Improving Cost Estimates in the Force Mix Allocation Process for the Active and Reserve Components

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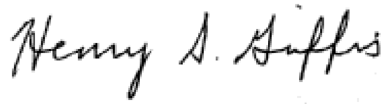

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It does not necessarily represent the opinion of the Department of the Navy.

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Executive summary

Background

Decisions on the allocation of military capability between the active component (AC) and the reserve component (RC) frequently focus on estimates of the relative costs of the components when used in different circumstances. It has been commonly observed, however, that it is possible to derive different and contradictory cost estimates, depending on what factors are included in analyses and the modeling approaches employed. The last few years have seen efforts to standardize approaches to estimating the relative costs of the AC and RC in various circumstances and to place these cost estimates into a broader discussion of all the various factors (both cost- and non-cost-related factors) that should determine the AC/RC force mix.

The Deputy Assistant Secretary of the Navy for Reserve Affairs (DASN RA), Office of the Assistant Secretary of the Navy (Manpower and Reserve Affairs), is concerned that the lack of a widely accepted method for valuing the role of the RC leaves the services at risk of making future force structure decisions based not on rigorous cost-benefit analyses but on more subjective grounds. This issue is important in the current environment given that cuts in service budgets may result in substantial reductions and realignments in both the AC and RC. The DASN RA asked CNA to assess what costing methodologies are most appropriate for the AC/RC force mix allocation process and to consider whether there are well-defined best practices for identifying the roles and missions to which the active and reserve components should be employed.[1]

1 The current analysis considers how the services should use cost comparisons in the process of deciding whether to allocate capability to the active or reserve components. In an earlier work (see Cox [1] (2010)) we considered when it makes sense to integrate the active and reserve components.

Findings

Recent changes in approaches to modeling

Over the last five years, there have been substantial changes in how the services approach AC/RC force mix decisions—both in the models that are used and in the interpretation of cost elements that are employed in these models. Reference [2] (Buck, 2008) discussed some of the most important recent developments in modeling, particularly the introduction of the boots-on-ground (BoG) approach that now underlies cost estimation for forces used in support of recurring, ongoing operations (variants of this model can be applied to ground forces, aviation activities, and even individual augmentees). Although, in the current operational environment, this approach is a significant improvement over previous models (which focused exclusively on the role of the RC as a strategic reserve), the BoG model can be criticized for understating the cost of using the RC as a strategic reserve and overstating the cost of using the RC as an operational reserve.

There is much greater scope than is commonly believed for the cost-effective use of the RC in support of operational deployments

In our 2010 paper, we demonstrated one way that the BoG approach might be modified to better allocate the costs of the RC in both their strategic and operational roles (see [1] (Cox, 2010)). Since then, a few defense analysis organizations and force planning groups have introduced their own approaches to jointly (simultaneously) capturing the value of the RC's operational and strategic roles (such models have been developed by the Army and the Office of the Secretary of Defense (Cost Assessment and Program Evaluation (OSD CAPE)). However, we demonstrate in this analysis that there are still limitations in the way costs are accounted for in these models and that, as a result, there is significantly greater scope than is generally believed for the cost-effective use of the RC in support of operational deployments. We recommend that any comparison of AC and RC costs should not consider the strategic and operational capabilities in isolation, but should simultaneously consider units' strategic and operational roles. Such an approach is likely to generate savings without reducing BoG or breaking dwell time requirements.

Generalizations on the relative costs of the AC and RC

A commonly heard complaint about the force mix allocation process is that it has too often involved estimating values for the relative cost of the AC and RC in narrow circumstances, and then applying these estimates (often inappropriately) across a broad set of situations. This happens because there are many cost factors that should be considered when allocating capability between the AC and RC that are difficult or impossible to measure with accuracy. Policy-makers have often started discussions of force allocation by comparing the easy-to-measure costs for the AC and RC, and then applying expert judgment and best guesses about the other more difficult cost measures.

We identify several situations that enhance the likelihood that the RC would have a cost advantage over the AC in providing planned and predictable deployments of operational units. These include

- capabilities for which a service needs to maintain a strategic force that is significantly larger than its operational force;
- capabilities that are labor-intensive—that may involve significant personnel and operations and maintenance (O&M) costs, but that involve relatively little equipment; and
- capabilities that require relatively less complex training workups between mobilization and deployment.

Additional recommendations

While the capabilities described above are those in which the RC is most likely to enjoy a cost advantage in supporting recurring rotation of operational units, there are likely to be capabilities that do not conform to these characteristics but for which the RC would still have a cost advantage in maintaining an operational presence. Identifying the full set of capabilities in which the RC can support planned and predictable deployment of units should involve detailed community-by-community analyses of alternatives that focus on the changes in resources, activities, and missions that would result from a reallocation of structure. The need for this type of detailed assessment becomes increasingly important as planners consider using components in never-before-used ways.

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Scope of this analysis

This analysis focuses on how the services should compare the net costs of the active and reserve components in various circumstances, and how they can use this comparison to inform decisions about allocating military capabilities across components. The topic is broad, and an exhaustive analysis would require a detailed consideration of many costs associated with various configurations of AC and RC units–many of which would have only small effects on the relative costs of the components.[2] An exhaustive analysis would also catalog the various analytic approaches that might be used in estimating the costs of the components, starting with a primer on cost/benefit techniques, and including linear optimization methods.

In this study, we seek to identify the cost estimation techniques that provide the best guidance for allocating military capability between the active and reserve components. We focus on a small set of models that have been widely adopted in estimating AC and RC costs, we identify shortcomings in these models, and we suggest improved techniques. We also examine the most critical cost data and the various assumptions on which the models are run. Again, we seek to focus on only the most important aspects of analysis—those cost elements and assumptions that have the greatest impact on cost estimates.

An important distinction about models

From the outset, we need to make an important distinction about the types of models and cost elements we are considering. There can be several reasons to estimate the costs of the AC and RC: programming (identifying the amounts that need to be included in the various budget items related to the support of the components), force allocation (e.g., considering how the components will fit into the services' force structure), and gaining insights into particular aspects of how

2 Examples of these costs include day care facilities, subsidized groceries, education assistance, and recruitment and advertising.

the components might be used (for example, assessing the relative speed with which units could be deployed).

Note that models constructed for one purpose are not necessarily useful for other purposes. For example, programming models may be *inappropriate* tools to use when planning how capability should be allocated across the AC and RC: programming models focus on a different set of costs than those that the services should consider in planning the size and shape of their components, and employing cost estimates from programming models could result in inappropriate allocation of capability across components. In this analysis, we focus on force allocation, and we consider the analytic approaches that the services should use in determining the size, structure, and mission areas that are appropriate for the active and reserve components.

Structure of the analysis

We break this study into three broad areas:

1. *A brief description of the general framework for our analysis.* The principal question addressed in this analysis—how to estimate the relative costs of the AC and RC when assigned various capabilities—is best understood within a larger analytic structure that considers a service's demand for different types of resources in meeting its mission goals, the supply of these resources, and the risks that would result if the services have inadequate resources to meet their mission objectives. Modeling initiatives in OSD, the Army, and the Air Force have begun to use this basic framework, and we will orient our analysis with a discussion of this analytic structure.
2. *A review of the models that have been used to assess the relative costs of the AC and RC, and a discussion of the strengths and weaknesses of these approaches when used in different circumstances.* We review three major model types: strategic, operational (BoG), and joint methods (hybrid models that simultaneously reflect the strategic and operational use of the reserve components).
3. *A discussion of the various costs that should be considered when allocating military capability across components.* A wide range of costs can, under different circumstances, be relevant to determining the missions, tasks, and resources assigned to the service's active and reserve force structures. Some of these elements

are easily measured and their role in cost modeling is straightforward. In other cases, data are available on particular types of costs, but the use of these data requires careful and nuanced interpretation. In still other cases, there are costs that are important in determining a service's AC/RC mix, but, because they are not quantifiable, their effects can only enter our analyses indirectly.

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Our analytical framework

During the Cold War and into the last decade, analyses of the allocation of force mix across the active and reserve components usually involved narrow discussions of the *costs* of the AC and RC in fulfilling various military capabilities (and there have been many discussions about precisely which costs should be included in these analyses and what types of models should be used to represent these costs). However, policy-makers have always been cognizant that cost analyses, no matter how well executed, are only one element that must be considered in allocating force mix. Other critical factors that need to be weighed along with costs include:

1. The future demand for forces (combatant commanders' expected requirements)
2. The future supply of forces (the ability of the services to construct different inventories given various limitations, such as end-strength constraints)
3. Critical characteristics of force profiles (e.g., the ability of a particular profile to surge)
4. The risks that are involved if the services fail to meet specific elements of future demand

Although these non-cost-related considerations have always been critical in allocating force mix, in recent years integrating these factors into the force planning process has become increasingly complex, and the services have begun to take a more structured and rigorous approach to modeling these non-cost-related elements. To lay the foundation for our discussion of AC/RC cost estimation, we need to briefly discuss each of these factors because all of these elements interact with and influence each other in the force mix planning process.

The future demand for forces

How the services size and shape their forces will depend, in part, on the types of forces that they expect will be needed in future conflicts and the point in these conflicts at which they expect these forces will be required. These requirements derive from the concepts of operations associated with various threat scenarios and reflect the Department of Defense's (DOD's) assumptions about the types, scale, and timing of possible conflicts. Since the end of the Cold War, there has been greater uncertainty about how the services are likely to use their forces in future conflicts—particularly their reserve forces—and those who plan for force allocation have had less guidance about what to expect regarding future requirements. The need to formally model expected demand as part of the force allocation process is discussed in Klerman [3], Davis [4], and Hansen [5]; this process is now being formally integrated into the force allocation processes for OSD, the Army, and the Air Force.[3]

Increased uncertainty about the future demand for forces can affect the cost of the RC

The increased uncertainty concerning future force requirements has a direct effect on the services' ability to predict the relative costs of the active and reserve components. When the services are less able to predict the mission sets for which their personnel should train, there is likely to be greater need to undertake mission-specific training immediately before deployment. This can increase costs for all units used in phased rotation, but it has a particularly great effect on the costs of the RC.[4] Similarly, the services may respond to uncertainty about future mission requirements by augmenting equipment packages for many

3. Both the Army and OSD CAPE have contracted to build models of future force demand that will interact with AC/RC cost models in combined approaches to allocating forces across the active and reserve components. The OSD CAPE effort is being conducted by the Institute for Defense Analyses (IDA), while the Army effort, which has been contracted by USARMY HQDA DCS G-8, is being undertaken by RAND.

4. In general, reserve units have only 39 days per year to train while in dwell, and they often face additional training requirements immediately before deployment. Any significant increase in the training burden between mobilization and deployment will reduce the amount of deployment time that one can take from RC units (assuming that these units are limited to a one-year mobilization). This, in turn, can greatly increase the cost of using the reserve in sustained, rotating deployments.

types of units in order to better equip units for a wider range of eventualities. As we discuss later in this analysis, the RC is less likely to enjoy a cost advantage over the AC in communities that are more equipment intensive.

Supply of forces

When looking for least-cost methods for meeting the future demand for forces, there are also important elements of force supply that need to be recognized. In addition to the budgetary and endstrength constraints that limit the sizes of the active and reserve components (at least in the short run), there are institutional factors that can have significant effects on force shaping and that can constrain the services' abilities to achieve cost-minimizing allocations of AC and RC in the short and medium terms.

First, many communities in the reserve components benefit from recruiting fully trained personnel from the AC because this keeps their training costs low. Some of these communities, however, already absorb such a large portion of qualified AC personnel that it would not be possible for them to undertake a substantial expansion without bearing the additional costs of recruiting and training non-prior-service personnel. Second, services may need to rebalance their AC and RC components to achieve cost-minimizing force profiles, and these realignments take time. Third, there are geographic constraints on reserve units (which can make it difficult and expensive to undertake combined unit training) and distribution constraints (the need to maintain some ratio of officers to enlisted or of senior enlisted to junior enlisted). Finally, how these forces are employed affects the supply of reserve forces: a high PERSTEMPO can affect the reserve component's ability to recruit and retain.

Critical characteristics of force profiles

Ability to surge

In identifying efficient ways to allocate forces across the AC and RC, a range of other factors (characteristics of particular force profiles) must be considered, and some of these can be difficult to quantify. Among these is the ability of units to surge with little warning and deploy to unexpected operations. The ability of units to surge will depend on where they stand in their training cycle (whether they are preparing for an imminent deployment, standing down from a recent deployment, or in the middle of their dwell phase), how often forces are expected to deploy, and the complexity of the mission for which they train. Also, the ability of the generating force to surge and increase the speed of training plays a role in the ability to operationally surge.[5]

Capacity and other considerations

In addition to the rapidity with which forces can surge, another critical concern is capacity—the number of units that a particular force profile can maintain on deployment. For the Army, Navy Expeditionary Combat Command (NECC), and the Marine Corps, the capacity of the AC and RC is largely driven by service policies regarding Deployment (DEP)/Dwell, Mobilization (MOB)/Dwell, the amount of contiguous training that is provided just before mobilization, and the amount of training that is permitted between mobilization and deployment.

There is also growing recognition within DOD that, in making force allocation decisions for one community in a service, it is often necessary to consider critical interdependencies between communities—both within a service and across services. For example, keeping a capability with rapid surge potential in the AC of one service may enable this capability to be shifted into the reserve component of another service.[6, 7]

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[5] An issue related to capacity to surge is the currency of RC members' training. It may not be obvious whether an RC sailor has the same knowledge, skills and abilities (KSAs) as an AC counterpart, even if the RC member has the same rating and NECs. RC members have less time to train than those in the AC and, as a result, their training may be less current.

[6] See Junor and Dyches [6].

[7] Strategic lift capacity and capability is a constraint that can also affect the ability to surge. Some surmise that the size of the AC should not exceed the lift capacity—the philosophy being that AC forces should fill the initial lift surge giving RC forces time to ready for following lift.

The risk of failing to meet mission requirements

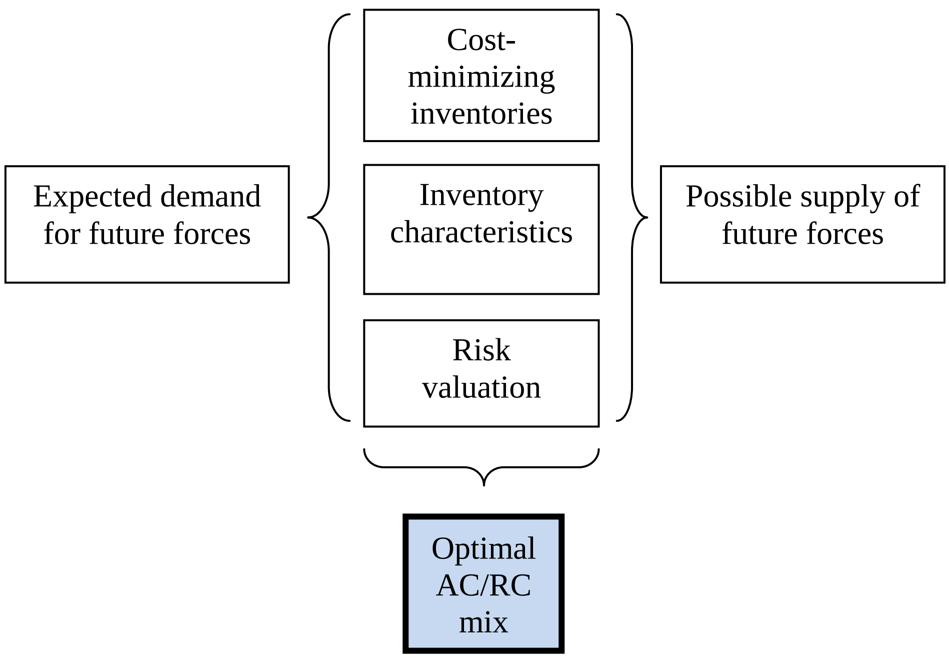
A final consideration when deciding on force mix is risk: what is at stake if a pattern of force allocation fails to provide combatant commanders with the resources they need, when they need them. It is important to counterbalance cost minimization with some explicit valuation of the risk of getting things wrong. Invariably, any force mix will have weaknesses—some communities or missions for which only thin capabilities are provided. If one focuses too intently on cost minimization, it is likely to be the most expensive communities and missions that get short shrift (in the Navy, for example, this might include the aviation communities).

The services have developed different methods for integrating into their force allocation decisions the effects of failing to meet mission requirements. The Marines, for example, use their Force Structure Review (FSR) and Force Optimization Review (FOR) procedures to size and shape their force relative to its mission requirements: when considering how to allocate additional funds, existing gapped billets and resource shortfalls are rank-ordered by their importance to meeting service mission goals. The NECC has contracted the development of a force-planning tool that explicitly links the size of the command's budget to both its ability to surge various types of units and the readiness levels of these units. Similarly, the Air Force's Total Force Enterprise Analytic Framework (TFE AF) constrains model outcomes to ensure that critical communities and capabilities receive adequate funding, regardless of cost minimization objectives. (For example, the Air Force prohibits RC units from working in particular functional areas, such as critical nuclear weapon systems, regardless of cost minimization considerations.)

Bringing the elements together

Figure 1 shows a theoretical schematic of how the various elements of demand, supply, force characteristics, risk, and cost combine in a force mix decision. This reconciliation process ensures that costs alone do not drive AC/RC mix. Note, however, that there is no single, accepted process for balancing all these considerations. The Air Force, for example, uses multiple approaches to reconciling these elements and compares the various outcomes to see how much variation exists across the different methods.[8] The other services apply processes (some less formal than that of the Air Force) that reflect their particular missions, doctrines, and culture.

Figure 1. Reconciling demand, supply, force characteristics, risk, and cost to determine a best AC/RC force mix



8 Given endstrength constraints in various AC and RC communities and particular surge requirements, the Air Force applies a combination of filters to identify the best AC/RC mix by minimizing (1) stress on aircraft, (2) deployment time for servicemembers, (3) cost, (4) the transition of aircraft from one component to another, and (5) the transition of personnel from one component to another. Once these filters have been applied in this order, the service changes the order in which it applies these filters and compares outcomes. Finally the service can change the endstrength constraints on the AC and RC, or the surge requirements, and again apply various combinations of these filters.

Modeling AC and RC costs

In this section, we consider the principal approaches to cost modeling that the services have employed in the past, and we present some of the better known findings that have emerged from these models. To explain important aspects of these approaches, we discuss some of the cost elements on which the models are run. However, we present a more complete discussion of cost elements—their use and interpretation—in a later section of this research memorandum.

AC/RC costs in a strategic environment

The simplest and most straightforward approach to estimating the costs of active and reserve elements applies when both forces are viewed as only part of a strategic reserve—when neither force is expected to contribute to operational activities in the foreseeable future. There have been few, if any, instances when an entire service branch could be characterized as being wholly strategic; some elements are almost always engaged in operational roles. But there are often elements within each service that are not engaged in current operations and whose only purpose for existing is to prepare for some future, as yet unspecified, deployment. The services maintain such forces because, although their near-term employment is unlikely, their immediate availability would be highly valuable if needed.

Throughout the Cold War, it was reasonable to think of large parts of the military as having only a strategic role. In the 40-year period of 1950 to 1989, there were 10 contingency deployments of reserve forces, and only 2 of these—Korea and Vietnam—involved substantial mobilizations of RC personnel. (In contrast, in the 14 years from 1990 to 2003, there were more than 40 contingency deployments, and 5 of these involved substantial mobilization from the RC.)[9]

[9] These included Kuwait Desert Storm (1991), Bosnia (1995), Kosovo (1999), Operation Enduring Freedom (2001), and Operation Iraqi Freedom (2003). Reference [7] (Gibbs, 2004) contains a fuller list of operations that employed mobilized RC personnel.

During the Cold War era, there emerged a generally accepted approach to comparing the costs of the AC and RC that focused exclusively on the expenses of maintaining AC and RC billets (or units) in a strategic posture. These methods did not consider the costs that would have to be borne to mobilize, train, and deploy reserve forces, or to maintain them on an operational footing. A strategic reserve approach continues to be useful in evaluating costs when there is no plan to use reserve forces on a recurring operational basis.

Two approaches to costing a strategic reserve

In [2], Buck describes two approaches to comparing AC and RC costs in a strategic (nonoperational) setting:

1. The "traditional, simple method" compares the proportion of military expenditures on the Guard and Reserve to the proportion of the total force that is resident in the Guard and Reserve.

2. The "cost of Guard and Reserve approach" compares the costs of active and reserve units that are engaged in similar missions (e.g., Army Brigade Combat Teams).

The traditional, simple approach

This method compares budget expenditures for the AC and RC with the total endstrength for these components. There has been disagreement about which precise cost elements should be included in these calculations (and we discuss this issue in a later section) and differences of opinion about the formulas that should be used in producing these estimates, but there is little disagreement that personnel and operations/maintenance elements drive most of the difference in cost between the active and reserve components, and we will initially explain this model using just these cost elements. As table 1 shows, these two costs account for 90 percent of the Navy's financial costs for the RC.

Table 1. Navy Reserve appropriations/categories (costs include OCO, base, and NGREA)

	Billions of dollars	Percentage
Personnel	1.861	55
Operations	1.245	35
MERHCF (Health Care)	0.240	7
Reserve Equipment*	0.070	1
Procurement	0.062	1
Military Construction	0.027	1
Total	3.505	100

Source: Navy Reserve, POM 13 brief [8].
* An estimate based on previous year's appropriation.

An example of simple method using Navy SelRes personnel costs

As of July 2012, the Navy has approximately 321,000 members of the AC, 54,000 Selected Reserve (SelRes), and 10,000 Full Time Support (FTS). While the SelRes comprises about 17 percent of the service's total force (Active Duty plus Selected Reserve), the Navy's personnel budget for the SelRes ($1.861 billion) is only 6 percent of the service's total personnel budget of $29.3 billion (see the Navy Reserve POM 13 Brief [8]; figures do not include funding for USMC or DHAN/DHANR). Another way of stating this is that, when manning an exclusively strategic reserve, personnel costs for the average SelRes member are only about one-third those of the average AC member. This cost advantage is largely driven by the fact that SelRes personnel who are performing their minimum annual training requirement are paid for only 63 days of service per year.[10, 11]

Operations and Maintenance, Navy (OMN) and Operations and Maintenance, Navy Reserve (OMNR)

The next largest cost associated with providing a strategic reserve is for Operations and Maintenance: $41.4 billion for the AC and $1.2 billion for the RC. Here again, the RC has a substantial cost advantage relative to its total manning: when measured in terms of operations and maintenance costs (and considering an exclusively strategic reserve), costs for the average SelRes member are only about one-sixth those of the average AC member.

As table 2 implies, when we add in OMN and OMNR costs to our previous calculations, costs for the average SelRes member in a strategic reserve are only about one-fourth those of the average AC member. We discuss these cost elements in a later section of this document.

Table 2. Personnel and O&M costs by component

	Billions of dollars	
	Active component	Reserve component
Personnel costs	27.400	1.861
Operations and maintenance	41.400	1.245
Total	68.800	3.106

Source: Navy Reserve, POM 13 brief [8].

* O&M for the AC and RC include costs for the Marine Corps Flight Hour program.

10 Unless they are mobilized or employed on voluntary assignments, SelRes members provide 39 days of service each year: 2 days of drill per month and 15 days of annual training. They are paid for 2 days of service for each day of drill and for 1 day of service for each day of annual training.

11 The AC, which comprises 83 percent of the force, costs more than 93 percent of the budget, whereas the RC, which comprises 17 percent of the force, costs about 7 percent of the budget. Expressing these figures as the percentage of the force that can be funded for each percentage of the budget, the RC is only about one-third the cost of the AC. (Both budget and personnel figures include FTS.)

The relative costs of AC and RC BCTs in a strategic reserve

The previous approach considered average relative costs of the strategic reserve in the AC and RC *across an entire service*, but the relative costs of the AC and RC are likely to vary substantially across the communities within a service. For example, operations and maintenance costs are likely to be relatively high in units that have aircraft, and lower in Masters at Arms units. Reference [2] (Buck, 2008) estimates the relative cost of the active and reserve components for a specific type of unit—the Army Brigade Combat Team (BCT). This analysis compares the costs of members of RC BCTs who are engaged only in drilling with the costs of members of nondeployed AC BCTs. This example considers the personnel-related programming cost elements that differ significantly between AC and RC, including basic pay, basic allowances for housing and subsistence (BAH and BAS), health care accrual, retirement accrual, and retired health care accrual. When all these

Table 3. Costs per servicemember in an Army BCT

Cost element	AC	RC	Relative cost
Basic pay	25,961	4,917	18.94
Full-time support	0.00	8,879	NA
BAH and BAS	9,601	0	0
Health care accrual	7,457	0	0
Retirement accrual	8,451	1,216	14.39
Retired health care accrual	11,527	4,424	38.38
Old Age, Survivors, and Disability Insurance and Hospital Insurance Programs	1,986	375	18.88
Subtotal	64,983	19,811	30.49
Operations and maintenance	9,799	2,704	27.59
Training	5,354	4,643	86.72
PCS, direct	17,813	0	0
Grand total	97,949	27,158	27.73

Source: Buck (2008) [2].

personnel costs are considered, Buck estimates that the cost for an average RC member in a BCT is only 30.5 percent the cost of a similar AC member. It is likely that these estimates for personnel costs would be good proxies in other communities, as well: although average personnel costs in both the AC and RC will be correlated with communities' paygrade structures, these differences in force profiles are likely to produce only modest variation across many communities.

There are other per-person costs in the Buck (2008) study, however, that are likely to show substantial variation across different types of units. These include training costs, full-time support of RC units, and permanent-change-of-station (PCS) charges (applied only to the AC). Adding on these additional expenses for the BCTs lowers the relative cost of the RC slightly—from 30.5 percent to 27.7 percent.

A frequently used rule of thumb for the strategic reserve

Buck's analysis suggests that the cost of maintaining an RC member in a drilling BCT is 28 percent of the cost of maintaining an AC member in a comparable nondeployed environment [2]. This estimate is consistent with many previous studies that placed the cost of a drilling RC strategic reserve unit at one-fourth to one-third that of a nondeployed AC unit. For example, Palmer et al. [9] estimated the cost of Army light and heavy divisions in the RC at 23 to 25 percent that in the AC. The Congressional Budget Office (CBO, 1990) suggested the cost of maintaining an Army heavy division in the RC (ARNG) within the continental United States (CONUS) at about 20 percent the cost of maintaining an AC heavy division in the European theater [10]. These estimates also correspond with congressional testimony provided by Warren Lenhart of the Congressional Research Service in 1983:

> the typical Guard and Reserve unit costs only 1/4 to 1/3 as much to operate as its counterpart active unit. In looking at [the highest] cost Guard and Reserve units such as tactical flying units, testimony indicates that reserve component aviation squadrons still only cost about 70 percent of what active units cost to operate. As indicated to the Committee by the Department of Defense, the message of these varying numbers is that reserve units are less expensive than active units, but the savings depend heavily on the degrees of support and level of readiness required of the reserve unit. [11]

Finally, these estimates agree with those recently published by the Reserve Forces Policy Board [12] who indicated that "the cost of an RC service member, when not activated…ranges from 22% to 32% of their AC counterparts' per capita costs, depending on which cost elements are included."

Modeling the cost of a purely operational reserve

With the increased and recurring deployments of the reserve associated with Operation Enduring Freedom (October 7, 2001) and Operation Iraqi Freedom (March 19, 2003), a cost model based solely on the strategic use of the reserve and active components provided inadequate guidance for allocating force structure. Two methods for estimating the cost of the operational use of the AC and RC were developed between 2004 and 2008, and both suggested a substantial reduction in the cost advantage of the RC. However, both approaches suffered from an important limitation: they focused exclusively on the operational use of forces and ignored the value of the ongoing strategic capability that these forces represent. In this subsection, we discuss the uses and limitations of these methods; later, we discuss how models can be constructed to incorporate *both* the strategic and operational uses of the AC and RC.[12]

The "cost of individual members" approach

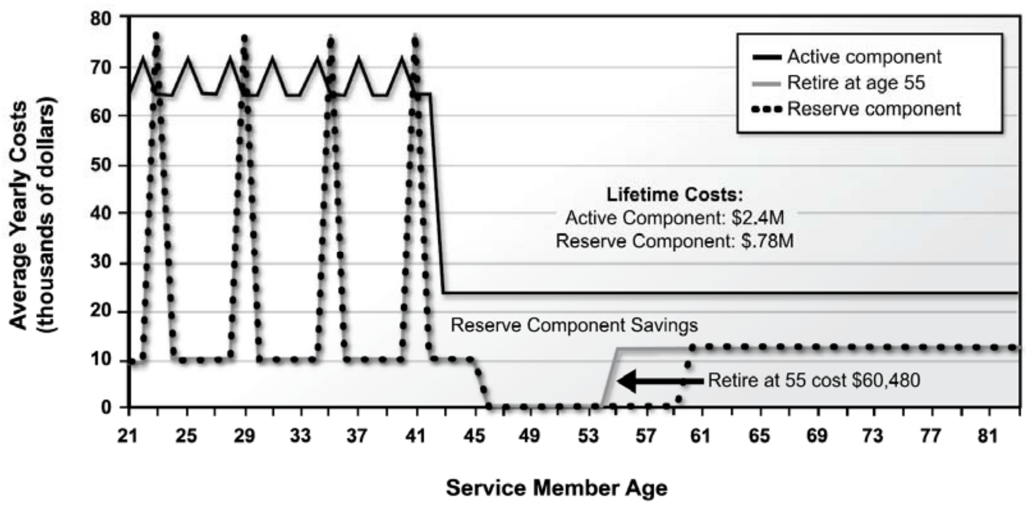
The first of these operational models (described by Buck [2]) compared the lifetime costs of a frequently deployed AC member with the lifetime costs of a somewhat less frequently deployed RC member. Figure 2 shows the importance of deployment frequency in driving relative personnel costs in an operational model. In this example, the cost of an AC member (pay and retirement accrual) is estimated at $2.4 million over a lifetime service of 22 years, while the cost of an RC member is calculated at $790,000 over a lifetime service of 25 years. The example assumes that AC members are deployed seven times over their service tenure, while RC members are deployed four times (the

12 The relative cost figures presented in this example, and in following examples, are only illustrative and are sensitive to underlying assumptions, particularly about the amount of mobilization spent deployed and relative cost of dwell time.

planning objectives for the deployment of active and reserve personnel are presented in [13] (U.S. Secretary of Defense (SECDEF), 2007).

The metric of interest for this model is the cost of individual deployments for servicemembers in the AC and RC. This is estimated by simply dividing the lifetime total cost of a member in a component by the number of times that such a member could deploy. Therefore, the cost per deployment is estimated at $336,000 for the AC ($2.4 million/7 deployments) and $198,000 for the RC ($790,000/4 deployments). This implies that the cost of using the RC for a deployment is about 0.59 the cost of using the AC ($198,000/$336,000).

Figure 2. Comparison of the lifetime personnel costs of AC and RC



Source: [2] (Buck, 2008). This example is based on the assumption that 17 percent of the active force and 24 percent of the reserve force reach retirement.

When the AC and RC are deployed on a regular, periodic schedule, the reserve force loses much of its cost advantage relative to the AC.

An important fact emerges from this method of costing the active and reserve components: when the AC and RC are deployed on a regular, periodic schedule (and not limited to dwell-time training) the reserve force loses much of its cost advantage relative to the AC.

This approach also highlighted some important distinctions about cost elements related to deploying the AC and RC that had not previously received much attention, including the following:

- Some cost elements, although substantial in their own right, can be ignored when comparing the costs of RC and AC. For example, costs that vary only with the size of the units deployed will "net out" of AC/RC cost comparisons. These include Hostile Fire Pay, Family Separation Allowance, and Combat Zone Tax Exclusion: all will be the same for any unit that is "boots on ground," regardless of whether they are AC or RC. They can, therefore, be ignored.

- Some cost elements must be borne for individual servicemembers (AC or RC) regardless of the frequency with which they are deployed. For example, the costs of recruiting and initially training an individual will not vary with the frequency with which members are used operationally. (However, as we discuss in a later section, different deployment patterns can affect the number of personnel needed to sustain a so-called pair of boots on ground, and this can affect the relative recruiting and training costs of the active and reserve components.)[13]

- Still other RC cost elements, such as personnel costs, will be greatly affected by the frequency with which reserve members deploy. As previously discussed, the personnel costs of RC members in dwell are between one-fourth and one-third those of AC members, but, when activated, reserve units cost about the same as active units. In fact, a typical reserve unit may actually be more costly during activation because its grade structure is usually more senior than that of an active unit.[14]

While this approach offers some useful findings, it suffers from some significant limitations, and it obscures some important elements of the relative costs of the AC and RC.

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[13] Recruiting and training costs may also be affected by the frequency of deployment because this may affect the willingness of members to stay in the RC.

[14] While retirement costs of reserve members increase when they are activated, over their lifetimes, retirement costs of regularly activated RC members will still be less than those of regularly deployed AC units because RC personnel become eligible for retirement benefits at a significantly later age. See [14] (Asch, Hosek, and Loughran, 2006) for information on the cost of retirement for AC personnel.

Limitation 1: Ignoring the value of the strategic reserve

One shortcoming of this approach is that it focuses on only the operational capability of the AC and RC and ignores the strategic capabilities that the components contribute simultaneously with their use on an operational footing. For example, in the case illustrated in figure 2, it would be possible for an RC member to undertake four regularly scheduled 1-year deployments over the 25-year service life, while also being available for unanticipated, unscheduled deployment in a strategic reserve over an additional 21 years. In contrast, a representative AC member would deploy for 7 years over a 22-year service lifetime but would only be available for additional, unanticipated deployments in a strategic reserve for 15 years. Taking into account the value of the strategic reserve contributed by personnel from the different components (as well as their value in an operational environment) would shift the cost advantage even more in favor of the RC.

Limitation 2: Ignoring the need for a "deeper bench" when employing the RC

A second shortcoming of this approach is that, when using servicemembers to maintain regularly scheduled, recurring deployments, a "deeper bench" (a larger rotation base[15]) will be required in the RC than in the AC, and this can significantly affect the relative costs of the two components.[16] Consider the example in figure 2 in which AC members deployed for one year, followed by two years in dwell. Such a case requires a rotation base of three AC members in order to keep one person on continual deployment. In contrast, the example suggests a notional rotation schedule for the RC of one year deployed, followed by five years in dwell.[17] This would require six RC members

[15] The rotation base is the total number of personnel, both deployed and in dwell, necessary to maintain one servicemember in deployment.

[16] Simple comparative methods that contrast the cost difference of the AC and RC, on a per-unit basis, can provide some insight into the cost difference of the components, but they provide only limited insight into the overall force mix that maximizes capability at minimum cost.

[17] For the moment, we are assuming that an RC member's entire mobilization is spent on deployment; that is, we do not include training time during mobilization.

to keep one person on perpetual deployment. In the next subsection, we discuss how the services' cost calculations should integrate the size of the rotational base necessary to support regularly scheduled, ongoing deployments.

The cost of the "boots on ground" (BoG) approach

The "cost of individual members" approach discussed earlier focused on the relative costs of individual AC and RC personnel when used in rotation, but it ignored the question in which service leadership is usually most interested: what is the full cost of delivering operational output with the AC and RC? Klerman (2008) was the first to propose a model that was capable of comparing the costs of using the AC and RC on an operational basis (that is, the cost of rotating multiple units through a regularly recurring deployment schedule to sustain one unit as BoG in theater) [3].

The BoG model has become central to how the Army, Marine Corps, and elements of the Navy estimate the costs of using the AC and RC on an operational footing.

This approach (which is generally denoted as the BoG model) has become central to how some of the services calculate the relative costs of employing the AC and RC on an operational footing: it is the basis of models used by the Army, the Navy Expeditionary Combat Command, and the Air Force. For this reason, it is worth describing the workings of the method in some detail. The approach proceeds in three steps: (1) estimating the cost of a single RC unit relative to the cost of a single AC unit, (2) calculating the number of regularly deploying AC units and RC units that are needed to sustain one deployed unit, and (3) putting these two ideas together to compute RC-relative-to-AC costs per unit BoG.

Costs per unit in dwell and on deployment

To illustrate the BoG model, we use some simple estimates of the relative cost of a single RC unit when it is engaged only in drill, and when it is regularly deployed. Following Klerman [3], we assume that an RC unit costs the same as an AC unit when it is used in deployment, but only 25 percent as much as an AC unit when it is in dwell (as discussed earlier in this analysis, these estimates are consistent with other studies). We then estimate that, across a 72-month deployment cycle (12 months deployed + 60 months in dwell), the cost of an individual RC unit is 37.5 percent that of an individual AC unit:

37.5% = (100% x 12 months + 25% x 60 months) / 72 months.

The number of units required to maintain one unit BoG

The second part of the BoG calculation is estimating the number of active and reserve units required to maintain one unit forward. For the active component, this calculation is straightforward:

AC units required (deployed and in dwell) to maintain one unit forward

= Cycle length (time deployed and in dwell) / Time deployed.

For example, if an AC unit is deploying for 12 months and spending 24 months in dwell, the service must have a rotation base of 3 units in order to always have one rotating on deployment (3 = (12 + 24)/12).

Estimating the number of RC units needed to support one unit BOG is slightly more complex. One must account for the time spent in training between mobilization and deployment (which is generally around 3 months) and the time spent in "stand-down" at the end of mobilization (generally 1 month):

RC units required (deployed and in dwell) to maintain one unit forward deployed on a rotating basis

= Cycle length (time deployed, in dwell, in training, and in stand-down) / Time deployed.

For example, DOD's goal for operational use of the RC calls for 12 months mobilized followed by 5 years in dwell. Of the 12 months in mobilization, however, about 3 months are usually in training and 1 month in postdeployment stand-down. This leaves only 8 months on deployment and implies the need for a rotation base of 9 units to support one unit BoG:

$$9 = (60 + 3 + 8 + 1) / 8.$$

In appendix A, we illustrate the relationship between mobilization time, training time, the number of units needed to support one unit BoG, and the average number of RC units that are mobilized at any point in time. In the current example, three times as many RC units as AC units are needed to support one unit BoG (nine RC units versus three AC units), and an average of 1.67 RC units are mobilized at any point in time.

Bringing the ideas together to estimate relative costs of AC and RC

Under the DOD's goals for deployment of units, the BoG model suggests that *an individual RC unit* costs roughly one-third as much as an individual AC unit (or, more precisely, 37.5 percent). However, under the target deployment schedules, the BoG model suggests that this cost advantage is completely offset because three times as many RC units are required as AC units to sustain a single unit BoG.

Table 4. The sensitivity of AC/RC costs to major drivers in the BoG model

Line Numbers	Component	Months mobilized	Months deployed	Months in training while mobilized	Months in stand-down while on mobilization	Cost of RC while mobilized, relative to AC	Months in dwell between deployments	Relative cost of AC and RC during dwell	Rotaion base necessary to sustain 1 BOG	Average cost of one unit, dwell and deployment, relative to AC	Cost of the strategic reserve contributed by the component	Cost of sustaining rotation base, relative to AC
1-A	RC	12	8	3	1	1	60	0.25	9.00	0.375	3.375	1.13
1-B	AC		12	0	0	1	24	1	3.00	1.000	3.000	
2-A	RC	12	9	2	1	1	60	0.25	8.00	0.375	3.000	1.00
2-B	AC		12	0	0	1	24	1	3.00	1.000	3.000	
3-A	RC	12	12	0	0	1	60	0.25	6.00	0.375	2.250	0.75
3-C	AC		12	0	0	1	24	1	3.00	1.000	3.000	
4-A	RC	12	9	2	1	1	48	0.25	6.67	0.400	2.667	1.48
4-B	AC		15	0	0	1	12	1	1.80	1.000	1.800	
5-A	RC	12	8	3	1	1	60	0.3	9.00	0.417		1.25
5-B	AC		12	0	0	1	24	1	3.00	1.000		
6-A	RC	12	9	2	1	1	60	0.3	8.00	0.417		1.11
6-B	AC		12	0	0	1	24	1	3.00	1.000		
7-A	RC	12	12	0	0	1	60	0.3	6.00	0.417		0.83
7-B	AC		12	0	0	1	24	1	3.00	1.000		
8-A	RC	12	9	2	1	1	48	0.3	6.67	0.440		1.63
8-B	AC		15	0	0	1	12	1	1.80	1.000		

Lines 1-A and 1-B of table 4 illustrate this approach to modeling the relative cost of the AC and RC for a purely operational reserve and shows that the BoG model suggests that the RC is actually 13 percent *more* expensive than the AC when used on a purely operational footing. (The other lines in this table demonstrate the sensitivity of component costs to other drivers, including deployment time for the AC and postmobilization training time for the RC; appendix A provides further discussion of the sensitivity of these estimates to "within-mobilization" training time.)

A model that is either operational or strategic, but does not jointly estimate

The Air Force maintains a set of models called the Total Force Enterprise Analytic Framework (TFE AF) for allocating force mix among the AC and RC. The full suite of tools allows for interaction among the following determinants:

- The service's weapon system supply, derived from the service's weapon system authorizations
- Manpower supply, derived from authorizations
- Demand for manpower (Note that this can be derived from either OSD-approved force planning scenarios or other hypothetical force utilization vignettes. The models first estimate demand for weapon systems, and then assesses the manpower needed to field these weapons at various DEP/Dwell and MOB/Dwell rotation levels.)
- Force employment policies and guidance
- A cost model that captures the cost of military manpower for the AC and the cost to maintain the RC

The cost model is capable of being used as either a purely operational model or a purely strategic model, but not as a joint model (as we explain later, a joint model is one that simultaneously estimates both strategic and operational elements). As an operational model, it assesses the cost of using different combinations of AC and RC to keep "force packages" (groupings of manpower/equipment that provide specific wartime capabilities) in sustained, rotating deployment. The model can also capture the strategic use of the RC and integrate requirements for nonrotational presence of the RC located at the home station. (Although it need not be, the role of the strategic reserve, or home location presence, can be explicitly linked to nuclear deterrence, outside-CONUS nonrotational forward presence in place, or use in Operation Noble Eagle—military operations related to homeland security and support to federal, state, and local agencies.)

The model looks for optimal solutions in a piecewise, sequential fashion. It first looks for the lowest cost force mix solutions for operations that involve surge (all deployment and no dwell) and for the after-surge period (a moderate level of MOB/Dwell and DEP/Dwell). Given this solution set, it then looks for solutions that involve non-surge-related use of personnel (defined as rotational use of forces with low MOB/Dwell and DEP/Dwell ratios) and nonrotational use of personnel. (The model can also do these solutions in the opposite order.) It cannot, however, find a solution that looks simultaneously at rotational and nonrotational use of forces (it cannot jointly, or simultaneously, consider operational and strategic use of forces).

The need for a jointly estimated, unified approach

Applying an operational model that does not simultaneously address the strategic value of RC units can result in highly biased estimates of the relative costs of the AC and RC. To illustrate this point, consider a circumstance in which a service has long used the RC to fill a requirement for nine units of strategic reserve, and (using the notional estimates from our discussion of the BoG model) these nine units cost a total of $3.38. Suppose that the service is considering how to meet a new operational requirement for one unit BoG (we'll assume that the one unit that is to be used operationally can be counted among the nine units required in the strategic reserve, and we assume the same rotation patterns that we assumed earlier—shown in line 1-A of table 4). If the force allocation decision were to look to the BoG model for guidance on whether to use AC or RC in this operational role, the model would consider only the costs of the operational use of the force and would find employing the RC to be

13 percent more expensive than employing the AC (an estimate taken from the BoG model described earlier). As a consequence, the model would suggest that standing up three new AC units to meet the new operational requirements would be less costly than employing the existing nine RC units. As a result of this guidance, the service would convert three of its RC units to AC. It would then have to identify the best way to meet the requirements for the remaining six units of strategic reserve: if it were to apply a strategic reserve cost model to find this answer, the likely prescription would be to fill the requirements with the six relatively inexpensive RC units. The net effect of this type of stepwise calculation would be to meet the operational and strategic requirements with three AC units and six RC units.

This outcome, however, would not be optimal. Again using the cost factors and rotation patterns employed in lines 1-A and 1-B of table 4, this mix of three AC and six RC would cost $4.50 ($3 + $1.50), while retaining the existing nine RC units as a strategic reserve and using all nine units in rotation to fill the requirement of one unit BoG would cost $3.37. As we explain later in this analysis, identifying the optimal AC/RC mix would require applying a model that can jointly (simultaneously) estimate costs for the strategic and operational capabilities and that can appropriately allocate dwell-time costs of RC units between these capabilities.

Joint modeling of the strategic and operational

This simple example illustrates that, to find the optimal allocation of operational and strategic requirements across the AC and RC, it may be necessary to simultaneously model the net costs of the AC and RC in both the operational and strategic settings. In fact, there are few circumstances in which forces are being used operationally in which this type of joint modeling is not necessary. Separate (or sequential) modeling of operational and strategic net costs would only yield sound estimates in those capabilities in which a service has no strategic requirements beyond those that are embedded in its operational forces.

We are aware of two attempts at constructing models that jointly estimate the net costs of AC and RC in both operational and strategic contexts, and each approach uses a different tack. In this subsection, we discuss the approaches of Horowitz [15] and Cox [1].

The "Analysis of Alternatives" approach

The model shows the "trade-space" between the budget, the number of deployable units, the size of the total force, and the proportion of the force in the AC.

The "Analysis of Alternatives" approach taken by Horowitz follows the general theoretical framework of the BoG model (in that it focuses on the costs of using the AC and RC to keep one unit forward deployed), and it incorporates detailed estimates of service costs and deployment cycles (early versions of the model integrate data from the Army's Force Generation (ARFORGEN) model). Perhaps the most significant feature of the Horowitz model, however, is that it expresses its output as a "trade-space" between (1) total cost, (2) operational capacity (the number of units that can be maintained in phased rotation, as boots on ground), (3) the size of the total force that can be maintained, and (4) the proportion of the force that resides in the AC. For example, the model can demonstrate how, for a given budget, a force can trade off the number of deployable units BoG against the size of the total force. Alternatively, the model can be used to explore how, for a given force size, a service faces a trade-off between its budget and the number of deployable units it can field.[18]

Continuing the example: a joint estimation approach

This approach is illustrated in figure 3, which shows a simple approximation of one of the model's outputs. Here, we continue our previous example in which there are nine RC units in a strategic reserve that cost a total of $3.38 (each RC unit costs $0.375, while each AC unit costs $1). The graph shows the trade-space between BoG units, total units (BoG plus strategic reserve), and cost. The bottom line shows how a service can maintain nine total units (either AC or RC) and how reallocating these nine units between the AC and RC affects both the total cost and the number of deployable units.

Point "A" in this diagram represents the cost and the deployment capacity of nine units when all of these are in the RC. This is the allocation of the nine units between AC and RC that minimizes the cost of maintaining one unit BoG. (By keeping all nine units in the RC, one unit can be maintained BoG for a total cost of $3.38.)

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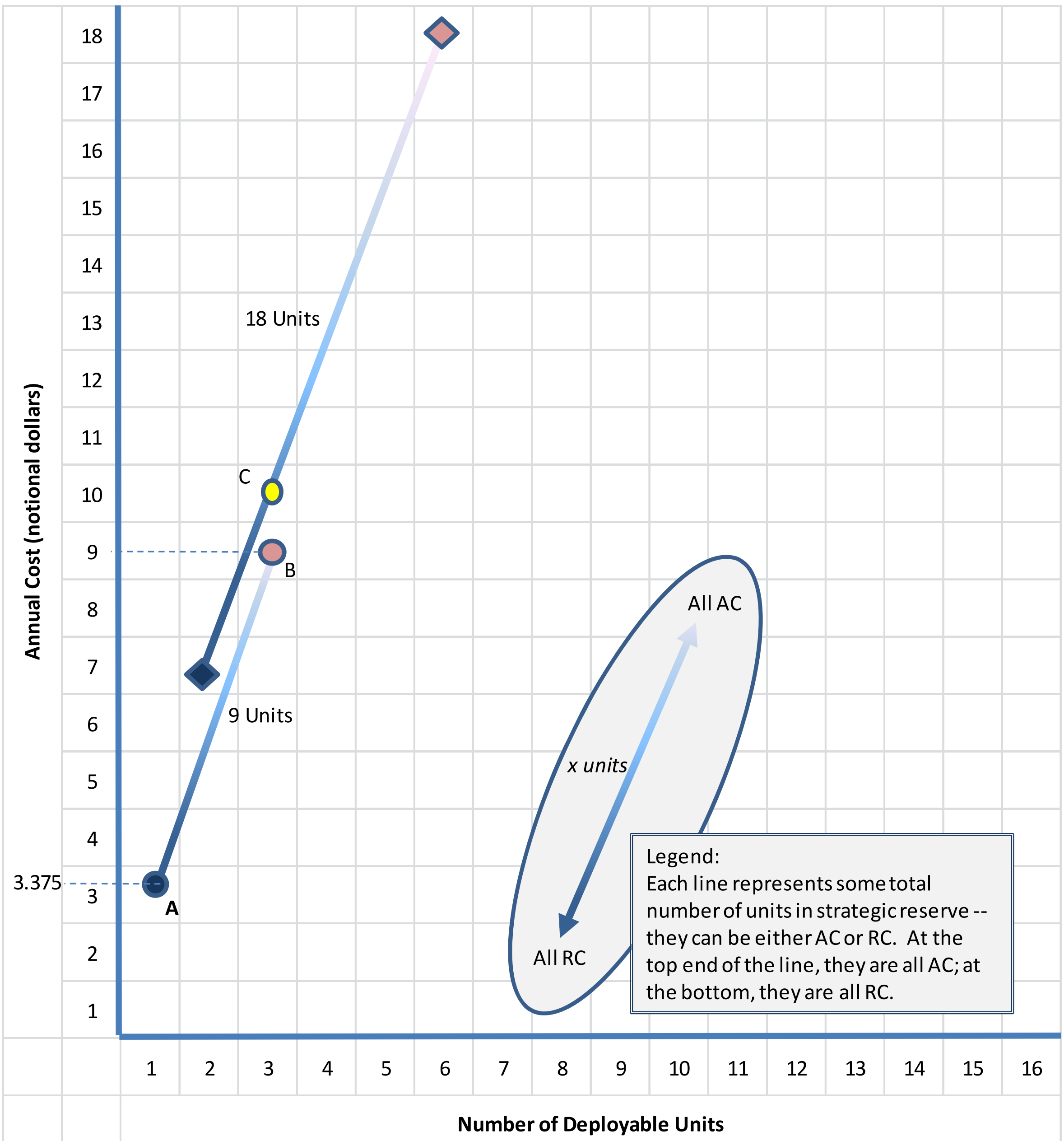
[18] A graphic is the most intuitive way of representing all dimensions of the trade-space that need to be captured in a joint model of AC/RC force mix. In addition to the Horowitz [15] graphic, a trade-space visualization tool is used by Air Force AF/A9. Such graphics, however, are inherently complex and patience is required to make sense of their implications.

An additional feature of this visual representation of the joint solution is that one can hold constant the number of deployable units and trade off the size of the budget against the size of the strategic reserve and the proportion of units that are reserve component.

Figure 3. The trade-space of costs, reliance on the RC, deployable units, and total units



Source: Horowitz [15].

Comparing points “B” and “C,” for example, the diagram shows that, by holding the number of deployable units constant at 3, it is possible to double the size of the strategic reserve (from 9 to 18) while incurring a 10-percent increase in costs (from $9 to $10) and a sharp increase in the proportion of forces in the RC (increasing from 0 percent to about 70 percent).[19]

A summary of the six cost models

Table 5 summarizes the characteristics of the most widely used cost models—strategic, operational, and joint (or hybrid). The table indicates the uses and limitations of the various models discussed in this study, including:

1. The traditional simple method
2. The cost of Guard and Reserve approach
3. The cost of individual members approach
4. The BoG model
5. The Air Force's Total Force Enterprise Analytic Framework
6. The IDA model (i.e., the Horowitz model)

In the next sections, we discuss enhancements that could be undertaken to improve joint modeling of the strategic and operational capabilities.

[19] The Horowitz model is more complex than others that simply offer AC/RC cost comparisons because it actually offers a set of AC/RC force mix alternatives that allow the decision-maker to see cost implications as well as operational and strategic capacity.

Table 5. A summary of characteristics of cost models

Type	Name	Application	Model complexity	Level of aggregation	Limitations	What data can be used?	Examples of use
Strategic	Traditional simple method	Comparison of costs: RC dwell and AC non-deployed	Simple	Highly aggregated, component level	Does not account for any costs associated with deployments (phased or full-surge deployments). Obscures variation in relative costs between capabilities, units. Using incomplete or inappropriate cost elements will bias estimates.	Any costs associated with maintenance of a nondeployed force (accrual, recurring short-term, or nonrecurring)	Occasionally used in theoretical discussions of component costs. Because estimates are made at a high level of aggregation, they are not of practical use in determining AC/RC force mix.
Strategic	Cost of Guard and Reserve approach	Comparison of costs: RC unit (e.g., BCT) in dwell vs. nondeployed AC unit	Complex: assumes detailed analysis of cost elements	Unit level	Does not account for costs associated with deployments (phased or full-surge deployments). Using incomplete or inappropriate cost elements will bias estimates.	Same as above	Widely used and effective in comparing the costs of AC and RC when used in strategic reserve
Operational	Cost of individual members	Comparison of costs per deployment: RC individual vs. AC individual	Simple	Individual	Does not account for strategic value of RC, for cost of larger rotational base required when RC supports sustained operations, or for variation across units in O&M and equipment costs	Any costs associated with maintenance of units in dwell and on deployment. May be accrual, recurring short-term, or nonrecurring.	Notable as an early attempt to capture costs of using RC in operations. Superseded by Boots-on-Ground model.
Operational	Boots-on-Ground (BoG) model	Comparison of costs of RC rotation base vs. AC rotation base	Simple to complex: readiness & capacity can be represented	Rotation base (no. of units needed to sustain one unit BoG)	Does not account for strategic value of RC	Same as directly above	Widely used and effective in comparing the costs of AC and RC when used on a purely operational footing. Army, OSD, and NECC all use variations of this model.
Operational	Air Force's Total Force Enterprise Analytic Framework	Comparison of costs of different levels of AC/RC blending at various deploy-to-dwell ratios	Very com-plex	Force package: a grouping of manpower/ equipment that provides a specific wartime capability	Does not account for strategic value of RC. Model considers various deploy-to-dwell ratios when RC is used operationally but does not account for strategic contribution of RC. Because of its complexity, model requires significant manpower to maintain.	Same as directly above	Principal force-shaping tool used by the Air Force
Joint Strategic and Operational	IDA model: Horowitz (2012)	Determining trade-space of budget, no. of deployable units, size of force, and proportion of AC in force	Complex	Rotation base (no. of units needed to sustain one unit BoG)	By necessity, model's trade-space output is complex, and users face a significant learning curve to understand full implications of model's findings.	Same as directly above	Being developed for OSD CAPE

Improving joint (hybrid) models

The Horowitz approach [15] is a significant improvement over the BoG model; it allows one to see the entire trade-space for the budget, the number of deployable units, the size of the force, and the proportion of the force in the RC. In this section, we suggest that one can take even more insight from joint models of AC/RC costs by integrating into these approaches an important distinction about how the services account for some of their RC dwell-time costs. When RC forces are being used to support both strategic and operational capabilities, it is not always clear how to allocate RC dwell-time costs to these activities. The way these costs are allocated, however, can have an important influence on AC/RC mix. The BoG model arbitrarily allocates all dwell-time costs to the services' operational capabilities.[20] However, we suggest an alternative, efficient method for apportioning RC dwell-time costs to a service's strategic and operational mission requirements and, in so doing, we arrive at two useful insights:

1. For forces that have both strategic and operational capabilities, BoG models (which focus only on the operational use of units) can significantly overstate the net cost of the RC, relative to the AC. If one allows for the possibility that RC units that are used in phased deployments may also have value as a strategic reserve, RC units may gain a significant net cost advantage over AC units.

2. A wider range of capabilities should be allocated to the RC than suggested by either the traditional Strategic Reserve or traditional BoG models. The stylized facts that emerge from these traditional models are that the RC enjoys a cost advantage relative to the AC when used as a strategic reserve, and that the AC enjoys a cost advantage relative to the RC when used as an operational reserve. Many have looked at these findings and concluded that the RC should be used exclusively as a strategic reserve force, and that the AC should be employed whenever there is a need for an operational force that is supported by phased rotation of troops.

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[20] The Horowitz model makes no distinction about the apportionment of these costs and does not identify specific optimal AC/RC force mixes.

> However, when we use a joint model and appropriately allocate dwell-time costs, we come to a very different finding: under a wide range of circumstances, there is a strong cost advantage to using the RC to support phased, BoG deployments while simultaneously providing a strategic capability.

To illustrate these points, we construct a graphical representation of the relationships between (a) the allocation of RC dwell costs among strategic and operational capabilities and (b) the cost of using the RC to provide support for recurring operations. We develop this graph in several steps throughout the rest of this section.

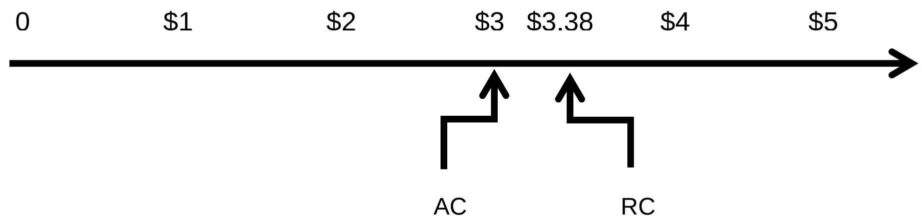
Building a visual representation of costs

To explain our findings, we will build on the previous examples in this analysis and will again assume that the cost of maintaining an AC unit for a year is equal to $1. For the purpose of illustration, we will also assume the following:

- The cost of an RC unit in dwell is $0.25.
- When deployed, an RC unit costs the same as an AC unit ($1).
- The cost of maintaining nine RC units in a strategic reserve is $2.25 (9 * $0.25).
- The DEP/Dwell ratio for the AC, the MOB/Dwell ratio for the RC, and RC training requirements between mobilization and deployment are such that the AC requires a rotational base of three to support one unit BoG, while the RC requires a rotational base of nine.

For the moment, we will also assume that all of the costs associated with maintaining RC units are allocated to the services' operational capability; none of these costs are allocated to the strategic capability. These assumptions imply that, for the AC, the cost of maintaining one unit BoG is $3 (3 * $1), while, for the RC, the cost of maintaining one unit BoG is $3.38, or 9 * [(($1 * 12) + ($0.25 * 60)) / 72]. Note again that our assumptions imply that it is more expensive to maintain a unit boots-on-ground using the RC than the AC: when all costs (active and reserve components) are assigned to maintaining an operational reserve, the AC is the least-cost provider of BoG. (The AC costs $3 and the RC costs $3.38.) This is illustrated in figure 4.

Figure 4. Costs for the AC and RC under the BoG model



In many instances, however, this approach would give a distorted picture of the relative costs of the AC and RC in supporting a unit BoG. To understand this, we need to recognize two characteristics of the BoG model:

- It doesn't really compare "apples and apples." Given our assumptions, the AC has a rotation base of three units to support one unit BoG; the RC requires a rotation base of nine units. This means that, if a service were to use the RC to support one BoG unit, it would have six additional units on hand to use as a strategic reserve if needed. See figure 5.
- Under the BoG model, all the costs of all six additional RC units are attributed to maintaining the service's operational capability; no costs are assigned to maintaining the strategic capability. There are circumstances when assigning costs in this way makes sense—that is, when the only reason for standing up these RC units would be to support ongoing operations (when these units would contribute no value to a strategic reserve). However, there are other instances in which assigning costs in this way does not make sense (e.g., if the service is going to have these six additional units as part of a strategic reserve regardless of whether they are used to support a BoG unit). In such circumstances these six units would constitute a sunk cost, and the costs of these units should be excluded from any cost comparisons intended to allocate operational capability between the AC and RC.

In those cases in which it is appropriate to assign the costs of these six additional RC units to maintaining a strategic reserve (to omit them from cost comparisons intended to allocate *operational* capability between the AC and RC), the cost of the RC supporting one unit BoG is sharply reduced. As figure 6 shows, omitting the $1.50 cost of these six additional RC units lowers the cost of the RC supporting one unit BoG from $3.38 to $1.88. In such a case, the RC has a substantial cost advantage in supporting BoG (at $1.88, the RC is 37 percent less expensive than the AC in supporting BoG).

Figure 5. When all RC dwell-time costs are assigned to the service's operational capability, the AC has a cost advantage in supporting BoG

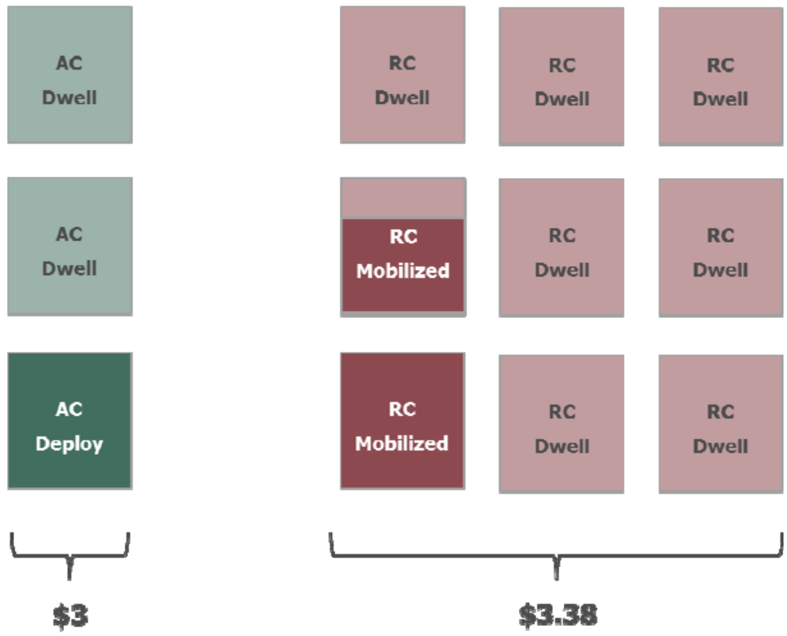
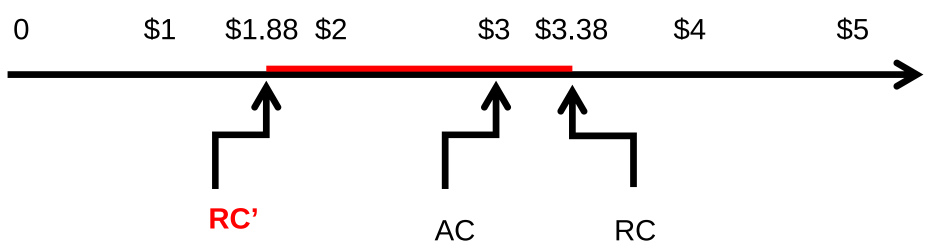


Figure 6. When some of the RC dwell-time costs are assigned to the service's strategic capability, the RC can have a cost advantage in supporting BoG

The red line in figure 7 illustrates the range of possible costs for the RC supporting one unit BoG. The extreme ends of this line represent (1) when none of the costs of the six additional RC units are allocated to the service's strategic capability (the cost of the RC supporting BoG is $3.38) and (2) when the costs of these six additional units are allocated entirely to the service's strategic capability (the cost of the RC supporting BoG is $1.88). There may be circumstances, however, when the cost of these 6 additional RC units should be split between a service's strategic capability and its operational capability and, in these situations, the effective cost of the RC supporting one unit BoG would lie somewhere between $1.88 and $3.38. This raises the question of how the services should allocate these dwell costs between the strategic and the operational.

Figure 7. An alternative allocation of dwell-time costs can give the RC a cost advantage



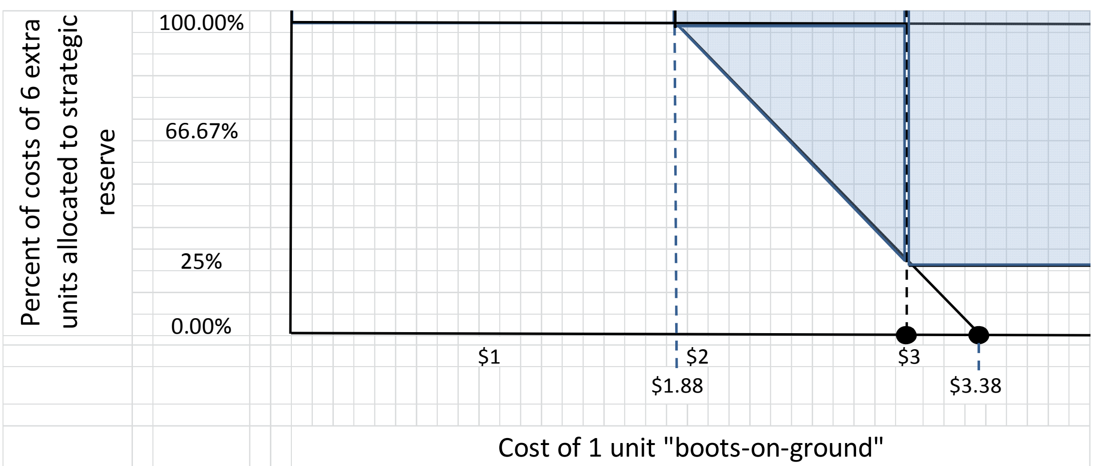
Rough estimates of value can greatly improve cost estimates

Economic theory provides general guidance for how to allocate the cost of these additional RC units to a service's strategic capability: the more important the role these additional RC units play in their service's strategic reserve, the more of their costs should be allocated to the strategic capability.[21] On one hand, if the six units would be maintained in the strategic reserve regardless of whether they are used as part of an operational capability, then the full cost of the units should be assigned to the strategic reserve. On the other hand, if service leadership values the contribution of the 6 units to the strategic reserve at only half the cost of these units, then only half their cost should be assigned to the strategic capability.

21 The general approach to these problems is to use a concept called the "shadow price." In the context of the current analysis, we should assign to the strategic capability costs equal to the maximum that the service would be willing to pay to acquire these units for their strategic value.

It is necessary to produce only some very rough estimates of the value of RC units to a strategic capability in order to significantly improve the estimates of the relative costs of the AC and RC in supporting BoG units. To see this, consider figure 8 which illustrates how the RC's cost of supporting phased operational deployments varies with the *percentage* of dwell-time costs allocated to the strategic capability. On the y-axis, we show the proportion of the dwell-time costs for the six extra units that are allocated to the strategic capability; on the x-axis, we show the associated cost for the RC providing recurring support of one operational unit BoG.

Figure 8. How the cost of using the RC to support BoG varies with the percentage of RC dwell-time costs allocated to the strategic capability



As in our previous discussion, we see that, when the six extra units of strategic capability have *no* value for the service, and when *none* of the dwell-time cost of these units is allocated to the strategic capability, the RC is at a cost disadvantage in providing support for regularly deployed units ($3.38 for the RC versus $3 for the AC). But the most important observation to take from this graph is that the additional RC units have to be of only modest strategic value to the service—and have to have only a modest portion of their dwell-time costs apportioned to the strategic capability—for the RC to have a cost advantage in the provision of recurring operational capability. If more than 25 percent of the dwell-time costs of the six extra units are apportioned to the strategic capability, the RC becomes the preferred provider of operational forces.

It boils down to answering one question

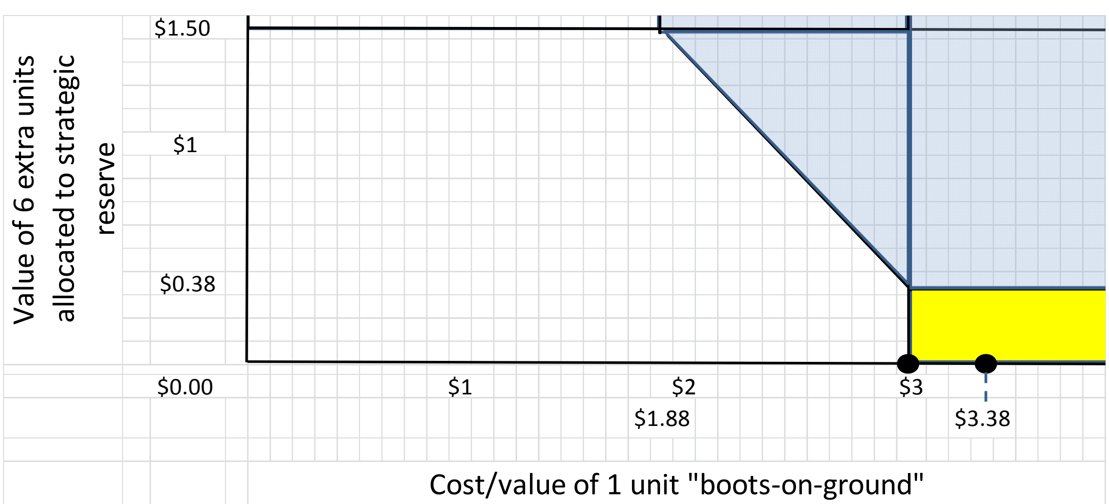
If a service would value having additional units of strategic reserve at more than 25 percent the cost of maintaining these units, the RC is the low-cost provider of operational units BoG.

Because this point may be counterintuitive, it is worth expressing this idea in an alternative form. In capabilities in which a strategic reserve has no value, the AC has a cost advantage in maintaining operational units. However, for capabilities in which having additional strategic capability has even a modest value, it is the RC that has a cost advantage in maintaining operational units. Whether the AC or RC is the low-cost provider of operational units comes down to service leadership answering a single question about the value of RC units in a strategic reserve: would the service value having additional units of strategic reserve at more than 25 percent the cost of maintaining these units? If the answer to this question is yes, then the RC is the low-cost provider of boots on ground.

When it makes sense to use the AC to support BoG

The yellow region depicted in figure 9 illustrates the conditions when the AC is the low-cost provider of operational units boots on ground (note that our y-axis is again being expressed in dollar values). In this region, the service values one unit BoG at more than the cost of having the AC maintain this operational unit ($3), but it values adding an additional six units to the strategic reserve at less than $0.38 (25 percent the cost of maintaining these units in dwell).

Figure 9. Using the AC to maintain BoG[a]



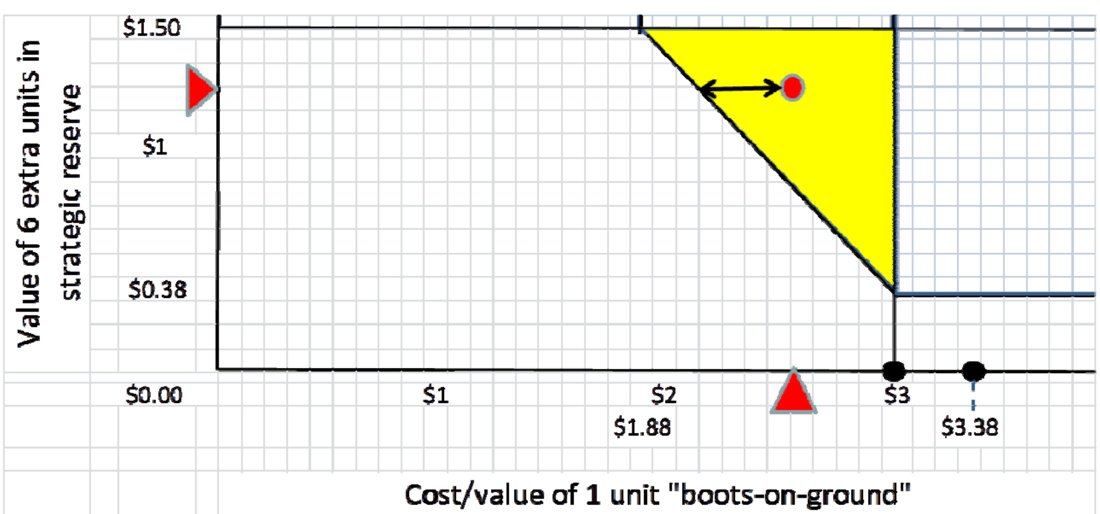
[a] The yellow region represents the conditions in which a service should rely on the AC to provide BoG units.

An area of new opportunities

Figure 10 further illustrates our assertion that there may be much greater scope than is commonly appreciated for using the RC to maintain operational units. The two red triangles represent the value a service might place on having six additional units in a strategic capability ($1.25) and the value it might place on having one unit BoG ($2.55). If we were to assess each of these values independently, neither would be funded. The $1.25 value placed on having the six units in the strategic reserve falls short of the $1.50 dwell-time cost of maintaining these units. Similarly, the $2.55 value placed on the BoG unit is less than the $3 cost of the AC maintaining this capability.

However, if we assess the costs and values of these capabilities jointly (considering both the strategic and operational capabilities of the units), it would make sense to fund nine units of RC to maintain one unit of BoG. The total value taken from these units (both strategic and operational) would be $3.80 (= $1.25 + $2.55), while the total cost would be $3.38: the value the service would take from these RC units would be $0.42 more than their cost (this is represented by the length of the double-pointed arrow in figure 10).

Figure 10. Jointly estimating how the value of the strategic and operational capabilities can change AC/RC force mix and AC/RC endstrengths



The entire yellow region indicates circumstances in which using the RC to maintain operational units in phased deployments would be justified by a *joint* cost model but rejected by *separate* applications of a strategic cost model and an operational cost model. The graph implies that there is likely greater scope for using the RC in an operational capability than is currently accepted (given that joint cost models are only slowly being introduced into the force mix planning process).

The graph also indicates that it might be possible for the services either to produce greater operational output with their current budgets or to meet their current mission goals with smaller budgets. The yellow area represents what may currently be unexploited opportunities for the use of the RC in operational deployments, and shifting the AC/RC mix to exploit these opportunities may enhance the services' abilities to meet mission outcomes or may produce cost savings.

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The cost elements

In the previous section, we discussed the various models and analytic approaches that can be used to assess the relative costs of the AC and RC, and we described in broad terms several of the cost elements that planners consider when deciding how to allocate capability. Here, we consider many of these cost elements in greater detail and discuss some of the nuances to bear in mind when using these data. We also describe cost elements that can greatly influence how the services apportion capability to the AC and RC but that usually do not appear explicitly in cost calculations because they can be difficult (or impossible) to measure. In all these discussions, we try to describe the biases that would result in comparisons of AC/RC costs if variables are omitted or entered into cost estimates without appropriate care.

Cost elements that are difficult to measure

Political issues that constrain access to the RC

Introduction

One of the most important but difficult-to-measure drivers of force allocation is the risk of not having access to RC units when they are needed. The service secretaries have only limited ability to independently mobilize reserve forces and, at various times in the nation's history, the county has undertaken large-scale military actions without the President mobilizing significant numbers of the reserve.[22]

[22] Perhaps the best known example was in July 1965 when SECDEF Robert McNamara recommended raising the number of U.S. servicemembers in Vietnam from 75,000 to 275,000 over the following year. He further recommended that this increase be supported by a call-up of 125,000 Army RC members. President Johnson ordered the increase in troop strength for Vietnam but declined to mobilize the RC. Many feel that this left the Army stretched thin and overcommitted for the following 3 years until the President ultimately mobilized large numbers of reserve members in 1968. See [16] (Odegard, 1980) and [17] (Currie, 1984).

This has produced concern within the military that, were the services to allocate important capabilities to the reserve components, they might have to go to war without essential forces. In one sense, this type of political risk can be viewed as increasing the effective, expected cost of using the reserve: for example, if a service were to invest $1 to build four RC units, but were to have access to only two of these units when they were needed, the effective cost per deployable unit would double, from $0.25 to $0.50.

Some political issues may trump cost considerations in allocating capability across the AC and RC.

Increasing the effective cost of the RC in this way would act to broadly reduce the military capability that the services would be willing to place in the RC. However, uncertainty about having access to the RC does more than just increase the general perceived cost of the RC; it can also distort the specific capabilities that the services place in the AC and RC. It has been suggested that concerns about access to the RC have, at various times, made the services reticent to place the most critical capabilities in the RC. An alternative interpretation is that this uncertainty has led the services to place such an overwhelming amount of essential capability in the RC that it becomes virtually impossible for the nation to go to war without a sizable mobilization of the reserve (many credit former Army Chief of Staff Creighton Abrams with implementing such a policy, and the scheme has become known as "the Abrams doctrine"). Regardless of how these political considerations play out, this uncertainty can have a large impact on the way forces are allocated to the active and reserve components, and these influences may trump cost considerations.[23]

The effect on force mix decisions

Uncertainty concerning the likelihood of mobilization increases the overall expected cost of the RC. It also acts independently of cost considerations to distort the military capabilities that the services assign to the RC.

[23] This concern was partially mitigated when Congress enacted section 12304(b) of the FY 2012 National Defense Authorization Act which permits the service secretaries to involuntarily activate SelRes units (not individuals) for preplanned missions (in addition to times of national emergency). This authority permits up to 60,000 personnel to be called up for a maximum of 365 days.

Deployment costs borne by RC members and their families

Description

A few important but difficult-to-measure costs that are generally borne by reserve members and their families may, under not uncommon circumstances, be shifted to the services. Among these are deployment-related costs. A decade ago, it was a common expectation that RC members' service obligations would be limited to 39 days of annual drill and training and, perhaps, one or two single-year mobilizations over their careers. Since the inception of OEF and OIF, however, many RC members have been deployed at much higher rates, and many have seen their training requirements raised substantially above 39 days a year—particularly in the year before deployment. Although increasing the frequency and duration of mobilizations can dramatically reduce the costs that the services bear when using the RC for sustained deployments,[24] the services recognize that there is a limit to how far they can increase the deployment-related costs borne by service-members. At some point, these increased deployment costs could rebound on the services, and the reserve components could suffer increased attrition and lower accessions. This, in turn, could require the services to offer greater monetary incentives in order to maintain desired levels of accessions and retention (see 2007 SECDEF memo, [13]). It has been a matter of frequent and intense speculation within the services how far mobilizations could be lengthened before increasing the services' costs of accessing and retaining personnel.

The effect of this unobserved cost on force mix decisions

As the Navy's RC is currently utilized, deployment costs are largely borne by RC members and their families. However, mission deployment length has a profound effect on how the Navy uses its reserve component. Those parts of the service's warfighting capability that

[24] In our previous examples, we assumed that the RC operated with a mobilization period of 12 months, a deployment length of 8 months, and a dwell period of 60 months. Under these circumstances, a rotation base of nine units would be needed to support one unit boots-on-ground. However, if mobilization lengths were extended by 2.65 months (to 14.65 months, an increase of 22 percent) and training were held constant, the rotation base would decline 22 percent to seven units.

reside in the fleet operate in forward-deployed settings for long periods, and this has generally restrained the use of the Navy Reserve in regularly scheduled fleet operations. Instead, the Navy Reserve has been employed principally with missions *in support* of the fleet and the Marine Corps: fleet support airlift, medical support, mobile inshore warfare, embarked advisory teams, adversary support, cargo handling, military sealift, and construction battalions. Employing the reserve in voluntary long-deployment operations (without mobilization) might require the use of substantial incentive pays that could make the RC significantly more expensive.[25] Appendix B describes how the Navy uses its reserve component.

Training costs

Description

Training costs can be an important driver of AC/RC mix, but often these costs are not calculated explicitly. Rather, training costs often enter the force mix decision as a screening criterion—a binary classification indicating whether a certain functional area is consistent with a service's training capabilities.

Training costs have usually been handled in this way for the following two reasons:

- First, it can be difficult to estimate precise training costs in capability areas in which the RC has not previously been used because one must consider the RC's ability to meet training requirements through a variety of methods: (1) acquiring trained personnel from the AC, (2) capitalizing on training that RC personnel might acquire and maintain in the civilian world, (3) sustaining training requirements through the 39

[25] Despite the long deployment periods associated with fleet operations, there are some fleet functions that might be appropriate for the use of the Navy Reserve and that are not currently being undertaken by the reserve. Jewell et al. [18] suggest that, while it is not feasible or desirable to support carriers with full manning during routine periods, during times of crisis adding a small number of additional RC personnel could greatly increase the effective firepower of carriers, especially in carrier flight deck, ordnance, and aviation intermediate maintenance functions.

days of annual drill, or (4) maintaining training readiness through voluntary participation in regular exercises (or operations) beyond the 39 days of annual drills and training.[26]

- Second, historical data on training may offer a highly imperfect proxy for future costs. In many fields, there are significant constraints on the size of the community that the RC can sustain without experiencing a rise in training costs. For example, some communities in the Air Force and Naval Aviation report that they are frequently constrained by the number of fully trained personnel who leave the AC and who are willing to join the RC. As a result, any significant expansion of these RC communities would require increased recruiting of non-prior-service personnel, and this would be associated with a substantial rise in recruiting and training costs. In addition, some service communities suggest that, because they are currently operating at close to their maximum capacity of their training facilities, they would have only limited ability to expand the use of RC units in support of BoG units without a significant investment in new training infrastructure.

The effect on force mix decisions

Because of the complexities in analyzing the various sources of Navy training, as well as the potential for sizable shifts in training costs associated with large-scale expansion in the use of reserve capabilities, analyses of AC/RC mix must frequently examine in detail the training capabilities of the communities under consideration for realignment. Failing to conduct this type of thorough analysis can result in underestimating the costs of RC training.

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[26] Because there are many different approaches to training, the RC is able to meet training requirements in a wide range of capabilities. For some high-tech fields, such as aviation, the RC recruits personnel from the AC and maintains these skills through drill, annual training, and voluntary participation in regular operations. In other specialties (e.g., medicine, logistics, and construction), the RC depends on members staying proficient largely through their civilian employment. In some lower tech fields, training can be sustained solely though drill and annual training.

The ability to surge

Description

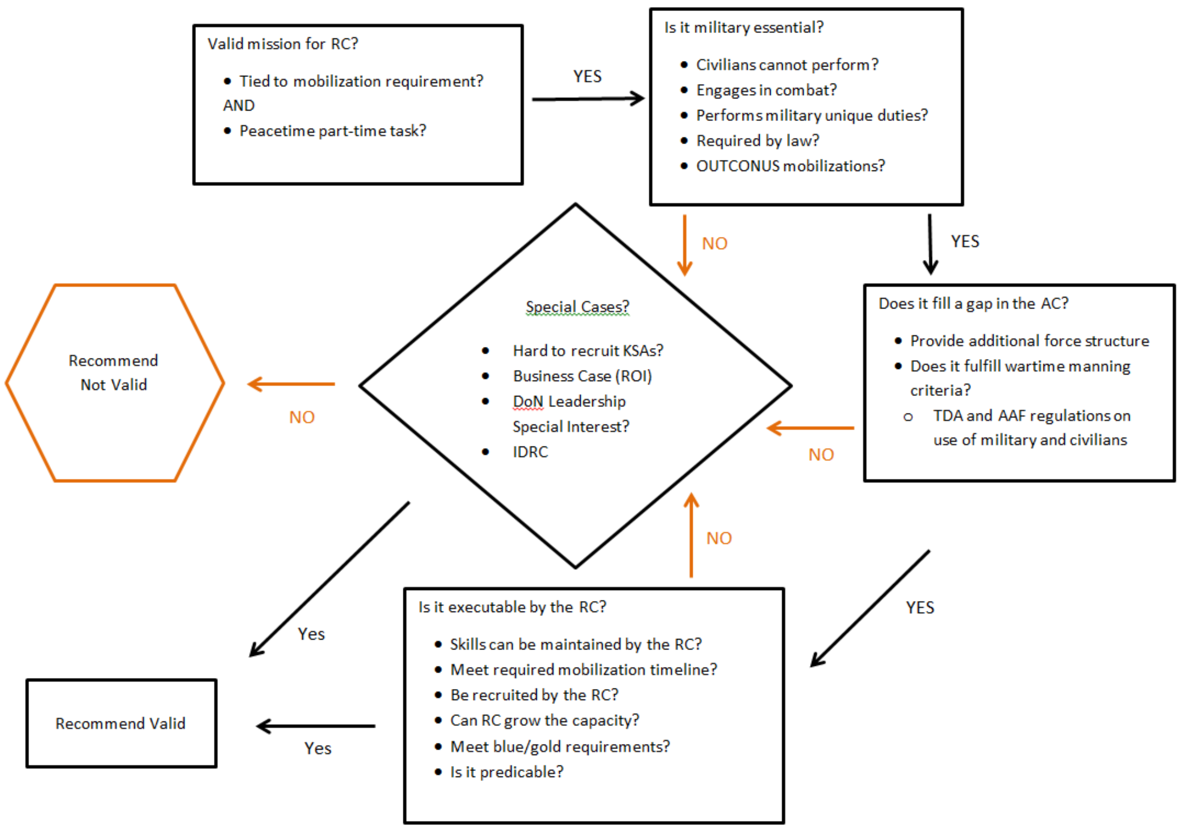
For many capabilities, especially those in ground forces, the ability to deploy rapidly is a principal justification for maintaining force mix in the AC rather than the RC. For those units that are able to train only 39 days per year, it is generally believed that they will require significant training between mobilization and deployment (whereas AC units, which are able to train full time while not in deployment, can head directly to a conflict).

The AC does not always enjoy a clear advantage over the RC in the ability to surge, however. For example, Air Force planners maintain that their reserve component is able to deploy just as rapidly as (and at times more rapidly than) their active component because they maintain readiness through voluntary participation in operations. Even among ground force units, some reserve units that provide phased support for ongoing operations will be ready to deploy to contingencies on short notice.

The ability to deploy has generally been one of the factors that enter only indirectly into the AC/RC force mix decision. As figure 11 shows, planners would assess when various capabilities would be needed in theater under various scenarios, would determine whether RC units could meet these deployment time-line requirements, and on this basis would either qualify or disqualify the use of the RC. Recently, however, models have been developed that provide some limited ability to calculate the cost of enhancing the ability to surge. For example, NECC's Capability Costing Model (NCCM) estimates the amount of time that nondeployed units serve in training (rather than dwell), and it can assess the dollar costs required to increase contiguous training (training that occurs just before mobilization) and, thereby, improve the ability to surge by a given amount of time.

Modeling the full costs of meeting surge requirements is much more complex than this, however, as one must estimate the ability of units to respond to multiple "peak surge" operations or to undertake "surge rotation" (i.e., closely spaced operations that vary in intensity and duration). Other relevant factors to be considered in such a model include the Relief in Place/Transfer of Authority (RIP/TOA) overlap and the ability to cross-level personnel among units (or to substitute smaller units within larger units). These elements are being integrated into surge models currently being produced by IDA for OSD CAPE and by RAND for the Army.

Figure 11. Validation criteria for the 2004 zero-based review of the Navy Reserve



Note: Some of the cost elements that drive AC/RC mix are easily measured and their role in cost modeling is straightforward. In other cases, data are available on particular types of costs, but the use of these data requires careful and nuanced interpretation. In still other cases, there are costs that are important in determining a service's AC/RC mix, but they are not quantifiable and their effects can only enter indirectly into force mix calculations. This decision tree illustrates how several hard-to-measure costs entered the force mix allocation process under the 2004 zero-based review of the Navy Reserve.

The effect on force mix decisions

In most circumstances, the failure to properly account for the ability to surge is likely to overstate the benefit of using the RC to support operational units BoG (in most situations the RC will be slower to the fight than the AC; failing to recognize this shortcoming will make the RC more attractive). Modeling surge, however, is another instance in which careful analysis can produce results that are counterintuitive and run contrary to common rules of thumb. Consider a service facing a choice of whether to support an emerging BoG requirement of medium importance with three existing AC units or nine existing RC units. An RC unit may not be at a full state of readiness until the last few months before a planned deployment, but AC units have more time for training and might always be fully ready. So, if the service were to use the RC units to fill the emerging requirement, the three AC units could be available to respond rapidly to more critical contingencies that might develop; however, if the service were to use the three AC units, there might be fewer RC units in a sufficient state of readiness to surge to the most urgent future contingencies.

Easily measured costs in force mix allocation models

At present, there is no single source of guidance for which costs the services should consider when dividing capability between the AC and RC. There is, however, guidance for which cost elements should be considered in *programming*. The broadest guidance, DOD 7000.14-R, provides detailed information on a wide range of service cost elements. In addition, DOD's Directive-Type Memorandum (DTM) 09-007, *Estimating and Comparing the Full Costs of Civilian and Military Manpower and Contract Support,* provides more focused information on how to estimate long-term and variable personnel programming costs for items that should be estimated on an accrual basis (such as retirement costs) [19]. Finally, DOD is formulating an instruction (7041.dd) that explicitly considers how programming costs should be compared between the active and reserve components (we have only limited information on this initiative). In this subsection, we consider cost elements delineated in the various sources of guidance on programming, and we then consider how they should be included in a force allocation model intended to compare the costs of the AC and RC.

Personnel costs

RC cost advantages are tied to AC endstrength reductions

Moving capability from AC to RC can only lower personnel costs if components' endstrengths are adjusted

Much of the literature on force allocation stresses the significant savings in personnel costs that can accrue from shifting military capability from the active to the reserve components. As we have previously indicated, much of this cost advantage derives from paying RC personnel on a part-time basis while they are in dwell (and paying AC personnel on a full-time basis). Note, however, that transferring military capability from the AC to the RC will not automatically lower personnel costs: personnel savings will only result if this reallocation of capability is associated with a reduction in AC endstrength. It has been observed by Gotz [20] and by policy-makers with whom we have spoken that decisions concerning allocation of capability between AC and RC are generally made in isolation from decisions concerning component endstrength. As a result, there may be little certainty that personnel savings will result from increased use of the RC, even if RC units were able to meet capability requirements at lower costs.

Cost elements associated with pay and benefits

Table 6 shows the programming cost elements identified in DTM 09-007 associated with personnel pay [19]. These costs, which accrue to a variety of agencies and departments in the federal government, are broken into three categories:

1. *Those that are variable in the short run.* These costs vary directly with personnel endstrength.
2. *Those that are fixed in the short run.* These are not directly tied to the number of personnel but are adjusted over time if changes in the size of the workforce are large enough, and of long enough duration, to warrant a change in the services associated with these costs.
3. *Those that are deferred, pay as you go.* These costs are obligated in the present, but will be incurred in the future, and include some types of deferred compensation.

Table 6. Programming cost elements related to pay and benefits (see [12] for further discussion of some of these cost variables)

Variable costs in the short run	Basic pay
	Allowances and special pays
	Incentive pays
	Health benefit, active duty and dependents
	Social Security and Medicare
	Retired pay (accrual)
	Travel/PCS/transportation subsidy
	Education assistance
	Health benefit, retiree (>65 MERHCF accrual)
	Training costs (amortized over years of practice)
	Recruitment, advertising, etc. (amortized)
Fixed costs in the short run	Child development
	Family support services
	Discount groceries
Deferred, pay-as-you-go costs	Health benefit, retiree (<65 retiree and family)
	Health benefit, other (TAMP and CHCBP)
	Discount groceries, retiree
	Separation pay and travel
	Unemployment benefits
	Death gratuities
	Survivor benefits

Which personnel costs to include and which to exclude?

Not all of these programming costs should be considered when apportioning capability to the AC and the RC. We should *exclude* cost elements that do not vary with AC/RC allocation of capability; for example, Department of Veterans Affairs (VA) health care costs, death gratuities, and survivor benefits for wounded personnel are likely to remain constant regardless of AC/RC force mix, and these elements can be dropped from our force mix analyses. We should also exclude costs that are fixed in the short run if reallocation of capabilities among components will not result in changes in the size of the workforce that are sufficiently large to warrant additional investment in these services (for example, shifting capability from the RC to the AC would not necessarily increase AC commissary costs). Finally, we should omit the costs of incentives and bonuses that are associated with current recruiting and retention conditions if these conditions are not expected to prevail over the long term.

For some of these costs, one cannot tell, without close examination of the specific circumstances facing a service community, whether the cost elements should be excluded from analyses of force allocation. One would need to undertake a detailed examination of conditions related to individual communities to identify which incentive pays and fixed costs should be considered.

Most big-ticket personnel costs are predictable.

It should be pointed out, however, that the fixed cost elements about which there is uncertainty are expected to have relatively small dollar values (on a per-person basis) and are unlikely to "tip the scales" in any cost assessments of force allocation. The Air Force recently conducted an analysis of its fully burdened manpower costs (following the guidance of DoDI 7041.dd) and found that the personnel-related cost elements for which there would likely be significant variation across different communities make up only 5.9 percent of total personnel-related costs. (These cost elements include day care facilities, subsidized groceries, DOD Education Activity, family assistance, education assistance, recruitment and advertising, and training; see TFE AF (2012) [21].

O&M and procurement costs

In planning alternative force mixes, there are substantial complications in dealing with O&M and procurement costs. As with personnel-related cost factors, one would have to examine the particular details of the relevant service communities in order to accurately assign all costs in force mix analyses. However, unlike the case with personnel costs, the uncertainties with O&M and procurement costs may involve big-ticket items, and incorrectly estimating these costs can result in significant misallocation of resources.

Large variation in O&M and procurement cost by unit type

Two points about these costs are worth noting. Perhaps most important is that they show substantial variation at both the unit level and the level of the individual servicemembers. Some types of capabilities are invariably more capital intensive than others, regardless of whether they reside in the AC or the RC (for example, an aviation squadron will have more O&M and procurement costs than a Chaplain's unit).

Depending on the circumstances, the RC may have a cost disadvantage when it comes to equipment and O&M costs

A second point is that the RC often enjoys a much smaller cost advantage with O&M and procurement than it does with personnel; in fact, depending on the circumstances, the RC may even be at a cost *disadvantage* when it comes to equipment and maintenance. There is no reason to believe, a priori, that the equipment packages issued to RC units, and the maintenance costs associated with these packages, will be significantly less expensive than those issued to AC units: while there are many stories about the reserves receiving "hand-me-down" equipment from the AC (equipment that is obsolete and fully depreciated), there are many instances in which RC units are provided with the same equipment as their AC counterparts. This implies that, on a unit-to-unit basis (and in the strategic reserve model), the RC equipment costs may be very similar to those of the AC.

Moreover, in a BoG model (when we measure the cost of using the AC and RC in phased deployment to maintain units BoG), it is possible that the RC may be substantially *more* expensive than the AC. Given that it takes more RC than AC units to support one deployed unit BoG, if all RC units are equipped to the same standard as AC units, the RC equipment costs would be higher than those of the AC. For example, if AC units operate on a DEP/Dwell ratio of 1:2 and RC units operate on a MOB/Dwell ratio of 1:5 with three months' training and one month stand-down, it takes three units of AC or nine units RC to sustain one unit BoG. In this case, if all RC units are equipped to the same standard as their AC counterparts, the equipment cost of the RC (in a BoG cost model) would be three times that of the AC.

Historical data on O&M and procurement may be misleading

The available, historical data on O&M and procurement may provide poor proxies for what the services would have to spend in the future to equip and operate RC units. This is particularly the case when AC and RC units regularly train and operate together. Commands that include both AC and RC units must maintain separate operations and equipment accounts for the two components, but there is an incentive to *overfund* these accounts for the active unit and *underfund* them for the reserve unit: regulations allow funds earmarked for the AC to be spent on the RC, but the reverse is not the case; funds that have been appropriated for use by the RC cannot be used to support the AC. As a result, commands that include both AC and RC units often err on the side of overfunding their AC accounts and underfunding their RC accounts, knowing that this arrangement will provide the greatest latitude in how they execute their expenditures.

Estimating costs when units "fall in" on equipment

Another complication is how the services should place a cost on equipment for the AC and RC when deploying units "fall in" on equipment left in theater by previous units. This is of particular concern in the context of the current study because it is often AC units that initially bring equipment into theater and RC units that later fall in on this equipment.[27]

When policy-makers look to historical data on equipment purchases for the AC and RC, it often appears that the AC is far more costly than the RC, but this may only be the result of the AC being charged the total cost of equipment that will ultimately be used by both components. This raises the question of how equipment costs should be allocated across units if it is being shared in this type of falling-in arrangement. One solution that is sometimes proposed is allocating these costs in proportion to the amount of time that the equipment is used by the active and reserve components. That is, if a piece of equipment (say, an aircraft) is used in theater two-thirds of the time by the AC and one-third of the time by the RC, the cost of the aircraft should be allocated two-thirds to the active and one-third to the reserve.

Note, however, that allocating costs with this proportionate approach misses an important point: if an aircraft depreciates at the same rate regardless of whether it is used by the AC or the RC, it should be excluded from any calculation of the relative costs of using the AC and RC. The services would, after all, have to pay the same amount for

[27] A similar question arises when the AC and RC work on common equipment, such as in Air Force "associate units."

If an aircraft depreciates at the same rate whether it is used by the AC or the RC, it should be excluded from calculations of the relative costs of the components

the aircraft irrespective of whether it is being flown by active or reserve personnel. (In fact, the Air Force's TFE AF model excludes unit equipment costs from force mix assessments.)

Estimating costs for units' organic equipment

This does not imply that all equipment costs should be excluded from our calculations of the relative operational costs of the AC and RC. We should include costs of equipment sets that are organic to units, and that units carry with them when they deploy. Although such equipment might depreciate at similar rates in individual AC and RC units, the fact that the RC requires more units than the AC to sustain a unit boots on ground (the RC requires a larger rotation base than the AC) means that it may be more expensive to provide RC units with this type of equipment.

Misestimating depreciation rates. There are yet other ways that historical data may provide a misleading indicator of future equipment costs. For example, RC units that have only recently been stood up are likely to show large equipment costs in the latest years (for example, many of the RC units in the NECC), but, if these units are now fully equipped, these large equipment costs are unlikely to be repeated in the near future. Similarly, if RC units have been engaged exclusively in drill for many years, their historical equipment costs may be less than those of other RC units that have similar missions and have been recently deployed.

The need for detailed unit-level analysis

We have indicated that some of the cost elements that should be included in AC/RC force mix analyses are likely to be common across units. The author of [22] (Carson, 2012) has made similar observations and suggested that commonalities are likely to be limited to some personnel costs (based on service personnel composite rates), a portion of Overseas Contingency Operation (OCO) costs, and some rates estimated using OSD Comptroller or CAPE guidance (e.g., calculation of retirement costs). However, Carson also points out that there are many other costs that are *not* likely to be common across units, including the following:

- Infrastructure costs: facilities, MILCON, utilities, facilities maintenance, base services (e.g., warehousing, runways, medical clinics, housing, and education)

- Equipment costs: equipping schemes based on community, intermediate and depot-level maintenance, anticipated modernization, service life, anticipated recapitalization—and fair allocation of these estimates

- Life-cycle costs: recruiting, initial training, and refresher training

An approach to estimating idiosyncratic, difficult-to-capture costs

In an important paper, Gotz et al. [20] also observed that precise estimates of the relative costs of the AC and RC would require detailed examination of the many idiosyncratic and difficult-to-capture costs associated with specific communities. They cautioned against generalizing from past analyses any simplistic rules of thumb concerning the relative costs of the AC and RC; they suggested that decisions about allocating force structure should rely on detailed analyses of alternatives that focus on the changes in resources, activities, and missions that would result from a reallocation of structure. The need for this type of detailed analysis increases as planners consider using components in ways they have never previously been used.

The authors focused on four sources of error that can occur when using historical data to assess the relative costs of the AC and RC. All four of the following errors act to *overstate* the cost advantage of the RC:

- Predictions of cost savings may ignore changes in the level of force structure. For example, moving an air transport squadron from the active component to reserve components could produce significant savings as a result of lower personnel costs. However, these savings might only be realized with a reduction in the flying hours of the squadron to levels that could be sustained by reserve personnel.

- Estimates of cost savings may fail to recognize the effects of force restructuring on units other than those immediately involved in the realignment. Extending the previous example, moving a transport squadron from the AC to the RC might result in the service losing essential peacetime services and might necessitate other AC units increasing their levels of activity to meet the service's air transport needs.

- Analysis of savings may be based on an assumption that important cost elements are fixed over time when they are, in fact, variable. The authors suggest that major realignments of force structure often result in substantial deviation from historical patterns of manning, peacetime activity level, equipment, mission, and basing.
- Savings projections may fail to account for nonrecurring costs associated with moving force structure from one component to another. The authors write that:

> nonrecurring costs have a high degree of variability, depending on the specific type of change in the total force and the characteristics surrounding the change. Specifically, nonrecurring costs tend to be higher when units and personnel are being added to the total force, when the basing location cannot provide existing facilities or a sharing of various logistic support assets, and when a high proportion of appropriate prior-service personnel cannot be attained. [20]

The authors also provide a detailed framework for assessing the net changes in DOD resources and missions that accompany changes in the AC/RC force mix. This structure is useful for defining the cost elements that should be included when applying any of the AC/RC force mix allocation models (e.g., the strategic model or the BoG model).

Summary

Conclusions

A commonly heard complaint about the force mix allocation process is that it has too often focused on some particular value for the cost of the AC and RC that has been estimated in a narrow set of circumstances and applied (often inappropriately) across a broad set of conditions. In the Cold War era, analysts who applied a strategic reserve model to a traditional set of cost elements generally found that the cost of maintaining RC units was between one-fifth and one-third the cost of maintaining nondeployed AC units. However, even this widely repeated estimate concealed much variation in relative costs: in equipment-intensive communities, the cost advantage of the RC is substantially less (some studies find that RC aviation units cost about 70 percent as much as AC units). The simple rules of thumb obscure the fact that in many communities—particularly capital-intensive communities—the RC enjoys a considerably smaller cost advantage. Once one considers the difficult-to-measure cost elements (e.g., uncertain access to the RC and nonrecurring costs associated with reallocation of force mix), in many circumstances, moving capability from the AC to the RC would produce little savings.

In the last several years, however, new cost models (such as the BoG model) have introduced new rules of thumb regarding the use of the reserve components in support of sustained operations. We have demonstrated that these models have generally overstated the cost of employing the RC and obscured savings that might be gained with greater use of the RC in support of sustained operations. (These models generally ignore the value of the strategic role of the RC and, in so doing, understate the overall military value of the reserve components.)

We have also demonstrated that the boots-on-ground approach can be modified to reflect the value of the RC in both strategic and operational roles (we first made this observation in [1] (Cox, 2010)). In the last two years, a few defense analysis organizations and force planning groups have introduced their own approaches to simultaneously capturing the value of the RC's operational and strategic roles. However, we demonstrate in this analysis that there are still limitations in the way costs are accounted for in these recent models and that, as a result, there is significantly greater scope than is generally believed for the cost-effective use of the RC in support of operational deployments.

We have also identified several situations that enhance the likelihood that the RC will have a cost advantage over the AC in providing phased deployments of operational units. These include capabilities

- for which a service needs to maintain a strategic force that is significantly larger than its operational force;
- that are labor intensive (capabilities that involve significant personnel and O&M costs, but that involve relatively little equipment); and
- that require relatively less complex training workups between mobilization and deployment.

Recommendations

While these are the capabilities in which the RC is most likely to enjoy a cost advantage in supporting phased rotation of operational units, there are likely to be capabilities that do not conform to these characteristics but for which the RC would still have a cost advantage in maintaining an operational presence. Identifying the full set of capabilities in which the RC can support phased deployment of units should involve detailed community-by-community analyses of alternatives that focus on the changes in resources, activities, and missions that would result from a reallocation of structure. The need for this type of detailed assessment becomes increasingly important as planners consider using components in ways they have never previously been used.

Appendix A: Training and dwell drive costs

RC costs under a 1:5 Mob/Dwell ratio for the RC

In this appendix, we consider how the relative cost of the AC and RC is affected by dwell time and training time. In the body of the study, we assumed a situation in which RC units face a 1:5 Mob/Dwell ratio. We assumed a 72-month deployment cycle with 12 months mobilization and 60 months in dwell, and we estimated the cost of an individual RC unit at 37.5 percent that of an individual AC unit:

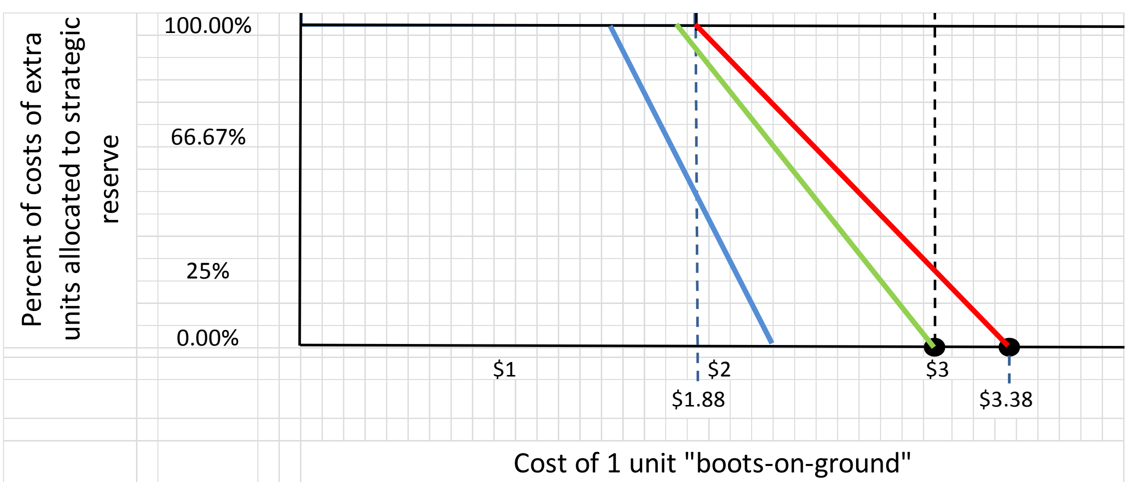
37.5% = (100% x 12 months + 25% x 60 moths) / 72 months

The number of AC units required to support one unit BoG will vary with the amount of mobilization time that is spent on training and stand-down. (Because training and stand-down time is taken away from deployment time, a larger rotational base is required to support a unit BoG.) In the text, we assumed that a one-year mobilization would include three months of training and one month stand-down. In such a case, a rotation base of nine units would be necessary for the RC to support one unit BoG. (The nine units would include six additional units over and above the rotation base that the AC would require to support one unit BoG.) The red line in figure 12 illustrates that the cost of the RC supporting one unit BoG would lie between $1.88 and $3.38 (depending on how much of the dwell-time cost of the six additional RC units is assigned to the service's strategic capability).

The green line in figure 12 illustrates the cost of the RC supporting one unit BoG if we maintain all our previous assumptions, but reduce the training time during mobilization by one month (i.e., training would be two months and stand-down would be one month). This would increase deployment time by one month and reduce the rotation base that the RC would need to maintain one unit BoG from nine units to eight units. (The eight units would include five additional units over the rotation base that the AC would require to support one unit BoG.) Under these assumptions, the cost of the RC supporting one unit BoG would lie between $1.75 and $3.00 depending on how much of the dwell-time cost of the five additional RC units is assigned to the service's strategic capability. Note that under these conditions, the cost of the RC supporting one unit BoG is always less than or equal to the cost of the AC supporting one unit BoG ($3.00).

The blue line in figure 12 illustrates the cost of the RC supporting one unit BoG if both (1) training time between mobilization and deployment and (2) stand-down time were eliminated.[28] In such a case, a one-year mobilization would yield 12 months of deployment, and the RC would require only six units to support one unit BoG. (The six units would include three additional units over the rotation base that the AC would require to support one unit BoG.) Under these assumptions, the cost of the RC supporting one unit BoG would lie between $1.50 and $2.25 (depending on how much of the dwell-time cost of the five additional RC units is assigned to the service's strategic capability), and it would always be cheaper to use the RC than the AC to support a BoG unit.

Figure 12. The cost of RC supporting a BoG unit, assuming 1:5 Mob/Dwell ratio for reserve units



28 DoDI 1235.12 indicates that the Services can exclude contiguous individual skill training when computing whether a mobilization exceeds one year. There have been instances in OIF/OEF where the Army excluded this training time from the definition of mobilization so as to maintain 12 month in-theater cycles for the RC.

RC costs under a 1:4 Mob/Dwell ratio for the RC

We will now assume that RC units face a 1:4 Mob/Dwell ratio. This would imply a 60-month deployment cycle with 12 months mobilized and 48 months in dwell. The cost of an individual RC unit would be 40 percent that of an individual AC unit:

40% = (100% x 12 months + 25% x 48 moths) / 60 months

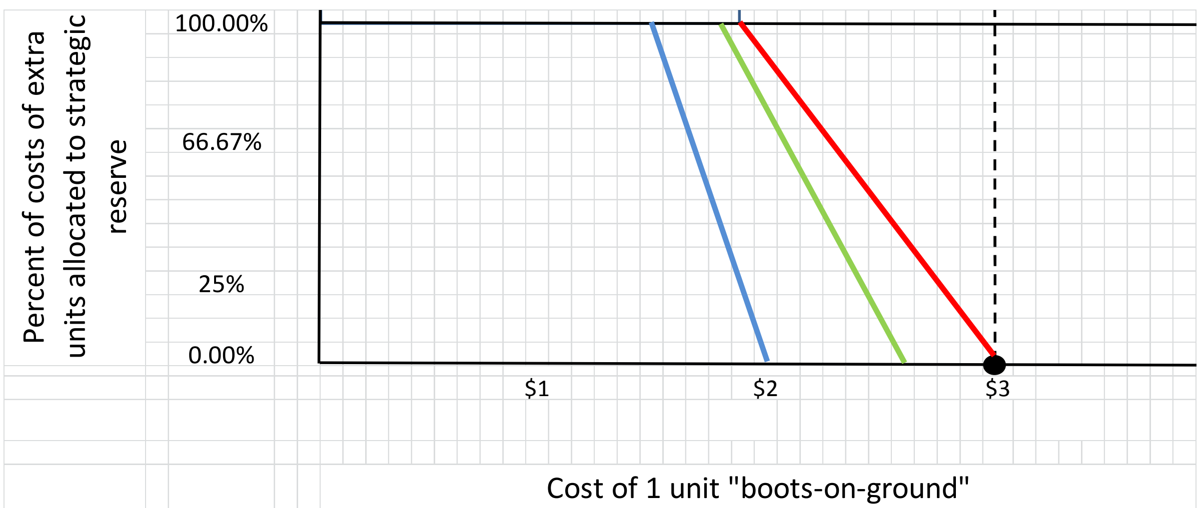
If we assume that the one-year mobilization would include three months of training and one month stand-down, a rotation base of 7.5 units would be necessary for the RC to support one unit BoG. (The 7.5 units would include 4.5 additional units over and above the rotation base that the AC would require to support one unit BoG). The red line in figure 13 illustrates that the cost of the RC supporting one unit BoG would lie between $1.88 and $3.00 (depending on how much of the dwell-time cost of the 4.5 additional RC units is assigned to the service's strategic capability), and it would always be cheaper to use the RC than the AC to support a BoG unit.

The green line in figure 13 illustrates the cost of the RC supporting one unit BoG if we maintain all our previous assumptions, but reduce training time during mobilization by one month. (Training would be two months and stand-down would be one month). This would increase deployment time by one month and reduce the rotation base that the RC would need to maintain one unit BoG from 7.5 units to 6.7 units. (The 6.7 units would include 3.7 additional units over the rotation base that the AC would require to support one unit BoG.) Under these assumptions, the cost of the RC supporting one unit BoG would lie between $1.74 and $2.67, depending on how much of the dwell-time cost of the 3.7 additional RC units is assigned to the service's strategic capability. Note that under these conditions, the cost of the RC supporting one unit BoG is always less than the cost of the AC supporting one unit BoG ($3.00).

Finally, the blue line in figure 13 illustrates the cost of the RC supporting one unit BoG if both (1) training time between mobilization and deployment and (2) stand-down time were eliminated. In such a case, a one-year mobilization would yield 12 months of deployment, and the RC would require only five units to support one unit BoG.

(The five units would include two additional units over the rotation base that the AC would require to support one unit BoG.) Under these assumptions, the cost of the RC supporting one unit BoG would lie between $1.50 and $2.00 (depending on how much of the dwell-time cost of the two additional RC units is assigned to the service's strategic capability).

Figure 13. The cost of RC supporting a BoG unit, assuming 1:4 Mob/Dwell ratio for reserve units



Appendix B: Use of the Navy Reserve

Although some services have developed their reserve components to be close substitutes for their active component (the Marine Corps, for example, often refers to its reserve component as being a "mirror image" of its active component), the Navy reserve force was designed as a *complement* to the service's active force. The active forces include many ship and aircraft types that do not exist in the reserve force, while other Navy capabilities reside either exclusively or predominantly in the reserve. (Historically, these have included CONUS-based logistic airlift, adversary air combat support, combat search and rescue, and cargo handling.)

The service's use of its reserve force has been, to a significant extent, driven by the deployment patterns of Navy ships and aircraft. At any time, about one-quarter of the service's ships and aircraft are forward deployed and remain forward deployed for six months or more at a time.[29] (In contrast, much of the Army and Marine Corps is "forward based" and the Air Force, which is often forward deployed, deploys for much shorter periods than the Navy.) The remainder of the service's ships and aircraft serve as a rotational base for supporting forward deployments. The long duration of Navy deployments, and their frequency, generally prohibits members of the Selected Reserve from participating in operations.

Another factor that has affected the Navy's allocation of capacity between the AC and RC is the service's self-deployment capacity. For the other services, waiting for lift can provide reserve forces with extra time for recall and training. However, by the nature of its missions, the Navy is endowed with the largest lift capacity of all the services and it is configured to rapidly deploy large amounts of resources. As a consequence the Navy Reserve is generally not afforded "awaiting lift time" that could be used for additional training and this can lessen the usefulness of the reserve.

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29 For example, surface combatants and carriers are generally on an 18 to 24 month cycle. Six of those months are spent on forward deployments.

Other factors affecting the desirability of placing capability in the RC

Various sources have enumerated conditions that can affect the desirability of allocating capabilities to the RC, and they have mapped these to specific Navy activities. Among recent efforts is the 2004 "Zero-Based Review" (ZBR) methodology by the Commander Fleet Forces Command (see [23] (Keith, 2005)) and a 2008 effort "Institutionalizing the Navy Reserve" (see [24] (US Navy, 2008)). A more dated effort, but one that is highly transparent and instructive, was provided by Mayer et al (1992) [25] who suggest the following factors as being highly relevant in allocating capability to the RC. (Those factors that they believe enhance the usefulness of the reserve are denoted with a (+), while those that diminish the usefulness of the reserve are denoted with a (-).)

Table 7. Factors that affect the desirability of placing capabilities in the RC

(-) Forward deploying: reservists needed as part of a rotational base for a forward deployed ship.

(-) Reservists would be needed immediately in a contingency.

(+) Reservists could be available rapidly.

(+) The active unit may require augmentation in time of crisis.

(+) Tasks are intermittent or schedulable, as opposed to continuous.

(-) Recruiting problems exist or would be expected if many for reserve billets were added.

(-) Placing the capability in the Reserve would result in little cost savings.

(-) Shore rotation: placing a shore-based billet in the Reserve would eliminate opportunities to use this billet to provide needed shore rotation.

(+) Category uses skills retained or relearned quickly, or uses civilian skills.

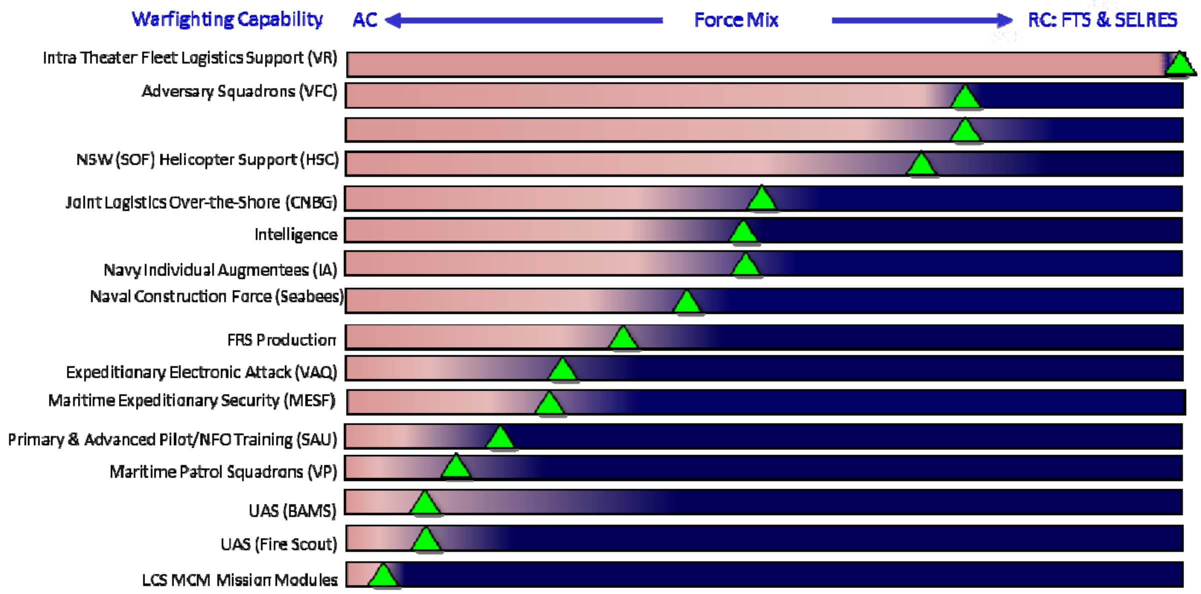
(+) Category calls for skills used individually or in small groups rather than in large groups. (Reserves can have difficulty in undertaking large unit training.)

Mayer et al. [25] mapped these characteristics to various Navy activities in order to identify which are most appropriate for allocation to the Reserve. This mapping remains relevant to current decisions regarding the assignment of capabilities to the active and reserve components; their results are shown in table 8. Figure 14 illustrates the capabilities that the Navy currently assigns to its Reserve Component.

Table 8. Assessing whether activities are appropriate for the Navy Reserve

Category	Tasks intermittent or schedulable	Forward-deployed unit	Could be recruited	Reserve cost as a fraction of active	Reserve needed immediately
Cargo handling	Y	N	y	Much less	Y
Naval construction forces	Y	B	N	Much less	Y
Amphibious forces ashore	Y	N	Y	Much less	Y
Mobility forces	Y	N	N	Much less	Y
Intelligence	Y	N	Y	Much less	Y
Land forces: division	Y	B	N	Much less	N
Direct-support squadrons	y	N	Y	About half	Y
Medical support	Y	B	N	Much less	Y
Supply operations	Y	N	Y	Much less	Y
Logistics support	Y	N	y	Much less	Y
Combat commands	Y	N	Y	Much less	Y
Support commands	Y	N	Y	Much less	Y
Personnel support	y	N	y	Much less	N
IMA ashore	y	N	Y	Much less	N
Maintenance operations	Y	N	Y	Much less	N
Mine warfare	S	N	Y	About equal	Y
Major/minor support ships	S	N	N	About equal	N
Centrally managed communications	y	N	y	Much less	Y
Combat installations and support activities	y	N	Y	Much less	N
Joint activities	Y	N	Y	Much less	Y
R&D/geo-physical activities	y	N	Y	Much less	N
Strategic: control and surveillance forces	y	I	y	About half	Y
Force support training	Y	N	Y	Much less	N
Individual training	Y	N	y	Much less	N
Attack, fighter, recon. squadrons	Y	Y	Y	About half	Y
Surface combatants	S	y	N	About equal	N
Amphibious ships	S	Y	N	About equal	Y
Strategic: offensive	N	Y	N	About equal	N
CVrCVN	S	Y	N	About equal	N
SSNs	N	Y	N	About equal	N
Naval support forces: CIF ships	S	Y	N	About equal	N

Figure 14. AC/RC mix for Navy warfighting capabilities



Source: Chief of Navy Reserve (2012), Navy Reserve Support to Navy presentation, April 30, 2012.

Glossary

AC	Active Component
ARFORGEN	Army's Force Generation Model
ARNG	Army National Guard
BAH	Basic Allowance for Housing
BAS	Basic Allowance for Subsistence
BoG	Boots on Ground
BCT	Brigade Combat Team
CBO	Congressional Budget Office
CONUS	Continental United States
DASN RA	Deputy Assistant Secretary of the Navy for Reserve Affairs
DEP	Deployment
DHAN	DHAN Medicare-Eligible, Navy
DHANR	Medicare-Eligible, Navy Reserve
DOD	Department of Defense
FOR	Force Optimization Review
FSR	Force Structure Review
FTS	Full Time Support
IDA	Institute for Defense Analyses
KSAs	Knowledge, Skills, and Abilities

MERHCF	Medicare-Eligible Retiree Health Care Fund
MOB	Mobilization
NCCM	NECC's Capability Costing Model
NECC	Navy Expeditionary Combat Command
NGREA	National Guard & Reserve Equipment Appropriation
OCO	Overseas Contingency Operations
O&M	Operations and Maintenance
OMN	Operations and Maintenance, Navy
OMNR	Operations and Maintenance, Navy Reserve
OSD CAPE	Office of the Secretary of Defense, Cost Assessment & Programs Evaluation
PCS	Permanent Change of Station
RC	Reserve Component
RIP/TOA	Relief in Place/Transfer of Authority
SECDEF	Secretary of Defense
SelRes	Selected Reserves
TFE AF	Air Force's Total Force Enterprise Analytic Framework
USMC	United States Marine Corps
VA	Department of Veterans Affairs

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