two components. One is the absolute change, from year to year, in the budget level. The other is the uncertainty of those changes. If budgets are erratic, but known, then the effects of unstable funding are much less severe.

If the Navy had known its topline funding a year in advance, then the loss in force levels would be about five percent instead of 15.

Figure 1 provides perspective on the Navy. The top line show force levels if budgets had grown steadily. The second line shows the effects of erratic funding, but with planned budgets equalling actual budgets. The bottom line shows what happens when planned budgets are estimated, and then changed to match actual funding.

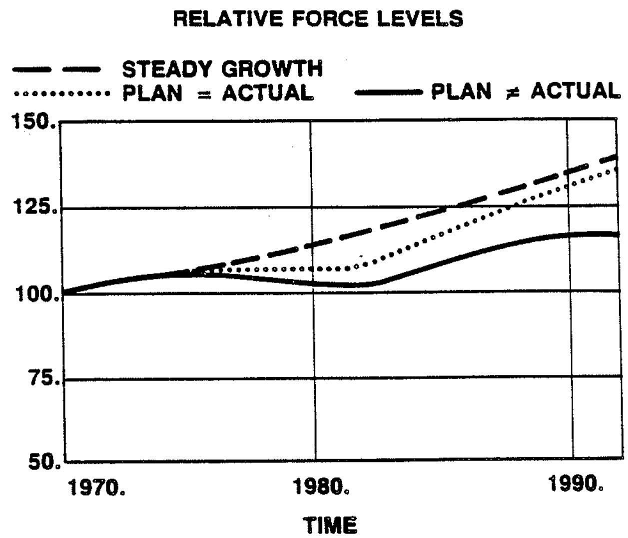

FIGURE 1. FORCE LEVELS AND BUDGET STABILITY.

Analogous results apply to the other services, though their growth patterns differ.

Much of the instability in funding comes from not knowing, when plans are made, how much funding congress will provide. But much also comes from defense planners assuming that budget growth will be greater than is warranted by past growth patterns. More realistic estimates of future budgets would negate much of the instability.

Acquisition versus Ownership

When budgets suddenly change, force levels do not ... not right away. Weapon systems stay active until they age enough to be inactivated. Forces therefore change slowly, so their demand for "ownership" funds (operating, maintenance, manpower, and support) change slowly too. That implies that unless ownership accounts are under funded, or inactivations are forced prematurely, budget changes must be absorbed by the acquisition accounts.

For crude perspective, if acquisition is one half of the total budget, then a five percent change in overall funding translates into a ten percent change in acquisition. If acquisition is a third of the budget, then a five percent budget reduction means a fifteen percent reduction in acquisition.

That acquisition budgets are the "swing" accounts is confirmed by historical data. Figure 2 compares fractional changes in actual defense budgets with changes to procurement accounts. When budgets change, the proportional changes to procurement are two or three times greater.

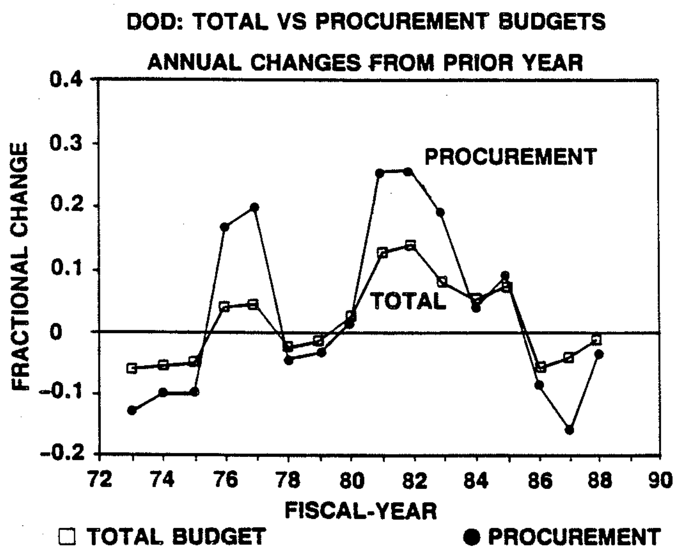

FIGURE 2. PROCUREMENT SENSITIVITY.

These dramatic budget changes affect unit costs and quantities produced.

Cost/Quantity Dynamics

There is a necessary relationship between unit costs, quantities procured, and the procurement budgets available. This triple relationship can be derived from logic and confirmed by historical data.

The data shows there is a different relationship between these factors for **assumed** budget changes -- as when plans are made -- and for **unexpected** budget changes -- as when plans are revised. This is a key difference.

Suppose a service plans on a five percent budget increase, and a year later that planned increase is negated. There is a net zero percent change, but unit costs will rise about ten percent due to the plan change. There would be no increase if the zero percent change had been planned.

The difference is embedded in the "elasticity" of unit cost with respect to quantities: how much unit costs change, proportionately, when quantities change. Historical data from 1976 through 1987 shows that this elasticity is about twice as large when changes are **unplanned** than when changes are planned.[1]

The logic behind these differing elasticities is that changes to plan occur later in the planning cycle, causing inefficient adjustments to production plans. Changing the architect's drawings late in the process is costly even if construction of the house hasn't begun. Perhaps the builder has less reason to bid low if he knows the buyer needs the house soon. Whatever their cause, the two elasticies result from the actual historical data.

This all means changing plans is costly. More is spent buying less. Furthermore, over time, the annual unit cost inefficiencies become embedded in the cost estimating relationships used to derive future costs. Estimates for future systems become inflated. Figure 3 shows typical unit cost trends under steady growth (bottom line), erratic growth with planned budgets equalling actuals (middle line), and erratic growth with planned budgets not equalling actuals (top line). The growth in unit costs under uncertain, erratic budgets is about four percent per year greater than under stable funding. Note that over two thirds of the relative unit cost rise is due to uncertainty, that is planned funding not equalling actual funding.

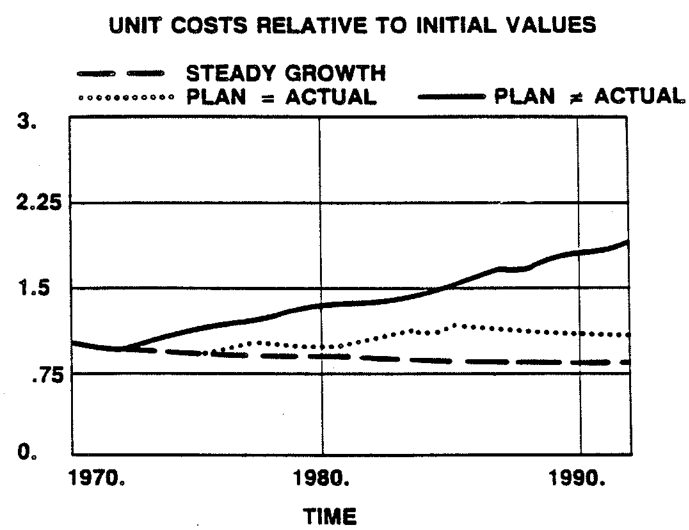

FIGURE 3. UNIT COSTS AND BUDGET STABILITY.

Interservice Dynamics:

Consider the following graphs showing the force levels relative to their initial levels, for the Army, Navy and Air Force. Each graph compares the force levels that would occur under stable funding and unstable funding. The total funds obligated by each service approximately equal those actually obligated over the past 20 years.

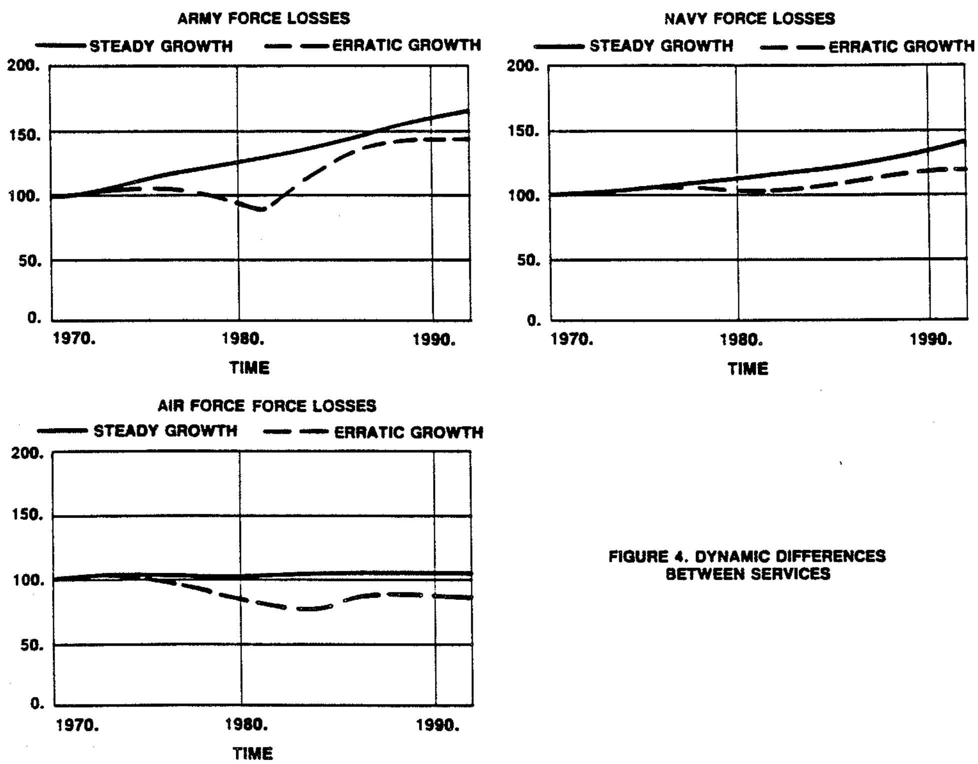

FIGURE 4. DYNAMIC DIFFERENCES BETWEEN SERVICES

The curves are not meant to provide absolute values for force levels, but rather to yield insight into the affects of instability. Absolute values are affected by things such as individual valuation of specific units, and the inclusion or exclusion of system categories like ballistic missiles. Nonetheless, the relative levels of the three services shown are fairly consistent with the results of a congressional report which found Army assets growing about twice as fast as the Navy's, and the Navy's about twice as fast as the Air Force -- during the 1970's and 1980's.[2]

There are two main observations from figure 4. Army dynamics -- the variance between steady and erratic growth -- are more extreme than the Air Force, and the Navy is the most stable of all. Budget changes to the Army cause fairly extreme changes to force levels in the near term. Thus Army assets suffer dramatically in the seventies and again in the late 1980's, when budgets were scarce.

The second observation is that while the Army is affected quickly, it also recovers rapidly after periods of budget growth, as in the early 1980's. The Navy, on the other hand, slowly losses force assets over the entire time span. The effect on the Air Force is somewhere in between.

More specifically, the Navy consistently loses relative forces over the 20 years of instability, so that its worst case occurs at year 20. The Army has 40 percent less forces at the midpoint, then starts gaining relatively, so that after 20 years it has only ten percent fewer forces than under stable funding. The Air Force has over 20 percent fewer forces at about year 16, then ends up with about a 14 percent difference by the 20th year.

These differing dynamics depend mainly on two things: the relative magnitude of acquisition budgets as fractions of the total budget, and the life span of the systems acquired.

Recall that acquisitions are forced to absorb most of the changes to a budget. Army acquisitions, which are a relatively small part of the Army total, are therefore hit hardest by budget changes. Army procurements, which are about of 20 percent of its overall budget, cannot absorb a 5 percent cut in the overall budget as easily as Navy procurements, which are about 40 percent of its budget.

Yet the Army recovers faster because its systems have shorter life spans than the Navy's 30 year ships. Army systems inactivate more rapidly in the years after budget cuts, leaving less systems to be supported thereafter. That, in turn, means more funds from subsequent budgets can be used to rebuild forces. Meanwhile the Navy is stuck with ships for two or three decades.

There is another implication. During periods of extreme budget reductions, the Army is more likely to be forced to reduce the readiness of existing forces. This is so because support funds, operations and maintenance funds, and manpower must absorb some of the budget reductions; procurement budgets are not large enough to do so themselves. The Army's industrial base would be too severely affected by the amplified swings if a large cut was absorbed totally by procurement. In some years, no procurement funds might remain at all were the ownership accounts not reduced.

One way to see the differing effects of budget changes on the services is by imposing an arbitrary cut to each service's topline budget, and observing the results. In the following figure, the vertical axis represents the fraction of the budget going to procurement. The dotted curves are the fraction if budgets grow steadily. The solid curves show the affect of a seven percent decrease in the fifth year of the simulation.

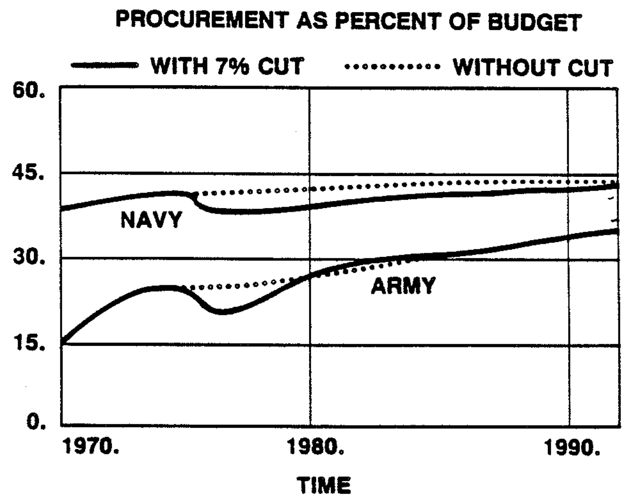

FIGURE 5. PROCUREMENT DYNAMICS.

The maximum difference in the Navy curves is about 8 percent. For the Army, the difference is about 19 percent.

Because Army systems can be inactivated faster, after 1980 less funds are required for ownership accounts, so the procurement budget returns and for a while slightly exceed its steady growth level. There are less forces to support, and therefore more money left over for procurement.

The Navy, meanwhile, must continue to operate and maintain its aging fleet, so procurements do not approach normal levels until 25 or so years have passed.

Policy Implications

Planners can incorporate knowledge of these basic dynamics in their long term considerations of readiness and force levels.

Proper budget policy can aid the resource allocation process. Acquisition budgets, specifically, can be realistic. Such strategic budget planning is particularly needed during periods of large budget reductions, as may be the case in the 1990's.

Efficiency can be increased considerably if planners can be reasonably sure of next year's budget. That does not mean every program manager needs to know his next year's funding level. That would be unrealistic. Efficiency is gained merely by each service knowing next year's **overall** constant dollar budget.[3] For then proper guidance on procurement levels can follow.

Nor is it expected that budgets grow at a steady rate. The knowledge of what the budget **will** be can recapture about two thirds of the losses caused by the uncertainty portions of instability.

Reasonable certainty about next year's budget level can be attained through congressional action. In a one year budget cycle, Congress would need to specify next year's budget before planners began their allocation decisions. In a two year planning process, the second year of the two year plan submitted to Congress, once the budget is approved, must become the first year of the **next** two year plan to be submitted.

With a realistic topline budget, planners can derive what will remain -- in aggregate -- for procurement of new systems, as the ownership funds -- also in aggregate -- demanded by existing forces next year is quite predictable. The cost of operating, maintaining, and manning next year's assets is estimable. Support costs, while less directly related to force levels, can still be estimated in a macroscopic sense.

Individual system acquisitions within the procurement account would, of course, still vie for the available resources. Political and other facts would still cause reallocations of available acquisition funds. But the reallocations would occur within a reasonable limit. Some programs would gain, others lose from planned levels. Overall, the adjustments from plan would net out to about zero. That is not the case if the entire procurement total is to be decreased or increased by 10 to 20 percent.

This is a crucial point. When all programs are cut or expanded, resources cannot be shifted easily. When some gain and others lose, on the other hand, the gainers can absorb the resources given up by the losers. Those expanding can, as one example, hire the engineers let go by the losers. Not so when everyone is hiring, or firing.

The Model

The model is preliminary, but captures most first order dynamics affecting resource allocation. A more detailed model would be appropriate if defense policy makers wish to assimilate this specific form of dynamic analysis into actual defense planning.

The major system states or "levels" are of two types. The is "asset" related -- both dollar value and size of existing forces, and those on order. With statistical data on the demand for operating, maintenance, and manpower funds, these assets determine the protion of the budget needed to operate and maintain current forces.

The second level type is "shortfalls". Shortfalls affect the readiness of forces. Maintenance backlogs, flying-hour and steaming-hour shortfalls, and manpower shortages are examples of shortfalls. When funding is not made available for the ownership accounts, these shortfalls build up, and a divergence between "active" force and "ready" forces emerges. The shortfalls remain to demand future funds if not reduced either through current funding or through accelerated inactivation of the forces, so that less ownership is demanded.

The model allows defense "what-if's". What if fiscal constraints apply? What if readiness is deliberately under funded? What if inactivations are forced? What if budgets are cut five percent a year for several years? What if less manpower intensive forces systems are acquired?

These what-if's are conducted without bogging down in the details of specific program allocations.

Several important relationships are embedded in the model. They can be changed for specific uses. The current model assumes that fiscal constraints apply, that ownership accounts are funded first, but are under funded if procurement residuals are less than a reasonable fraction of that needed to replace inactivating assets. Unit costs are assumed to be impacted by what has been paid for units recently, but only after a lag of several years.

Funding reallocations during times of severe budget reductions are based, roughly, on historical information. Manpower budgets cannot be under funded by more than five percent in a single year, as personnel cannot be forced out any faster than that. Operations/maintenance is limited to a 10 percent under funding per year, and support to 50 percent.

During times of extraordinary budget growth, such as experienced by all services in the early 1980's, the industrial base is assumed to be limited in its growth rate. Expert opinion on industrial base growth lead to limiting the increase in the overall industrial base to five percent, if recent growth had averaged more than 10 percent per year.[4] In other words, while individual firms can grow without bound, the defense industry as a whole cannot grow by more than about 30 percent over a short period, without being limited to five percent growth the following year. Excess funding during those periods leads to rising unit costs ... and inefficiency.

Notes

1. The elasticity for planned changes is estimated to be -.27, and for unplanned changes -.51. These parameters are derived by the author from data collected by James W. Abellera of the Defense Systems Management College. Equations relating budgets, quantities, and unit costs can be shown to be:

Q=(P/K)**(1/(1+b)) and

C=KQ**(b); where

P is the ratio of the new procurement to original procurement, Q is the average ratio of new quantity to original quantity, C is the average ratio of new unit cost to original unit cost, K is the initializing constant and b is the elasticity, a negative number. K was near 1.0 for both sets of data analyzed. The symbol ** means "raised to the power".

2. See Lane Pierrot's "Operation and Support Costs for the Department of Defense", Congressional Budget Office, July 1988.

3. Abellera's work is relevant. The model used here benefits from his analysis, which relates production efficiency for a program on at least three factors: year to year budget changes, changes to the current year's plan, and changes in last year's plan. See the "Spending Instability and Acquisition Costs, Proceedings of the 1989 Acquisition Research Symposium, pages 105-111, available from the Defense Systems Management College, Fort Belvoir, Virginia, 22060, for some of his preliminary findings.

4. Dr. Franz Frisch, of the Defense Systems Management College, provided expert opinion on industrial base issues.