The Effects of Changing the Staffing in Military Treatment Facilities

Jacob Alex Klerman, M. Rebecca Kilburn

National Defense Research Institute

PREFACE

The military provides health services to dependents and retirees both through the on-base military health system—Military Treatment Facilities (MTFs), and through the private health care system—CHAMPUS (Civilian Health and Medical Plan for the Uniformed Services). Because the average cost per visit has been estimated to be less in the MTFs, it has been suggested that increasing MTF staffing levels might draw into the MTFs patients who otherwise would use CHAMPUS, thereby decreasing total military health expenditures. This report addresses this assumption.

The report uses data on variation in staffing levels between FY 1988 and FY 1992 to generate estimates of the effects of increasing MTF staffing on the utilization of MTF care and on the utilization of CHAMPUS care. Two considerations are examined that might diminish the projected cost savings. First, increased staffing levels may yield a less-than-proportional increase in patients served. Second, with better care available in the MTFs, total utilization may increase.

The study was sponsored by the Office of the Director (Program Analysis and Evaluation). It was prepared for the Office of the Secretary of Defense to support the Comprehensive Study of the Military Health-Care System requested by the 1992–1993 Defense Authorization Act. The research was conducted in the Forces and Resources Policy Center of RAND's National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, and the Defense Agencies. This report was initially prepared in 1996. It reflects research carried out in 1993–1995.

The findings of this study will be of special interest to government and other agencies concerned with the efficient use of resources in the military health care system.

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SUMMARY

The military provides health services to dependents and retirees both through the on-base military health system—Military Treatment Facilities (MTFs), and, as a third-party payer—to the private health care system (CHAMPUS[1]). The continuing rapid increase in total military health expenditures has focused attention on these systems. Because the average cost per visit has been estimated to be less in the MTFs, it has been proposed that increased MTF staffing levels might draw patients into the MTFs who otherwise would use CHAMPUS, thereby decreasing total military health expenditures.

Using economic theory, survey results, and regression analysis, this report considers the logic of cost savings through increasing MTF resources. The three modes of analysis are complementary and all point to the same conclusion: Additional patients seen in the MTF as a result of increased MTF staffing will not all come from CHAMPUS cases. Moreover, many of the services provided to the additional MTF patients will be services that—absent the increased staffing—would have been reimbursed by other (non-CHAMPUS) health insurance, paid for by the patient, or gone unprovided. Therefore, for many services, unless the MTF can provide care at a substantially lower cost, increasing MTF staffing may actually increase total medical costs. This result is consistent with the findings of the Department of Defense (DoD) Comprehensive Study of the Military Medical Care System (DoD, 1994) which used different data and methods.

If the calculations of our study are correct, then increases in staffing and resources above what is indicated by the readiness mission may lead to higher cost for the benefit mission. Of course, an increase in MTF resources may well generate additional advantages for beneficiaries. However, the military population already experiences high utilization levels.

These computations assume no recovery of MTF costs from private insurance carriers. If the required data systems were in place, and cost recovery were aggressively pursued, increasing MTF staffing would be attractive in more situations.

The survey results suggest that considerable care provided by civilian doctors to CHAMPUS eligibles is not reimbursed by CHAMPUS. Among the reasons are (1) the use of other insurance, including Medicare by retirees after age 65 and other insurance

[1]CHAMPUS is the Civilian Health and Medical Program for the Uniformed Services.

(usually available through private employment) by CHAMPUS eligibles; (2) decreased patient demand resulting from CHAMPUS cost sharing, incomplete coverage (especially of preventive services), and the paperwork burden; and (3) different practice patterns in the civilian sector. Thirty percent of beneficiaries report that they did not get medical care when they thought they needed it during the most recent six months because of the cost of CHAMPUS and the lack of available MTF providers. These survey results suggest that, as the availability of MTF care improves (as it would with increased staffing), many of the additional cases will not come from CHAMPUS.

The regression results point in a similar direction. We used new approaches to estimate the trade-off factors, exploiting new data on MTF staffing to overcome some of the weaknesses of previous studies. Our regression results consistently show that production of health care (outpatient visits and inpatient admissions) in the MTFs is characterized by decreasing returns to scale: for a given MTF, each additional doctor sees fewer patients than did the existing staff. Furthermore, the overwhelming majority of the new patients seen do not come from CHAMPUS. The implied trade-off factors—the number of additional patients seen in the MTF required to decrease CHAMPUS care by one patient—are over three for outpatient and inpatient services. Trade-off factors are higher for surgical care than they are for medical services.

These large trade-off factors are consistent with our theoretical model of patient care-seeking behavior. A naive model of cost savings from increasing MTF staffing notes that MTF costs are below CHAMPUS costs, and, therefore, shifting care from CHAMPUS to the MTF would lower the total cost to the DoD. Implicitly, this argument assumes that the additional utilization would otherwise have been handled through CHAMPUS. The theoretical model and the survey results suggest that some of the care might previously have been financed by other (non-CHAMPUS) insurance, Medicare (for retirees over 65), or not utilized because of limited MTF access and CHAMPUS cost sharing or coverage limits. The regression results suggest that these alternative sources of demand should not be ignored.

Inefficient staffing and capital availability provide an additional possible reason for the high trade-off factors. One possible explanation for the decreasing productivity of additional doctors is that different inputs (doctors, nurses, capital) are not being expanded in the appropriate ratios. Without enough additional support personnel, waiting rooms, and lab facilities, additional doctors will not be fully utilized.

The results reported in this report are based on limited aggregate data. It seems likely that, for some procedures and in some locations, MTF costs are lower than

CHAMPUS costs, whereas MTF costs are equivalent or higher for other procedures and locations. The size of each of the three groups (those using CHAMPUS, private insurance, or receiving no care in a given situation), and more importantly, which specific procedures and locations fall into each group are questions that require further study and better data. Nevertheless, the results of this study suggest that the assumption that all of the additional MTF cases would otherwise have been served by CHAMPUS will yield extremely biased estimates of the cost savings from increasing MTF staffing.

The data we use predate the introduction of managed care (the Tricare program) and a per-capita budgeting system for the MTFs. These programs should lower the trade-off factor because they control beneficiary utilization levels, reduce CHAMPUS out-of-pocket costs, encourage a more cost-effective mix of MTF and CHAMPUS care, and eliminate MTF incentives to provide unnecessary outpatient visits and inpatient days.

ACKNOWLEDGMENTS

This report has benefited at all stages from the staff of related projects that are evaluating two demonstration projects currently under way in the military health services system. The comments of our colleagues Susan Hosek and Lloyd Dixon on model formulation and on the institutional details were invaluable. The project has also benefited from the programming support of Carol Edwards, Steve McKenney, Afshin Rastegar, Jan Hanley, and Rodger Madison; the research assistant work of Mary Anne Doyle; and the secretarial support of Irene Sanchez, Edie Nichols, DeeBye Meyers, Eric Weiss, and Natasha Kostan.

1. INTRODUCTION

The Department of Defense (DoD) currently runs a health system consisting of two components. It provides care directly through a network of Military Treatment Facilities (MTFs), and it reimburses civilian doctors for services provided through the Civilian Health and Medical Plan for the Uniformed Services (CHAMPUS). The continuing rapid increase in total military health expenditures has focused attention on this dual system.

Some proposals to control costs have involved using MTFs more intensively by increasing their staffing. The advisability of this strategy is a function of two considerations: the relative cost of providing service in the two systems and the changes in beneficiary utilization that would result from improved availability of MTF services. After a short discussion of the background of the problem, the remainder of this report is devoted to exploring the magnitude of the utilization changes.

Why are utilization changes potentially important? A naive analysis of the optimal size of the MTFs would compare the cost of providing a service in the MTF with the payment to a civilian provider through CHAMPUS. Subject to any overall capacity constraints, the MTF should then be expanded until it could provide all services for which its costs are less than CHAMPUS's costs.

This analysis implicitly assumes that if capacity in the MTF is increased, there will be a *one-for-one transfer* of medical services from CHAMPUS to the MTF. This report demonstrates that the assumption of one-for-one transfer is generally incorrect. We find that when resources are added to the MTF, some cases are transferred from CHAMPUS to the MTFs. However, in addition, the sum of MTF and CHAMPUS utilization increases. The added care is partially for patients who were not previously served by CHAMPUS and partially for previous MTF patients who use more care in response to its greater availability.

The 1992–1993 Defense Authorization Act requested an analysis of trade-off factors as part of the DoD Comprehensive Study of the Military Health Care System (the 733 study). Our report and another RAND report, Hosek, et al. (1995), both examine changes in MTF and CHAMPUS utilization resulting from MTF expansions. Whereas our study relies on catchment area utilization data, the Hosek et al. (1995) study investigates the question from a different angle—using person-level utilization data. As we discuss in more detail later, the two approaches produce similar conclusions.

The remainder of this report is organized as follows. The next section describes the institutional background and presents some survey data to describe the sizes of the various patient groups served by the military health systems. The third section presents an economic model that incorporates the possibility that demand might change with MTF staffing and presents some survey evidence to support the model's characterization of the beneficiaries' health care options. The fourth section reviews previous empirical estimates of the size of the demand effect as measured by the trade-off factor between MTF and CHAMPUS services; it then describes and implements a new methodology for estimating aggregate trade-off factors. This new methodology exploits newly available data on MTF staffing to overcome some of the problems with earlier studies. The final section presents the conclusions of the study and discusses how current changes in the military health system may affect the trade-off factor.

2. BACKGROUND

The military health system performs two sometimes conflicting missions. The first, called the *readiness mission,* provides health care to members of the active forces in peace time and care for the wounded and sick in time of war. The second, called the *benefits mission,*[2] provides health benefits for the dependents of active duty personnel and for retirees and their dependents and survivors.

The MTFs and CHAMPUS support these two missions. The MTFs support both missions, whereas CHAMPUS supports only the benefits mission. The two systems also differ in their availability to different classes of people and their monetary and nonpecuniary costs. This section reviews those differences and discusses some innovations introduced since 1988.[3]

The armed services maintain a worldwide network of more than 120 hospitals and hundreds of clinics. Health services at these facilities are provided without charge to patients. Military active duty personnel are *required* to receive care through the MTF system. In addition, dependents of active duty personnel and retirees and their dependents and surviving spouses are eligible for care on a *space-available basis.*[4]

For nonactive duty persons under age 65, CHAMPUS provides an alternative source of care. They may receive care through CHAMPUS, which operates in a manner similar to a conventional private health insurance plan.[5] CHAMPUS was established in 1956. At that time it paid civilian doctors and hospitals for some hospitalization, minor surgery, and maternity care. The program was expanded in 1966 to resemble standard private sector health insurance. It now covers most health care services (Slackman, 1988).

Unlike care in the MTF, which is free to the patient, most CHAMPUS patients pay a deductible ($150 individual, $300 family)[6] and a copayment (20 to 25 percent). Dependents of active duty personnel pay only a token charge for CHAMPUS-provided

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[2]See Hix and Hosek (1992) for a discussion of the two missions and their interrelation.

[3]This discussion relies heavily on Phelps et al. (1984) and Hosek et al. (1993).

[4]In addition to these peacetime services to dependents and retirees, the MTFs serve several other functions. In peacetime, they provide staff to support ongoing military activity—e.g., shipboard medical care, environmental and occupational health, aerospace and flight medicine, and underwater medicine. They also provide a standby system for medical care for combat-related injuries.

[5]At age 65, CHAMPUS is automatically replaced by Medicare. Medicare recipients are still eligible to use the MTFs, however.

[6]Prior to 1991, these deductibles were $50 and $100. These lower deductibles were retained for the dependents of junior enlisted personnel.

inpatient care, but retirees and their dependents pay a share of their inpatient costs. Table 1 summarizes the major features of MTF and CHAMPUS cost sharing.

Table 1

Major Features of MTF and CHAMPUS Cost Sharing

	Active Duty Dependents	Retirees and Their Dependents
MTF		
Outpatient	None	None
Inpatient	$9.30/day	Retiree: $4.90/day Spouse: $9.30/day
CHAMPUS		
Outpatient		
Deductible	Single: E-1 to E-4, $50; others, $150 Family: E-1 to E-4, $100; others $300	Single: $150 Family: $300
Copayment	20%	25%
Inpatient	Max ($25, $9.30/day)	Min (25%, $271/day)
Out-of-pocket max (family)	$1,000	$7,500

SOURCE: Handbook for Military Families, 1994 Edition.

Because the care is free, all else being equal, CHAMPUS eligibles tend to prefer MTF care. However, MTF staffing is limited and staffing levels fell during the late 1980s. Two forms of rationing have resulted.

First, there is a *de jure* set of rules covering allocation of scarce MTF care. Active duty personnel receive first priority, followed by their dependents, and then retirees and their dependents. Active duty personnel must use the MTFs. Their dependents have a choice for most outpatient care: They may use the MTF on a space-available basis or they may use a civilian doctor of their choice. For inpatient care, active duty dependents must use the MTF unless they are issued a nonavailability statement by the MTF (either because the MTF is too busy or because the service is unavailable there).[7]

Second, there is *de facto* rationing through queuing for nonemergency procedures. As is detailed formally in the modeling discussion of Section 3, eligibles are offered future nonemergency appointments. When the offered appointment is far enough in the

[7]Dependents living farther than 40 miles from the MTF (the catchment area) do not require a nonavailability statement. In 1991, the program was expanded to include major ambulatory surgery.

future or the appointment book is temporarily closed, patients will decide that they cannot wait. Instead, the patient will bear CHAMPUS's explicit monetary payment or forgo treatment altogether. Similarly, as the number of calls it takes to get an appointment increases or the office wait before seeing a provider grows, some eligibles will choose not to use the MTF.

Figure 1 provides a summary of utilization patterns by CHAMPUS eligibles over the previous 12 months. The analyses are based on tabulations of data drawn from the 1992 Military Health Care Survey, a survey of a national sample of military beneficiaries. A more complete description of the survey can be found in Lurie (1994), and the tables and definitions underlying the figures in the text can be found in Appendix A. Figure 1 displays the utilization of the military health care system among those with any use.[8] It reveals that while most beneficiaries use the MTFs, nearly 40 percent use CHAMPUS, either by itself or to augment MTF care. As would be expected, since they are more likely to have other insurance and live farther from the MTFs, the retired population uses CHAMPUS slightly more than do active duty dependents (see Table A.1).

Figure 1 is essentially the view of the military health care system from the perspective of the Department of Defense. The DoD directly pays the staff, materials,

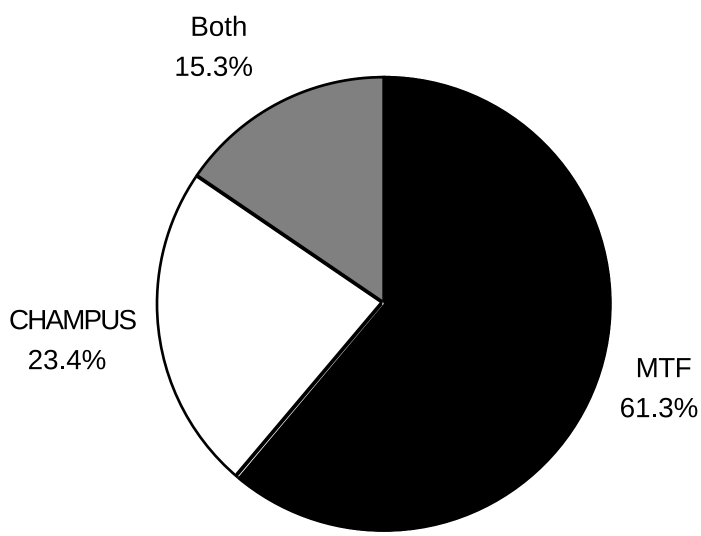

Figure 1—System Utilization by CHAMPUS Eligibles
(Percent of Beneficiaries)

[8]The utilization numbers in the text are derived from questions about whether a sector was used in the past year. They are not weighted by the number of outpatient visits or inpatient admissions.

and facilities costs of MTF care and monitors utilization through the MEPRS (Medical Expense and Performance Reporting System), which is discussed in more detail in Appendix B. It also pays for civilian care through CHAMPUS.

Figure 1 is fundamentally incomplete in that it leaves out two important populations. First, some people get no care, but might get care if it were cheaper or more readily available. Second, some people get care paid for through a nonmilitary option—usually insurance provided by the civilian employer of a family member. Figure 2 provides a revised view of utilization. It includes categories for CHAMPUS beneficiaries who received no care over the past year (some of whom might have received care if MTF care were more readily available), those who paid for civilian care through non-CHAMPUS health insurance, and those who mixed non-CHAMPUS civilian health insurance with MTF and/or CHAMPUS care. Not included in Figure 2 are Medicare-eligible retirees who use either the MTF or non-CHAMPUS insurance, but not CHAMPUS.

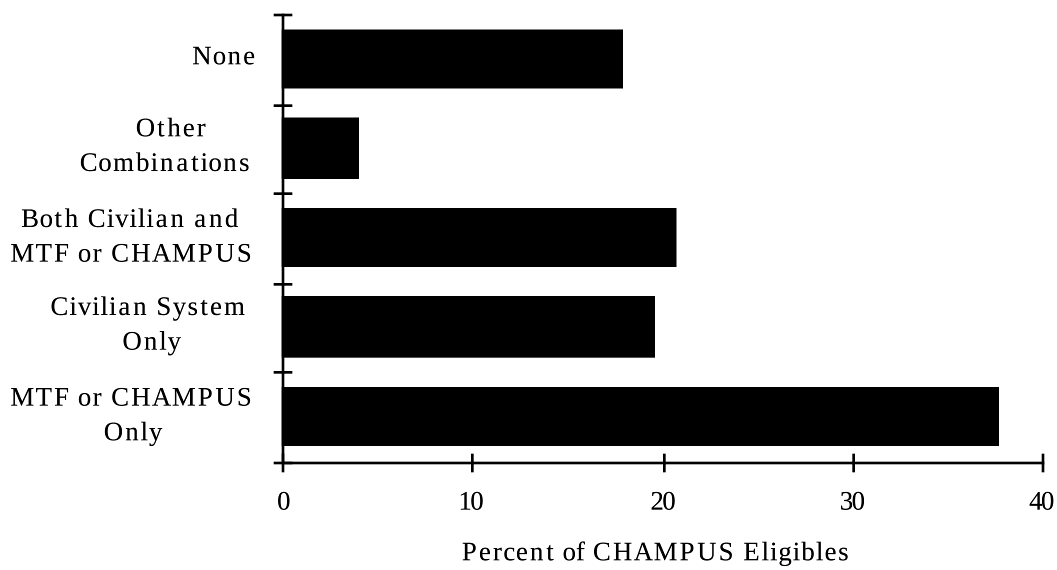

Figure 2—Sector Choice in Previous 12 Months, All Sectors
(Bars sum to 100 percent)

Finally, Table 2 suggests that there is considerable unmet demand for care. Nearly 30 percent of the eligible population report that they did not receive health care when they thought it was needed. Among the major reasons were the cost and availability of care.

These tables have shown that if DoD increases the staffing levels of the MTFs, the additional workload might come from one of three sources:

1. health services for which DoD was already paying (CHAMPUS),
2. services for which someone else was paying (private insurance, Medicare, or patient "out-of-pocket"), and
3. services no one was paying for (services not provided).[9]

Even assuming that DoD can provide less costly care in its MTFs, only the first group of patients represents a cost savings for DoD. The other two groups represent a clear cost increase. Furthermore, the cost savings from the first group are *second order*; the savings come from the cost differential between the two modes of health care delivery (the MTF and CHAMPUS). The cost increases from the second and third groups are *first order*; the cost goes from zero to the cost of MTF provision. Where the service would have been reimbursed by other insurance, the benefit of military care is smaller than where the patient had to pay or forgo the service.

Table 2

Reasons for Not Getting Needed Medical Care (CHAMPUS Beneficiaries)

	Active Duty Dependents	Retirees and Their Dependents	All
		(Percent)	
Time constraints	16.2	10.6	12.7
They thought it might cost too much	6.1	7.7	7.1
Administrative problems/difficulties	24.9	11.6	16.6
They couldn't find the kind of doctor they needed or wanted	12.3	6.3	8.5
Other	16.1	7.8	10.8
No unmet care need	71.8	82.7	78.7
Number of respondents	7,022	8,036	15,058

SOURCE: 1992 DoD Health Care Survey.
NOTE: All percentages are weighted. People with missing values for these items are excluded.

Whether, in net, there will be cost savings as resources (e.g., doctors) are added to the MTFs cannot be determined a priori. It is an empirical question. If care in the MTF is cheaper, a critical ratio of patients will be drawn from CHAMPUS as opposed to totally new

[9] In addition to going untreated, some illnesses might also be treated with fewer visits, with different services, or by waiting a longer time before seeking treatment.

patients seen in the MTF, in which case, adding MTF staff is a cost-saving change. Whether the net change results in a cost savings depends on how many new patients are served in the MTFs who previously would have used other insurance or would have received no insured care.[10]

Formally, CHAMPUS is a second payer. If a service to an individual is covered by employer-provided health insurance, then the private health insurance pays. CHAMPUS pays only what the private health insurance does not pay. Hence, a beneficiary can bill both private insurance and CHAMPUS and obtain 100 percent payment for medical services. If we assume that making MTF care more available would make beneficiaries less likely to use employer-provided health care plans, we might see an even greater influx of beneficiaries using MTF care from those who previously did not use the medical system or who only used CHAMPUS for partial payment.

Similarly, this discussion assumes that the full costs of MTF care are paid by DoD. Although DoD is authorized to collect payment from employer-provided insurance, currently, the amount of money collected is quite small. Were this to change in the future, the net savings from increased MTF resources would increase.

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[10] Hosek et al. (1995) present a similar argument to the one we use here.

3. THEORETICAL MODEL

In this section, we outline a simple model of patient choice of health care provider and MTF resource level. We use this model to formally describe possible behavioral effects that might mitigate the savings implied by a simple comparison of the cost per service delivered between CHAMPUS and the MTF.

We begin by describing the choice of a representative beneficiary from among four options: (1) the MTF, (2) civilian care reimbursed through CHAMPUS, (3) civilian care reimbursed by other health insurance, and (4) not treating an illness. Data from the 1992 DoD Health Care Survey are used to describe the beneficiary's characterizations of the MTF and the civilian health care system. The beneficiary's choices when he/she is covered by other (non-CHAMPUS) health insurance, and when he/she is not, are compared given varying MTF waiting times and varying severity of illness.

The next subsection describes the beneficiary's choice of care when other health insurance is not available and when it is. The third subsection discusses how the MTF uses staff to provide health care (outpatient visits, inpatient admissions). The final subsection explores the relationship between the two parts—beneficiary choices given the length of wait for care in the MTF and the relationship between MTF staffing and utilization—and shows how the wait for care in the MTF is determined in equilibrium.

BENEFICIARY CHOICE OF SECTOR

Beneficiaries value their health, their consumption of goods, and their leisure. All other things being equal, they prefer to be in better health, have more goods, and have more leisure. Furthermore, the sicker a beneficiary gets, the more goods and time the beneficiary is willing to expend to get medical care and get better.

A military dependent or retiree under age 65 has five choices when he or she gets sick: (1) go to the MTF, (2) go to a private doctor and file a CHAMPUS claim, (3) go to a private doctor and file a private health insurance claim (with or without CHAMPUS secondary payments), (4) go to a doctor and pay for the care out of pocket, and (5) get no care.

Note that the options of going to the MTF or of getting no care are free to the patient. Using CHAMPUS and private health insurance will usually require out-of-pocket payments. Thus, all other things being equal, the beneficiary would choose the MTF.

However, all other things are not equal. Anecdotal evidence suggests that there are often long waits in the MTF until an appointment is available. Evidence from the 1992 DoD Health Care Survey suggests that the number of calls until an appointment is obtained and the time waiting in the MTF until the doctor is seen are considerably longer in the MTF than in a civilian doctor's office.

Figures 3 and 4 display the survey results. Whereas walk-in appointments are slightly more common in the MTF, more calls are required, overall, to access the MTF. Only about 10 percent of civilian patients make three or more calls to schedule an appointment, whereas the corresponding figure for MTF appointments is nearly 40 percent.

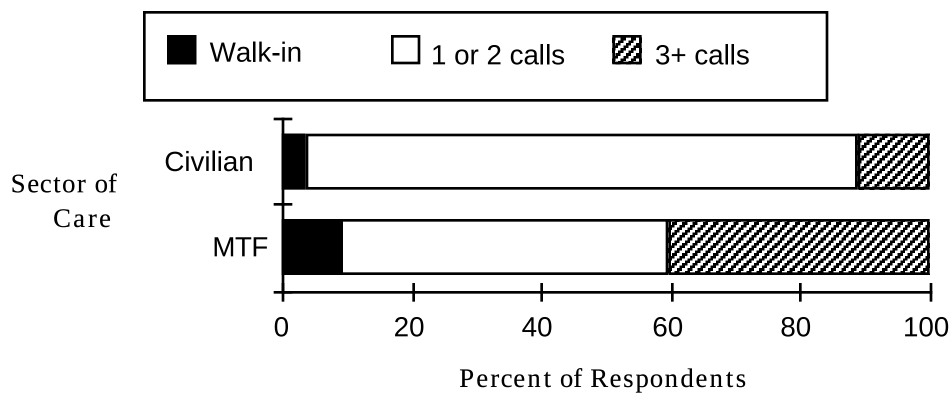

Figure 3—Calls to Make an Appointment

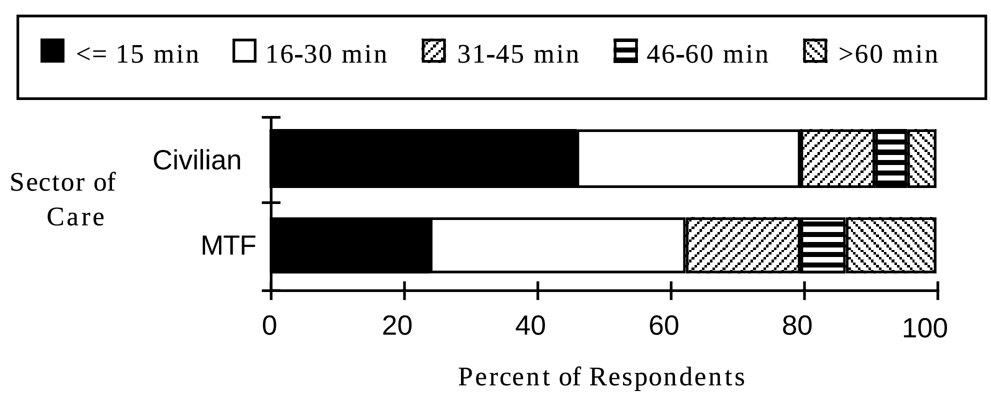

Figure 4—Minutes Waiting for a Doctor

Figure 4 presents equivalent results for waiting in the doctor's office. About 45 percent of all civilian patients wait less than 15 minutes in the doctor's office. The comparable figure is less than 25 percent in the MTF. At the other extreme, approximately 20 percent of patients wait more than half an hour in the civilian sector and the corresponding figure in the MTF is nearly 40 percent.

These unfavorable comparisons of MTF to civilian waiting times should not be interpreted as implying that beneficiaries are totally satisfied with CHAMPUS. Table 3 reports responses from the 1992 DoD Survey for reasons that no CHAMPUS claim was filed for civilian care received. Among all CHAMPUS-eligible respondents, 47 percent had used civilian care at least once in the past 12 months (32 percent for active duty dependents, 55 percent for retirees). Of those users of civilian care, 50 percent did not file a CHAMPUS claim (26 percent for active duty dependents, 57 percent for retirees). In addition to the obvious answers (that CHAMPUS did not cover the care), complaints about the "hassle" of filing a claim, that CHAMPUS payments take too long, or not obtaining the nonavailability statement are among the most frequently mentioned answers. The other category is instructive: "Other insurance covered all or most of the charges."

If other insurance is available, it is likely to be chosen for two reasons. First, by statute, CHAMPUS is a second payer to employer-provided insurance. Despite the

Table 3

Reasons for Not Filing a CHAMPUS Claim[1]

Reason	Active Duty Dependents	Retirees and their Dependents	All
		(Percent)	
CHAMPUS did not cover visit	43.7	32.0	34.0
Didn't obtain a nonavailability statement (NAS) before care was received	17.0	13.0	13.7
Wasn't worth the hassle of filling a CHAMPUS claim	43.4	42.6	42.7
Other insurance covered all or most of the charges	23.4	62.8	56.3
Payments from CHAMPUS take too long	25.9	11.5	13.8
Another reason	33.0	24.7	26.1
Number of respondents who used civilian care but did not file a CHAMPUS claim	281	701	982

SOURCE: 1992 DoD Health Care Survey.
NOTE: Respondents checked all that apply. All percentages are weighted.

[1]For those respondents who used civilian care in the past 12 months but did not file a CHAMPUS claim.

availability of CHAMPUS, the other insurance must first pay what it would be obligated to pay. Second, beneficiaries may prefer to have the other insurance pay, independent of the first-payer regulations. The other insurance does not require a nonavailability statement from the MTF and may require less paper work.

Figures 5 and 6 depict a beneficiary's choice between the MTF and CHAMPUS for an illness of a given severity.[11] Figure 5 depicts the case in which no health insurance is available while Figure 6 depicts the choice when other health insurance is available. In both figures, we depict severity of illness on the vertical axis and the MTF wait on the horizontal axis. Thus, in these figures, the time cost of MTF care increases from left to right.

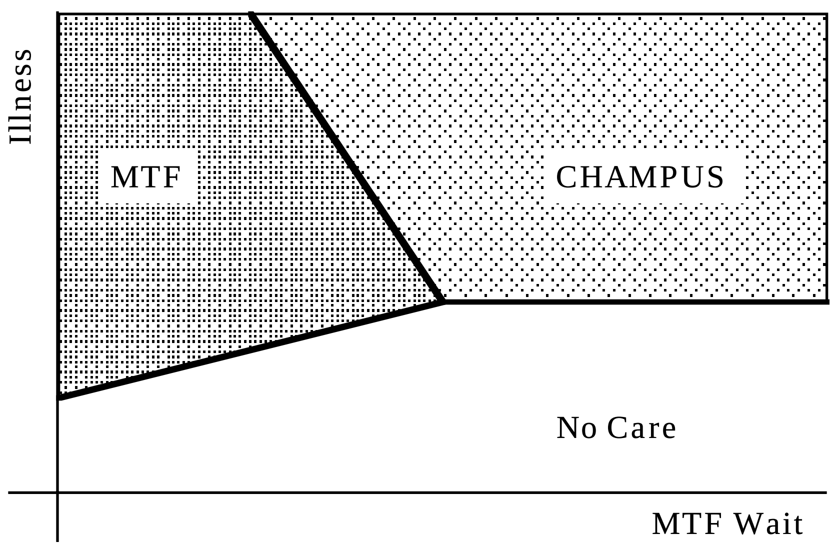

Figure 5—Sector Choice Without Other Health Insurance

Consider first the case in which no private health insurance is available (Figure 5). There are then three choices. If the person is not very sick and the MTF wait is very long (the lower right), the person gets no care. If the person is sick enough and the MTF wait is not very long, then the person goes to the MTF (the top left). If the person is very

[11]The implicit model is that of Lillard et al. (1986) and Keeler et al. (1988). Episodes of illness are assumed to follow a point process (arrive discretely), and episodes have varying severities. The beneficiary makes a discrete choice of the sector in which to treat each episode.

sick and the MTF wait is long, then the person pays for care in CHAMPUS (the top right).

Thus, holding MTF wait constant as we vary severity of illness, we discern three regimes. When the MTF wait is short (at the far left), only the most minor cases (for some of which treatment may not be medically indicated, e.g., a common cold) go untreated. Above some low threshold, the beneficiary goes to the MTF for treatment. CHAMPUS is never used. Note that if the wait for MTF care is short enough, beneficiaries may seek care even in cases in which seeing a health professional is not medically indicated (e.g., a common cold). Some unnecessary demand-treatment occurs in all health care delivery systems. The shorter the MTF wait, the more common will be unnecessary care at the MTF.

Similarly, when the length of the MTF wait is long enough (at the far right) and the patient sick enough, the beneficiary seeks care in CHAMPUS. The MTF is never used. Note that the care/no care threshold is higher than when the MTF wait is shorter. If the MTF wait is long enough and if CHAMPUS conditions are sufficiently bad (e.g., high copayments, oppressive paperwork requirements), then no care will be obtained even when it is medically indicated. Again, in all health care delivery systems, some illnesses go untreated, even those for which treatment is medically indicated. The worse the CHAMPUS conditions are, the more common untreated illness will be.

Finally, between those two extremes, there is a range of MTF waits for not-very-severe illnesses in which the person gets no care. The upper threshold of the no-care region is intermediate between the two cases already considered. Above that threshold, there is a range of not-very-severe illnesses in which the beneficiary accepts the long MTF wait in return for avoiding the CHAMPUS paperwork and cost sharing. As the severity of illness increases, the MTF wait the patient will accept before switching to CHAMPUS decreases. This phenomenon explains the backward slope of the line separating the MTF and CHAMPUS regions. Finally, when the beneficiary is sufficiently sick, he chooses to pay the CHAMPUS copayment rather than to suffer any extra MTF wait.

Changing MTF resources affects the length of the MTF wait. Along a horizontal line in Figure 5, the severity of illness is constant, but the MTF wait increases from left to right. Thus, for illnesses more serious than a given threshold (the horizontal line on the right side of the figure), there is a critical MTF wait time at which the beneficiary shifts from CHAMPUS to the MTF. Similarly, below the threshold, there is a critical MTF wait time at which the patient shifts from no care to the MTF. Finally, there is a region of very-low-intensity illness which will never be treated no matter how short or long is the wait time in the MTF.

Figure 6 plots sector choice when the beneficiary has, and prefers to use, other health insurance—which is by statute the first payer. The general shape of the figure is similar to the case in which no other health insurance is available. The dotted lines denote where the sector borders were when no other health insurance was available (i.e., they reproduce the lines from Figure 5). Relative to that case, the boundary has shifted down and to the left.

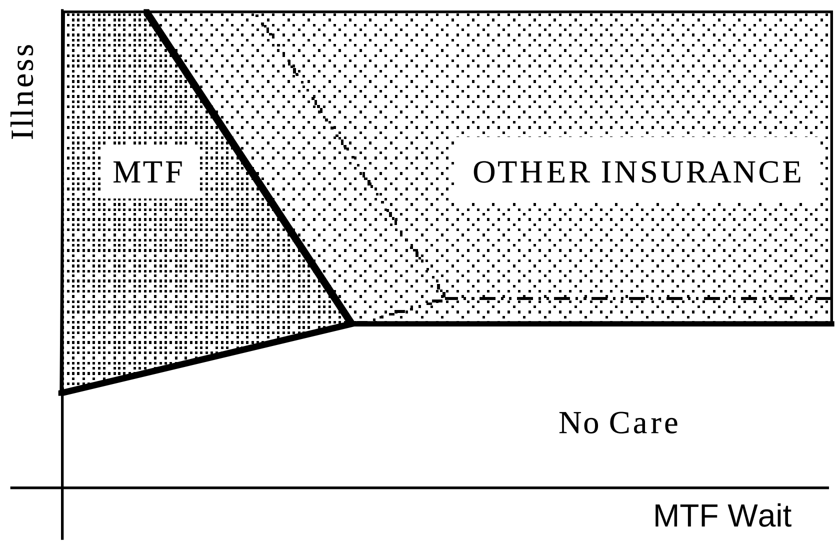

Figure 6—Sector Choice with Other Health Insurance

Some illnesses that were not worth treating because the CHAMPUS cost sharing was too expensive will now be treated under the more generous other-health-insurance cost sharing (the horizontal line moved down). Similarly, some illnesses for which the MTF wait was preferable to the CHAMPUS cost sharing are now treated by civilian doctors and reimbursed by other health insurance.

This general movement from Figure 5 to Figure 6 indicating that the “other insurance” region includes a wider range of illnesses and MTF waits is a result of the fact (noted above) that other insurance makes civilian care more attractive than it would be if only CHAMPUS were available. The other insurance does not require a nonavailability certificate and may have simpler paperwork requirements.

Each of these figures (Figures 5 and 6) represents a prototypical division between the regions. Each beneficiary will have his/her own set of regions with varying boundaries. For those who live close to a military hospital, the MTF will be relatively more attractive; for those who live farther away, it will be less attractive. For those who distrust doctors, no care will be a more attractive option. The increase in *total MTF demand* and *total CHAMPUS demand* with a decrease in the MTF wait is found by considering for how many illnesses and for how many beneficiaries the change in the wait moves them from a non-MTF sector (CHAMPUS, other insurance, or no care) to an MTF sector.

While the two cases—MTF versus CHAMPUS and MTF versus other insurance—generate the same figure in illness/wait space, the consequences for total DoD health expenditures are quite different. For beneficiaries whose options are represented by Figure 5 (they have no other insurance, for example), decreasing the waiting time shifts care from the more expensive (for DoD) CHAMPUS to the less expensive MTF. As discussed earlier, it is also possible that decreasing the waiting time might also shift individuals from no care to MTF, induce active duty personnel to use more care at MTFs, and encourage Medicare patients to use more MTF services. In addition, improved MTF availability could induce people to shift from Figure 6 to Figure 5. If new MTF patients come only from CHAMPUS rolls, DoD's savings are the difference between the CHAMPUS and MTF costs (unless DoD collects from the other insurance)—*a second-order decrease in expenses*. In the second case, when new MTF patients come from sources other than CHAMPUS, decreasing the waiting times shifts those expenditures from a non-DoD cost to a DoD cost—a *first-order increase in expenditure*. Thus, ironically, the more strictly the first-payer rules are enforced (a cost-saving measure), the less money will be saved by increasing MTF resources to increase cases seen in the MTF.

A comparison of Figures 5 and 6 suggests one way to cut CHAMPUS costs. If we make CHAMPUS less attractive than it is now (e.g., raise the cost-sharing deductible, the coinsurance rate, and the expenditure cap—as was done for deductibles on April 1, 1991), then we will go from the situation depicted in Figure 6, in which other health insurance is old CHAMPUS, to the situation in Figure 5, in which CHAMPUS is the new higher cost-sharing CHAMPUS. This shift would have the desired effect of cutting DoD costs. Some CHAMPUS cases would return to the MTF (whose staffing levels could be increased), some CHAMPUS cases would switch to private insurance, and some former CHAMPUS-treated illnesses would be left untreated. The obvious deficiency of this approach is that the level of benefits to dependents and retirees would decline. Beneficiaries would be worse off and unhappy about it.

Note that if MTF health provision resources were expanded, there could be sources of increased MTF utilization in addition to the CHAMPUS-eligible beneficiaries just discussed. First, if MTF resources are expanded to the point that waits are shorter and more services are provided, then active duty personnel (who are not eligible for CHAMPUS) may increase their use of the MTF. Second, if MTF care is enhanced, Medicare recipients (who also are not CHAMPUS eligible but are eligible for MTF care) may raise their demand for MTF care. Hence, for the same reasons that there could be an influx into MTF care of CHAMPUS eligibles who previously either left illnesses untreated or used insurance outside the military system, so, too, could there be an influx into MTF care of patients who are not CHAMPUS eligible.

MTF USE OF STAFF TO PRODUCE HEALTH CARE

The MTF delivers many types of health care: outpatient visits and inpatient admissions for a range of specialties that varies according to the size of the MTF. This health care is delivered using several types of labor (doctors, nurses, paraprofessionals, administrators, maintenance workers, and clerical personnel) and capital (the clinic and hospital facilities and equipment). We assume here that capital is fixed and that labor inputs can be proxied by the number of doctors.

Anticipating the empirical work to follow, we can represent the relation between inputs (doctors) and outputs (visits and admissions) by a production function. For example, the Cobb-Douglas form (which we use in the empirical work below):

$$U = AS^{\beta}$$

where U is medical care utilization (visits or admissions) and S is MTF staffing levels. Taking logs yields a linear regression of the log of utilization on the log of staffing:

$$\ln U = \alpha + \beta \ln S$$

where $\alpha = lnA$. The crucial issue is the magnitude of β. Figure 7 plots the relation between staffing and care provided for two cases. First, if $\beta = 1$, we have a linear production technology: doubling the number of doctors will double the number of patients served. This is the implicit specification in the comparisons of average cost per visit (or per procedure).

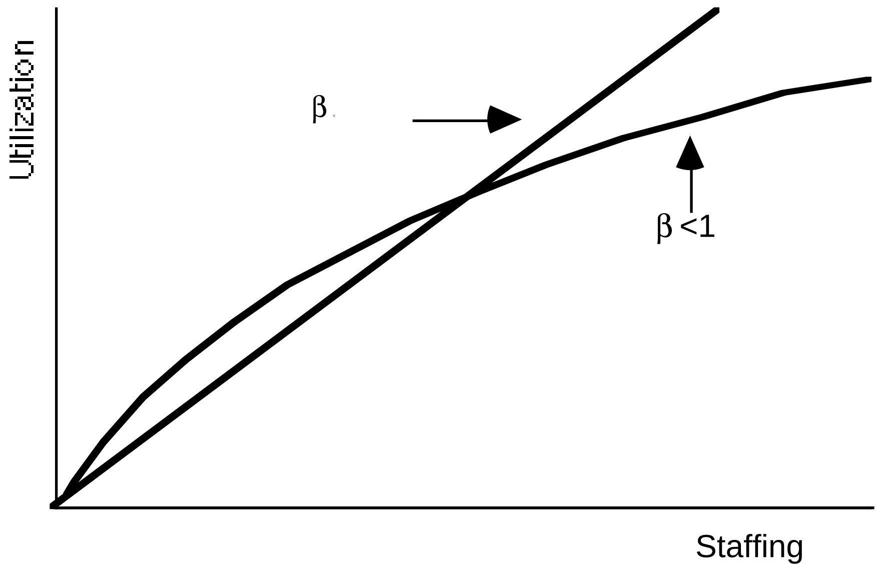

Figure 7—MTF Production of Health Services

We also plot the relation between staffing and health care delivered for the case of $\beta<1$. In that case, each additional doctor provides fewer visits than the previous doctor. As the number of doctors increases, the total number of patients seen increases, but the average number of patients seen by each doctor declines. When β is less than one (as we find in the empirical work that follows), using the average MTF cost per patient (total costs divided by number of patients seen) will yield an optimistic estimate of the cost of an incremental MTF patient. If each additional doctor sees fewer patients than the doctors already assigned to the MTF, then the current average cost will be below the true incremental cost of another case.[12]

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[12]When there is more than one input, the concepts remain the same, but the implementation becomes slightly more complicated. Maintaining our Cobb-Douglas example, consider the case of two inputs (doctors and nurses):

$$U = AS_d^{\beta}S_n^{\gamma}$$

where the d subscript refers to doctors and the n subscript to nurses. Then, again taking logs, we have:

$$\ln U = \alpha + \beta \ln S_d + \gamma \ln S_n$$

If $\beta+\gamma=1$, then increasing the number of both doctors and nurses by 10 percent will increase the number of patients seen by 10 percent. If $\beta+\gamma<1$, then the increase in patients seen will be less than 10 percent.

In the two-input case, there is also the possibility of allocative inefficiency. We could have too many doctors and not enough nurses, or vice versa. Thus, even if a 10 percent increase in total staff yields a 10 percent increase in patients seen, a 10 percent increase in doctors alone (or nurses alone) will not.

It is not necessary to view this phenomenon—that the average number of patients seen by each doctor declines as the number of doctors increases—as a negative outcome. At lower staffing levels, doctors may be overworked. If a sufficiently sick patient walks into a busy clinic (or tries to make an appointment), the doctor will stay a little later to treat the patient. When we increase the number of doctors, the number of patients above that threshold remains approximately constant, but the number of doctors over whom those emergency cases is spread increases. If this is the case, the number of emergencies (or amount of overtime) per doctor decreases, yielding the convex production function.[13]

Queuing theory provides an alternative explanation for less-than-constant returns to scale. With only a few doctors in the MTF, there are always patients waiting to be seen. Doctors go from one patient to the next with no breaks. If demand varies from period to period (as seems likely), then above some staffing level there will occasionally be no line of patients outside the door, and the doctor will have no patients to see. As we increase the number of doctors beyond that point, the average beneficiary wait in the queue will shorten. Simultaneously, the amount of time that doctors spend with no patients to see goes up. This increase in doctors' "idle time" will yield the curvature in the relation between staffing levels and visits.

This downtime is not necessarily bad. In addition to making the doctors happier, queuing theory suggests that empty queues are a joint product of shorter average lines (i.e. wait times). In order to get a shorter average waiting time, there must be some periods during which there is no one waiting. Such over-capacity is a prime way in which civilian doctors produce the shorter waiting time which patients report and prefer in the civilian sector. Drawing patients voluntarily from the civilian sector to the MTF will require exactly such downtime.

The same result will occur as clinic and equipment capacity is reached. Physicians working with only one exam room, as many military physicians do, are less productive than those working with more than one exam room. Delays may also be caused by nursing shortages or inadequate lab or X-ray capacity.

EQUILIBRIUM MTF WAIT

In this section, we put the two parts together: beneficiary choice of sector and MTF production of visits using staff. We show how the MTF wait time adjusts so that the

[13] Slackman (1990, 679–772) has a similar discussion of why there might be less-than-constant returns to scale in MTF staffing.

demand for MTF care (given a waiting time) does not exceed the supply of care (determined by the staffing levels). The equilibrium we describe is rationing by queuing.[14] When MTF staffing increases, the waiting time declines endogenously until the amount of health care (outpatient visits, inpatient admissions) is equal to what MTF staffing can deliver and support.

Figure 8 describes the equilibrium graphically. The left panel reproduces Figure 7. It describes the relation between MTF staffing levels and the amount of utilization (e.g., visits) that a given staffing level can support. Again, the straight line represents the constant returns to scale case (where a 1 percent increase in staff yields a 1 percent increase in capacity), and the concave curve represents the less-than-constant return to scale case (where a 1 percent increase in staff yields a less than 1 percent increase in capacity).

The new panel on the right plots MTF waiting time against utilization (visits). Figures 5 and 6 showed sector choice for a representative individual as the MTF wait varied. The exact placement of the boundaries in those figures varies from beneficiary to beneficiary. As we progressively shorten the MTF wait, more beneficiaries will choose to treat a wider range of illnesses (as they arise) in the MTF. Thus, the overall slope of the curve is negative. The shorter the wait, the larger will be the number of visits desired in the MTF.

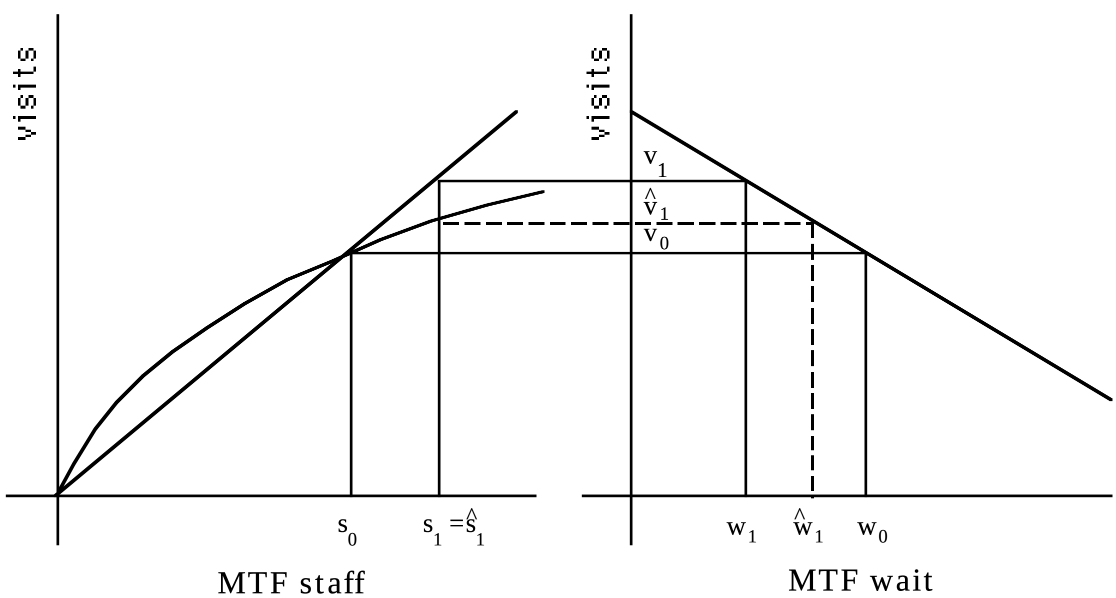

Figure 8—Equilibrium MTF Wait

[14]See Acton (1973) for a similar equilibrium.

The equilibrium number of visits is determined by the technological relation between staffing and visits (from the left panel). Thus, given a staffing level, we read upward in the left panel to the line relating staff to visits to determine the number of visits. We then read across into the right panel and down from there to the equilibrium waiting time. At this waiting time, the number of illnesses that beneficiaries choose to have treated in the MTF equals the amount of care that the present staffing levels can provide.

The figure depicts three cases. We start with a staffing level of s_0. That staff can provide v_0 visits. The equilibrium waiting time will be w_0. If we assume constant returns to scale (the straight line), then increasing the staffing level to s_1 raises MTF capacity to v_1 visits, and the new equilibrium waiting time is w_1, where $w_1 < w_0$. Increasing the staffing levels has decreased the waiting times—not directly, because new patients choose to use the MTF, but indirectly, because the MTF wait must improve to induce new beneficiaries to use the MTF.

Alternately, if there are less than constant returns to scale (the curved line), then staffing levels of $s_1 = \hat{s}_1$ yield only $\hat{v}_1 < v_1$ visits. The equilibrium waiting time is then $\hat{w}_1$. This equilibrium waiting time is less than it was before the increase in staffing levels but more than it would have been if there had been constant returns to scale.

Concrete examples help to make the operation of this equilibrium clear. Consider the case of when the MTF operates purely on appointments and the appointment book extends infinitely into the future. Patients calling are told the date of the next available appointment. If it is acceptable they take it; if not, they decline the appointment, choosing instead to see a civilian doctor (paying with CHAMPUS or other insurance) or to get no care. In addition, mothers of children with minor aches and pains schedule an appointment, but cancel it when the ailment disappears before the appointment arrives and, thus, the ailment receives no care. A more serious illness is still present when the date of the appointment for it arrives, and the child is treated in the MTF. If the child is very sick, the parent will refuse to wait until the (far-off) date of the MTF appointment for care. Instead, he/she decides to accept the cost sharing (e.g., pays the deductible and copayment) and to see a private doctor. That visit may be partially reimbursed by CHAMPUS or other health insurance. In equilibrium, the length of time between the date of the phone call requesting an appointment and the next available appointment adjusts so that some parents (beneficiaries) choose care in the MTF and some do not.

If, instead of scheduling appointments infinitely into the future, the MTF closes the appointment book when all of the appointments in the next two weeks or 30 days are taken (as is the practice in many MTF clinics), then multiple calls will be needed to schedule an appointment. This is one interpretation of the reported difference in the number of calls until an appointment can be made reported in Figure 3.[15]

A similar equilibrium story can be told for other dimensions of care. Waiting time in the doctor's office, reported in Figure 4, is a prime candidate. Similarly, the number of phone calls to secure an appointment (plotted in Figure 3) may simply represent a queue greater than phone-line capacity.

Thus, Figure 8 summarizes how rationing by queuing adjusts endogenously to equilibrate the supply of care with the demand. From a cost perspective, the crucial question is: Who are the new patients treated in the MTF when staffing levels are increased? This corresponds to moving to the left on Figures 6 and 7. Some of the new patients will have formerly been untreated, some will have been treated and reimbursed by other (non-CHAMPUS) health insurance, and some will have been reimbursed by CHAMPUS. Only the third group results in a cost savings to DoD. The first two groups result in increased costs.

The net effect is an empirical question. It will be determined by several factors. First, what is the relative size of the three groups? Table 4 suggests that about 45 percent of all

Table 4

Coverage by Private Health Insurance

	Active Duty Dependents	Retirees and Their Dependents	All
		(Percent)	
Private / PPO[1]/ HMO[2]	12.5	58.3	42.3
CHAMPUS Supplemental	9.2	13.5	12.0
Medicare Part B	3.5	27.5	19.1
Other	3.0	8.9	6.8
Any Non-Supplemental	14.6	61.4	45.0

SOURCE: 1992 DoD Health Care Survey.

NOTE: Multiple responses allowed. All percentages are weighted. Any Nonsupplemental is part of the group that has private/PPO/HMO or other insurance.

[1]PPO—Preferred Provider Organization.

[2]HMO—Health Maintenance Organization.

[15]The construction of the equilibrium is only formally correct for the example of the infinitely long appointment book. The solution in Figure 3 assumes that the production function is a technological datum independent of demand conditions. The queuing theory examples discussed in the previous section imply that there is a different production function for each level of MTF wait. In that case, we need to solve the two problems simultaneously (as opposed to Figure 8, where we read the number of visits off of the left panel). Nevertheless, the basic insight remains correct, that the waiting time adjusts endogenously to clear the market at least partially on the demand side (but perhaps partially on the production side).

beneficiaries have some other form of health insurance (excluding CHAMPUS Supplemental coverage). Table 3 suggested that such beneficiaries with some other form of health insurance make up about half of the beneficiaries who ever use CHAMPUS. This is an underestimate of non-CHAMPUS insurance coverage. The survey does not include those retirees (primarily age 65 and older) who are covered by Medicare.

Second, what is the exact shape of individual preferences for out-of-pocket costs versus waiting time? We noted that each individual has his/her own set of figures corresponding to Figures 5 and 6. The crucial question thus becomes how many people's dividing lines between no care and MTF care, CHAMPUS and MTF care, and other health insurance and MTF care will be crossed when we change (decrease) the waiting time of MTF care?

Note that we have modeled only the patient side of the military health care market. We could also model providers' behavior using a similar model. At the same time that patients are choosing whether or not to use MTFs rather than CHAMPUS or other care, MTFs are deciding which patients to treat and which patients will receive nonavailability statements as well as making other allocation decisions. Another consideration is that many MTFs are not able to treat the most severe health problems. While we do not outline an explicit model of provider behavior, it should be kept in mind that outcomes in this market result from both patient and provider decisions.

CONCLUSIONS

In this section, we have described an equilibrium model of beneficiary sector choice (MTF, civilian care paid for by CHAMPUS, civilian care paid for by other health insurance, no care) and the provision of care by health professionals in the MTF. The model describes how the waiting time in the MTF adjusts to ration care. Only those who are willing to bear the longer wait receive care in the MTF.

Embedded in this model is the insight that beneficiaries choose the sector in which they will be treated. Thus, waiting times must shrink to induce more beneficiaries to use the MTF. Similarly, any policy that improves the MTF is likely to draw cases not only from CHAMPUS (in which case there is a second-order cost savings) but also from other health insurance and no care (in which case there is a first-order cost increase).

The crucial question is the relative size of the three populations. If MTF costs per patient truly are lower, then the matter of whether there will be cost savings from increasing MTF staffing is a function of the relative sizes of the other two populations. The larger are the cost differentials and the more patients come from CHAMPUS, the larger will be the cost savings. However, if the cost differentials are small, and the proportion of patients drawn from CHAMPUS is not overwhelming, then increasing MTF staffing would *increase* total DoD health costs.

The correct estimate of the overall cost implications rests on two items. The first is the size of the cost differential, an issue that we do not examine in this report. The second is the mix of patients which additional MTF staffing will draw from CHAMPUS versus those drawn from other health insurance and no care. In the next chapter, we survey previous attempts to assess that mix. We then describe and implement a new procedure that exploits the availability of new and superior data.

4. EMPIRICAL ANALYSIS

In the previous chapter, we discussed a model of beneficiary choice of sector in which to receive health care. We then used that model to explore the possible effects on CHAMPUS utilization, MTF utilization, and total military medical care expenditures of increasing MTF staffing. That section concluded that there are two opposing cost considerations. Increasing MTF staffing will allow some cases that would previously have been treated in CHAMPUS to be treated in the MTF. If MTF costs are lower than CHAMPUS costs, this change will decrease expenditures.

The theoretical discussion emphasized that there is, however, a second countervailing effect. Some of the new MTF patients would previously have forgone some care, or paid for care through other private health insurance, rather than use CHAMPUS. Payment through private health insurance is particularly likely since by law CHAMPUS is a second payer to most private insurance and is superseded by Medicaid. When the beneficiary has other insurance, as do about 15 percent of active duty dependents and half of retirees under age 65, CHAMPUS pays only after the other insurance does. For these beneficiaries, cases shifted from civilian care to the MTF represent a large increase in DoD costs—from zero to the cost of providing the MTF care.

In Appendix C, we derive the following expression for the sign of the net cost impact:

$$TOF - CF = \left[- \frac{\Delta U_{MTF}}{\Delta U_{CHA}} \right] - \frac{AC_{CHA}}{AC_{MTF}}$$

The equality is definitional. The first term is the *trade-off factor* (TOF). It is the additional number of cases that must be seen in the MTF for CHAMPUS cases to decrease by one. The second term, the *cost factor* (CF), measures the importance of the cost differential. It is the ratio of CHAMPUS to MTF average costs for a given procedure.[16]

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[16]Appendix C notes that this formula assumes constant returns to scale. If there are decreasing returns to scale (as we find below), this formula is biased towards showing cost savings—it will show cost savings when there are none. If there are decreasing returns to scale in the MTF (the curved line of the previous chapter) the AC_{MTF} is replaced by MC_{MTF} (the marginal cost of MTF care) which will, in general, be higher.

When the cost factor is larger than the trade-off factor, increasing MTF staffing decreases total military health care expenditures. When the trade-off factor is larger than the cost factor, increasing MTF staffing decreases total military health care expenditures.[17]

Slackman (1988a) has estimated costs for inpatient care. From his calculations, it is possible to compute several estimates of cost factors (the ratio of CHAMPUS costs to MTF costs). A low estimate of MTF costs can be derived from raw budget numbers. A higher number can be derived from multiple regressions that control for case mix. Using the low estimates, the cost factors for different specialties range from 4.3 to 6.9. Using the high estimate, the cost factors range from 1.4 to 3.0. These figures do not include the cost sharing that is required when military retirees use CHAMPUS. Once those contributions are included, the relevant ranges for the low estimate are 2.8 to 4.4, and for the high estimate, 0.9 to 1.4. Slackman notes that these cost factors are likely to be too high for at least two reasons. First, the typical CHAMPUS patient may be sicker than the typical MTF patient. This would bias the unit costs of CHAMPUS (and the cost factor) upward. Second, Slackman notes that the impending (at that time) change to a prospective reimbursement system might lower CHAMPUS costs.

The Army PRIMUS outpatient clinics, which hired civilian doctors to provide outpatient care, provide another estimate of the cost factor. These clinics are a model for some of the “resource sharing” concepts that have been proposed as a way to expand MTF resources. Slackman notes that pediatric costs were actually more expensive in PRIMUS than in civilian care—a cost factor of 0.94 and 0.80 for active duty dependents and retiree dependents, respectively. For adult medical visits, the cost factor was about 1.32, slightly greater than one; so for adults, the MTF with civilian doctors is slightly cheaper.

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[17]This formula assumes no recovery of MTF costs from private insurance carriers. Currently, recovery of MTF costs from private insurers is limited. See for example House Appropriations Committee (1991, p. 84) which states:

> The current method of billing for care rendered to insured beneficiaries in military medical facilities is based on a per-diem charge with a cost breakdown limited to institutional, professional services, and ancillary fees. The Committee believes that this method of billing has failed to result in any significant recoupment of dollars due to the government. DoD could greatly enhance the collection of monies from third-party carriers by providing a more detailed description of a patient care episode from a cost and workload perspective and by enhancing its current third-party collection program.

If the required data systems were in place and substantial costs were recovered, then the formula in the body of the paper would be overly conservative. Significant cost recovery would imply a larger optimal MTF staffing level.

Even using the more favorable budget-based cost estimates, a moderate trade-off factor of above 2 for outpatient care or 3.5 for inpatient care will offset any potential cost savings from the lower cost of providing care in the MTF. This is the overall finding reported in the Comprehensive Study of the Military Medical Care System, which examines the possibility that DoD could reduce overall medical program costs by expanding MTF access (Department of Defense, 1994). The estimated cost to both beneficiaries and the military of providing a given quantity of care in the MTF is up to 24 percent less than the cost through CHAMPUS (DoD, 1994). However, as discussed earlier, expanding MTF access is likely to raise beneficiaries' demand for care. To quantify the additional cost due to this increase in demand, Hosek et al. (1995) estimated trade-off factors just for CHAMPUS-eligible beneficiaries living in catchment areas using beneficiary-level data. For active-duty dependents, they estimate an outpatient trade-off factor of 1.79, and for retirees, survivors, and their dependents, they estimate a trade-off factor of 1.56. Their estimate of a combined outpatient trade-off factor is 1.67. They also estimate an inpatient trade-off factor of 2.50.[18] Hence, the additional medical costs to the DoD due to this demand effect more than offset the cost savings of increasing MTF access.

The remainder of this chapter reviews the evidence from previous studies that use aggregate data on the degree of CHAMPUS-MTF substitution. We then present our own estimates using a new methodology that relies on new and improved aggregate data.

REGRESSION STUDIES

Early studies of CHAMPUS-MTF substitution were hampered by a lack of staffing data. Thus, they could not directly compute the relation between MTF staffing and MTF utilization. Instead, they computed a trade-off factor. Taking a sample of beneficiaries in a state, they examined the covariation of MTF and CHAMPUS utilization.

Since the crucial data were lacking, computing a trade-off factor required strong assumptions. Roehrig and Meyer (1987) at Vector Resources Incorporated (VRI) performed what appears to be the first analysis. They assumed that the beneficiary population is composed of two "pure types": MTF users and CHAMPUS users. For a given MTF staffing level, each individual is one pure type or the other and uses only the sector corresponding to his/her pure type. They also assumed that the usage rates for

[18] They note that including other beneficiaries, such as those covered by Medicare or civilian care, would raise the estimated trade-off factor because CHAMPUS utilization would not decrease to offset their increase in MTF utilization. The current study includes these other beneficiaries and does in fact find higher trade-off factors, as reported later in this section.

each pure type were constant across geographical areas. They then show that these assumptions are sufficient to derive a nonlinear least squares regression equation. The regression equation estimates the usage rates for each pure type. Appendix D gives a new derivation of the VRI estimator. This derivation provides a simple explanation for how the estimator yields a trade-off factor.

According to the VRI model, when we change MTF staffing, we shift some beneficiaries from one pure type to the other. The trade-off factor is thus simply the ratio of the pure-type usage rates. VRI computed these nonlinear regression estimates from a single year's usage data, in which the unit of observation is a state. The results were disappointing (see Table 5). The medicine/surgery figures were somewhat higher than had been expected: 2.9 for active duty dependents and 6.0 for other beneficiaries. The

Table 5

VRI Trade-Off Factors

	Med/Surg	Obstetrics	Psychiatric
Active duty dependents	2.9	66.9	0.3
Other beneficiaries	6.0	25.0	1.4

NOTE: Computed from Roehrig and Meyer (1987), Exhibit 4-1, pp. 4–8.

obstetrics estimates were implausibly high—more than 65 for active duty dependents and 25 for other beneficiaries. The psychiatric figure for active duty dependents was less than one.

VRI provided face validity for the medical/surgical numbers by noting that these correspond quite closely to the percentage of individuals eligible for CHAMPUS who submit a CHAMPUS claim as reported in the 1984 Military Health Services System Beneficiary Survey. The implicit assumption is that marginal individuals (who use or do not use the MTF as staffing is varied) would behave like the inframarginal individuals (who currently do not use the MTF).

These medicine/surgery results are plausible, but the obstetrics and psychiatry results are not. Furthermore, the strong assumptions of the VRI methodology seem questionable for several reasons. First, we saw from the 1992 DoD Health Care Survey (Figure 1 and Figure 2) that the concept of pure users is incorrect. There is considerable mixed use. A large portion of the beneficiaries mix care in the MTF with CHAMPUS-covered care and other-health-insurance-covered care.

Second, the assumption that utilization rates are constant within sector (CHAMPUS or MTF) for each beneficiary population (active-duty dependent or other beneficiary, mostly retirees) across regions seems questionable for three reasons. First, as Slackman (1988a) notes, there is considerable unexplainable geographic variation in utilization rates. This alone invalidates the VRI methodology. Second, there is some variation in the age and sex composition of the beneficiary populations. This factor would also cause the utilization rates to vary. Finally, the available MTF resources, civilian care options, and private insurance coverage rates also vary by region. This factor would also cause the utilization rates to vary.

On a more fundamental level, the VRI estimator simply examines the scatter plot between two endogenous variables: MTF utilization and CHAMPUS utilization. Because the VRI researchers did not have staffing data, they could not directly investigate the reason for the varying relative sizes of the MTF-reliant and the CHAMPUS-reliant populations.

John Bircher (1989) of the Office of the Secretary of Defense (Health Affairs) (OSD(HA)) noted the problem of heterogeneity of the beneficiary populations across states. He said that with information on utilization in two or more years, one could control for this heterogeneity. Maintaining the notion of distinct populations, he proposed a solution based on the "missing data principle."

He assumes that the sizes of the pure populations are the same in both years but that the trade-off factors vary. Unlike VRI, he directly estimates the trade-off factors. Because he had two years of data on each state with which to identify the sizes of the pure populations,[19] he can assume not that the pure utilization rates are constant but that the ratio of the CHAMPUS utilization rate to the MTF utilization rate is constant across catchment areas and time.

Table 6 reproduces his results. His trade-off factors are considerably smaller than VRI's. The trade-off factors are higher for retirees, as would be expected since they are more likely to have other health insurance.

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[19]See Appendix D for a derivation.

Table 6

Bircher Trade-Off Factors

	Trade-off Factor		Changes in Utilization	
	FY85	FY87	Direct Care	CHAMPUS
Outpatient visits				
Active duty dependents	2.057	1.821	13.2%	27.9%
Retirees	3.205	2.793	3.7%	19.0%
Inpatient admissions				
Active duty dependents	1.001	0.807	–2.0%	21. 6%
Retirees	2.344	2.749	5.3%	–10.2%

SOURCE: Bircher (1989), Table 2, p. 11.

Given our theoretical analysis, the assumption of constant numbers of pure-sector users seems strange. As the length of the wait for care in the MTF varies, we would expect beneficiaries to shift care from one sector to the other. Such shifts in care are the reason for increasing MTF staffing. In that case, the number of pure-sector users, or more generally the allocation of caseload between the two sectors, would change.

An alternative assumption would have been that the trade-off factors remain constant but the sizes of the populations (distribution of care) varies. The third and fourth columns of the table reveal that would be an inappropriate assumption. At least for outpatient visits, *both* care in the MTF *and* care in CHAMPUS increased.

What is happening is not a simple movement of cases from the MTF to CHAMPUS, or vice versa. The inpatient utilization changes might support such a model; utilization in one sector increases and utilization in the other decreases, as would be expected if there were a “trade-off.” The outpatient results suggest that something else is changing: Both utilizations go up, a result that is not consistent with the pure trade-off explanation for the increase in CHAMPUS utilization. Finally, this study fails to identify why utilization in either sector changes. Implicitly, we are again regressing one output (CHAMPUS utilization) on another output (MTF utilization).

One problem with this approach is that the health care environment is not stationary. Many things are changing in addition to who uses which sector or what the trade-off factor is. The main change appears to be that overall utilization is rising sharply over time.

This problem also plagues a related GAO (General Accounting Office) report (Baine, 1989). The GAO was asked to investigate whether the increase in CHAMPUS costs over the period FY 1985–1987 was a result of decreases in MTF caseload. The GAO report concluded:

> The amount and cost of care provided under CHAMPUS has increased in part because the amount of care provided to beneficiaries at military facilities has decreased. Other reasons for CHAMPUS cost increases include an overall increase in the cost of providing medical care, an increase in the number of military beneficiaries, and an increase in the rate at which they utilize the medical care system.[20]

This conclusion is the result of case-study work at several MTFs. It is also based on a simple analysis of the data. MTF inpatient visits decreased by 64,000 over the three-year period. CHAMPUS inpatient visits increased by 50,800. After subtracting the 900 claims due to individuals living outside of MTF catchment areas, there is still an increase in CHAMPUS use of 49,900.

Similarly, MTF outpatient visits decreased by 2.7 million over the three-year period. CHAMPUS outpatient visits increased by 2.5 million. After subtracting the 0.7 million claims due to individuals living outside of MTF catchment areas, there is still an increase in CHAMPUS use of 1.8 million.

The report notes that the MTF decrease is (considerably) larger than the CHAMPUS increase. The report's explanation notes some of the ideas we have discussed earlier: claims are not submitted to CHAMPUS; some patients do not seek care.

A simple calculation would imply a trade-off factor of 1.2 for inpatient and 1.4 for outpatient (i.e., 2.5 million fewer MTF cases divided by 1.8 million CHAMPUS cases equals 1.4). However, the fact that there was a large increase in noncatchment-area cases suggests that this result is only a weak lower bound on the true trade-off factor. If the demand for medical care also went up in the catchment areas, then the increase in CHAMPUS use would have been at least partially a result of this increased demand. In turn, this suggests that the trade-off factor is even larger.

While Hosek et al. (1995) estimated a trade-off factor using the same data source as the current study, their trade-off factor is based on beneficiary-level data and includes only beneficiaries residing in catchment areas. They note that including other beneficiaries, such as those covered by Medicare or civilian care, would raise the estimated trade-off factor because CHAMPUS utilization would not decrease to offset the increase in MTF utilization. The current study includes these other beneficiaries and does in fact find higher trade-off factors, as reported later in this section.

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[20] Baine (1989, p. 32).

NEW METHODOLOGY

Our review of the literature has identified several problems. First, previous analyses were unable to model why utilization varies from year to year and from place to place. Second, there is clear evidence of heterogeneity both across time and place. Overall, health care utilization is clearly rising and the beneficiary mix (and thus demand) varies from place to place. Thus, we need an empirical model that identifies the reason for changing utilization patterns and controls for variation across catchment areas and variations across time.

Recent improvements to the medical data systems make such an analysis possible. One reason for changing utilization rates (and the policy lever under consideration) is changes in MTF staffing levels. Because consistent (across time and place) MTF staffing level data were not available, previous researchers were unable to model directly the response of utilization to changes in staffing.[21]

The MEPRS data system now provides MTF staffing data by specialty and type of labor for FY 1988 through FY 1992.[22] In addition, we have MTF and CHAMPUS utilization (inpatient and outpatient, by specialty) for the same period. Note that MTF and CHAMPUS utilization data are disaggregated by either specialty or beneficiary class (active duty dependents, retirees and dependents under age 65, retirees and dependents over age 65), but not both. As a result, we can only estimate a single aggregate specialty trade-off factor rather than a trade-off factor for each beneficiary group. Appendix B contains a detailed discussion of our data sources.

Our econometric approach is designed to exploit the availability of data on MTF staffing levels as well as CHAMPUS and MTF utilization levels and beneficiary counts over five years. This variation of staffing levels and utilization across both time (the five years) and place (the catchment areas) forms a time series of cross sections that allows us to control for time-invariant catchment area variations and location-invariant time variation. These are exactly the uncontrolled variations that we noted in the earlier studies.

We begin with a standard double log specification for CHAMPUS and MTF utilization, U, in terms of MTF staffing, time effects, and base effects:

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[21] Baine (1989) makes this point explicitly.

[22] FY 1987 data are available but appear to have major data quality problems.

$$lnU_{CHA,i,t} = \alpha_{CHA,i} + \beta_{CHA} \ln S_{MTF,i,t} + \lambda_{CHA} X_i + \gamma_{CHA} Z_{it} + \delta_{CHA} d_t + \varepsilon_{CHA,i,t}$$

$$lnU_{MTF,i,t} = \alpha_{MTF,i} + \beta_{MTF} \ln S_{MTF,i,t} + \lambda_{MTF} X_i + \gamma_{MTF} Z_{it} + \delta_{MTF} d_t + \varepsilon_{MTF,i,t}$$

where S is staffing level, the t subscript refers to the time period, the i subscript refers to the catchment area, and d_t, dummy variables for each time period (with one excluded). The Xs are time-invariant base characteristics (e.g., service, teaching-hospital status, type of forces stationed in catchment area; thus, they lack a t subscript). The Zs are time-varying base characteristics (in our example, the size and characteristics of the beneficiary population; thus the i and the t subscripts). The βs have the interpretation of elasticities: a 1 percent change in MTF staffing implies a β percent change in utilization.

We first estimate a "cross section model" which does not account for the fact that we observe the same MTFs in multiple years, but rather treats observations on the same MTF in different years as independent. We regress catchment area MTF and CHAMPUS utilization on staffing levels, year dummies, and active-duty and CHAMPUS-eligible population counts, service-branch dummy variables, year dummy variables, the number of HMOs in the catchment area, and whether the MTF hospital was small, medium-sized, or a medical center. The number of HMOs in the catchment area proxies for the availability of civilian health care plans in the catchment area. Appendix B reports detailed regression results.

The resulting estimates give the percentage change in CHAMPUS utilization for a one-percentage-point change in MTF staffing, β_{CHA}, and the percentage change in MTF utilization for a one-percentage-point change in MTF staffing, β_{MTF}. The first measures the decrease in CHAMPUS load when the MTF staff is increased. The second measures the returns to scale discussed under the theory. In Appendix C, we show that these are related to the trade-off factor by:

$$TOF = \frac{\partial U_{MTF}}{\partial U_{CHA}} = \left[\frac{\partial U_{MTF}}{\partial S}\right]\left[\frac{\partial S}{\partial U_{CHA}}\right] = \left[\frac{\beta_{MTF}}{\beta_{CHA}}\right]\left[\frac{U_{MTF}}{U_{CHA}}\right]$$

where U_{MTF} and U_{CHA} are the utilization rates for MTF and CHAMPUS respectively.

Table 7 reports the trade-off factors from the cross section estimates. The first two columns report the parameter estimates for the percentage change in MTF utilization and CHAMPUS utilization for a one-percent change in MTF staffing. All of the estimates have the expected signs, and their magnitudes seem plausible. Increasing

MTF staffing by 10 percent raises MTF utilization by 3.2 to 7.8 percent and lowers CHAMPUS utilization by 2.5 to 6.3 percent. All the trade-off factors are reasonable, except the surprisingly large inpatient surgery value of 24.9. The relatively high value for surgical outpatient visits could result from the relatively high share of care that is for non-CHAMPUS beneficiaries (50 percent; the share is 25 percent for medicine) and also the way in which outpatient utilization is recorded. In the private sector, a visit is often counted as a single unit. In MTFs, each procedure during a visit is recorded separately. This calculation method would result in more utilization counted in an MTF for the same visit and would lead to high values of U_{MTF}/U_{CHA} and thus to artificially high trade-off factors.

Table 7

Trade-Off Factors from Cross Section Estimates

	β_{MTF}	β_{CHA}	$\frac{U_{MTF}}{U_{CHA}}$	TOF
Outpatient				
Medicine	0.318	–0.361	2.606	2.295
Surgery	0.629	–0.253	1.919	4.784
Inpatient				
Medicine	0.779	–0.615	2.323	2.942
Surgery	0.699	–0.315	11.221	24.874
Obstetrics/gynecology	0.771	–0.631	4.980	6.082

NOTE: Computed from regression results as described in Appendix C. Final regressions include doctors as a measure of staffing (except Ob/Gyn, which also includes nurses), number of operating beds in the MTF for surgery, year dummies, the log of the active-duty population, and the log of the CHAMPUS-eligible population.

This problem of how MTFs and CHAMPUS count visits is especially acute for outpatient obstetrics/gynecology and is the reason we do not estimate an outpatient trade-off factor for this specialty. The inpatient obstetrics/gynecology trade-off factors are also surprisingly high. We would expect the trade-off factors for obstetrics alone to be close to one using either methodology. A large portion of cases in this category are active-duty spouses, and each additional obstetrics case seen by the MTF is likely to have come from CHAMPUS, which would yield a trade-off factor of one, rather than from the pool of individuals who were previously not seeking care, which would yield a trade-off factor greater than one.[23] Gynecology, like surgery, is performed for retired beneficiaries (spouses), who might otherwise use Medicare or other insurance instead of CHAMPUS. It is also possible that active-duty spouses either time their childbearing to be near an MTF with an obstetric service or seek care at another MTF, if one is nearby, when their MTF cannot provide the care.

One explanation for the relatively small absolute value of the parameter estimates is measurement error. Standard linear regression theory implies that if the staffing levels are measured with error, then the parameter estimates will be biased towards zero (i.e., they will be too small in absolute value). It is likely that there is a considerable amount of measurement error in the staffing variables. As is discussed in detail in Appendix C under standard assumptions, such measurement error will not affect the estimates of the trade-off factor. The measurement error enters multiplicatively, so it will cancel from the ratios.

While these results represent an advance over previous results because they take into account variation in staffing levels and other base characteristics, it is possible to improve upon these estimates by using the additional information provided by the fact that we observe the same MTFs in multiple time periods. We can exploit these repeated observations of the same catchment area using a specification known as the "fixed effects estimator."

We can construct a fixed-effects estimator for our problem as follows. The mean of lnU_{it} for an individual catchment area, *i,* is (omitting the CHAMPUS and MTF subscripts) :

$$\overline{lnU_i} = \alpha_i + \beta\overline{S}_i + \lambda X_i + \gamma\overline{Z}_i + \delta\overline{d}_t + \overline{\varepsilon}_i \,.$$

If we subtract the mean of the utilization for a catchment area from each catchment area observation, we have:

$$lnU_{CHA,i,t} - \overline{lnU_{CHA,i}} = \beta_{CHA}\left(lnS_{MTF,i,t} - \overline{lnS}_i\right) + \gamma_{CHA}\left(Z_{i,t} - \overline{Z}_i\right) + \delta_{CHA}\left(d_t - \overline{d}_t\right) + \left(\varepsilon_{it} - \overline{\varepsilon}_i\right)$$

$$lnU_{MTF,i,t} - \overline{lnU_{MTF,i}} = \beta_{MTF}\left(lnS_{MTF,i,t} - \overline{lnS}_i\right) + \gamma_{MTF}\left(Z_{i,t} - \overline{Z}_i\right) + \delta_{MTF}\left(d_t - \overline{d}_t\right) + \left(\varepsilon_{it} - \overline{\varepsilon}_i\right)$$

In doing so, the constant, α, and time-invariant characteristics of the base, $\lambda_{MTF}X$, drop out of the equation to be estimated. Thus, we only need to control for things that vary

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[23]It seems unlikely that childbirth goes "untreated." Furthermore, since childbirth is quite expensive and, under the Pregnancy Discrimination Act of 1976, all private health insurance plans must cover childbirth, out-of-pocket payment seems unlikely.

over time: the Zs (e.g., population) and staffing, S. This result is particularly important because standard linear regression theory implies that if we do not include all relevant Xs or Zs our estimates of β will be biased. Taking the deviations from means implies that we do not have to worry about unobserved Xs that could bias our cross section estimates above.

Another potential advantage of the fixed-effects specification is that by using the additional information provided by the repeated observations on the same MTF we will be able to improve the efficiency of our estimates. One way to view the difference between cross-section and fixed-effects specifications is that the cross-section specification restricts each MTF to the same intercept as every other MTF, whereas the fixed-effects estimator is effectively allowing a different intercept for each MTF. We can test the hypothesis that the constant terms are all equal using an F test. The test statistic implies that we can reject the hypothesis that the constants were equal across MTFs, supporting the use of the fixed effects strategy.[24] To summarize, there are theoretical reasons supporting the use of the fixed-effects strategy and this test provides empirical support as well.

In this fixed-effects specification, the βs retain their elasticity (percentage change for percentage change) interpretation. Intuitively, we are estimating a separate level of utilization (that holds in all periods) for each catchment area, a separate level of utilization (that is constant across catchment areas) for each period, and a single regression parameter relating utilization to staffing for all periods. This eliminates all variation caused by base effects and nationwide period effects. Since time-invariant base characteristics drop out of the equation after differencing, the fixed-effects regressions do not include the service branch dummy variables, the HMO measure, or whether the MTF hospital was small, medium-sized, or was a medical center. The only variation left is the relative change in staffing levels and characteristics that vary across both time and base (population counts in this case) as explanatory variables to explain differences in utilization across catchment areas. This is exactly the "experiment" we want.

Table 8 contains the parameter estimates (the βs) and the estimated trade-off factors for the fixed-effects specification. All of the estimates have the expected signs. Increasing MTF staffing by 10 percent raises MTF utilization by 1.5 to 6.2 percent and

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[24] The test yielded an F-statistic of 2.80, well above the critical value for conventional confidence regions.

lowers CHAMPUS utilization by 0.8 to 2.9 percent. While the coefficient estimates seem plausible, they appear to be relatively small. Once again, measurement error may play a role in the small size of the parameter estimates. Moreover, as Freeman (1984) has

Table 8

Trade-Off Factors from Fixed Effects Estimates

	β_{MTF}	β_{CHA}	$\frac{U_{MTF}}{U_{CHA}}$	TOF
Outpatient				
Medicine	0.154	–0.087	2.606	4.629
Surgery	0.373	–0.014[1]	1.919	—[1]
Inpatient				
Medicine	0.199	–0.151	2.323	3.049
Surgery	0.358	–0.106	11.221	37.84
Obstetrics/Gynecology	0.621	–0.285	4.980	10.873

NOTE: Computed from regression results as described in Appendix C. Final regressions include doctors as a measure of staffing (except Ob/Gyn, which also includes nurses), number of operating beds in the MTF for surgery, year dummies, the log of the active-duty population, and the log of the CHAMPUS-eligible population.

[1]This coefficient was insignificant and hence is considered to be zero. This implies that we cannot compute a trade-off factor for this category.

pointed out, this problem is exacerbated in the fixed-effects approach used here. The measurement error is now measured relative to the size of the real year-to-year changes in the variable (i.e., the staffing levels).

As in the cross-section estimates, the trade-off factors are reasonable except for the Inpatient Surgery value of 37.8. The Inpatient Obstetrics-Gynecology value of 10.873 is also quite large. In addition, the estimated CHAMPUS Outpatient Surgery point estimate is not significantly different from zero. Given the definition of the trade-off factor, this implies division by zero and, implicitly, an implausibly large trade-off factor. As an alternative, we estimated a specification that combined Outpatient Medicine and Surgery categories. The corresponding trade-off factor for this combination is 3.64.

Comparing the cross-section and fixed-effects results, we find that the fixed-effects coefficients are generally smaller than the cross-section results. This is what one would expect if measurement error were a problem—as discussed earlier, the fixed effects strategy exacerbates the tendency for measurement error to bias the coefficients toward zero. However, the arguments of Appendix C continue to hold. Therefore the estimated trade-off factors are unaffected by measurement error of the standard form. The utilization ratios remain the same for the two specifications, but differing ratios of the coefficients yield higher trade-off factors for the fixed-effects specification.

CONCLUSIONS

This chapter has reviewed and critiqued previous estimates of the trade-off factor. We found that previous estimates did not account for differences across geographic regions and across time in the patterns of health care utilization. We proposed instead a regression approach that uses the MTF staffing figures recently made available and that exploits the fact that they are available for multiple years. This approach allows us to model utilization changes as a function of MTF staffing changes. Hosek et al. (1995) estimated trade-off factors but used beneficiary-level data that included only CHAMPUS-eligible beneficiaries who lived in catchment areas rather than the full set of individuals who could shift to MTFs were MTFs given more resources.

We first used the new data to estimate a set of cross-section regressions that used base characteristics as well as staffing levels to predict utilization. Then, we outlined theoretical reasons that supported the use of a fixed-effects strategy instead. That strategy implicitly controls for all measured and unmeasured time-invariant base characteristics. Next, we estimated the same set of outcomes using the fixed-effects model. A conventional F-test rejected the cross-section estimates in favor of the fixed-effects estimates. In addition, the fixed-effects approach controls for some forms of bias due to omitted regressors.

For both the cross-section and fixed-effects models, the estimated parameters had the expected signs. Increasing MTF staff increases total care and MTF care but lowers CHAMPUS care. The estimates were, however, relatively small. There appear to be considerably less than constant returns to scale in the MTF. Increasing MTF staff by 10 percent results in increased utilization of only 2 to 6 percent. This finding implies that MTF marginal costs are approximately twice MTF average costs. In addition, increasing MTF staffing has only small effects on CHAMPUS utilization. Increasing MTF staffing by 10 percent lowers CHAMPUS utilization by only about 1 percent for outpatient visits and 1 to 3 percent for inpatient admissions. The trade-off factors that rely on the ratio of these two estimates appear to be reasonable, however. Note that the trade-off factors estimated here are, as expected, larger than those estimated by Hosek et al. (1995) but yield the same conclusion: Expanding MTF care leads to an increase in

MTF utilization that is much larger than the decline in CHAMPUS utilization. This overall growth in DoD health care demand as a result of MTF expansion is likely to outweigh any potential cost savings resulting from the lower cost of MTF care relative to CHAMPUS care.

5. CONCLUSIONS

This report has considered the likely effects on CHAMPUS utilization of increasing MTF staffing. The results suggest that not all additional patients seen in the MTF as a result of increased MTF staffing will come from CHAMPUS cases. Instead, many of the additional patients, absent the increased staffing, would have been reimbursed by other (non-CHAMPUS) health insurance and Medicare or would have gone untreated. Slackman's (1988a) survey of MTF-CHAMPUS cost comparisons suggests that when MTF costs are properly allocated, the MTF is not appreciably cheaper than CHAMPUS. According to some of the estimates he quotes, when civilian doctors are hired to provide care in the MTF, the MTF is more expensive than CHAMPUS. Therefore, if even small numbers of new MTF patients are not drawn from CHAMPUS (they would have billed private insurance or received no care), increasing MTF staffing will *increase* total medical costs.

These computations assume no recovery of MTF costs from private insurance carriers. If the required data systems were in place and cost recovery were aggressively pursued, increasing MTF staffing could be more attractive as a cost-cutting move.

These conclusions are derived from three complementary analyses: our theoretical analysis, the survey data, and our regression analysis. Our theoretical analysis suggested that DoD saves money only if most new MTF patients come from CHAMPUS. However, new patients from other sources—i.e., the private-health-insurance and no-care categories—are also likely.

The survey results suggest that a considerable amount of care provided by civilian doctors is not reimbursed by CHAMPUS. Among the reasons are the use of Medicare reimbursement by retirees after age 65, the availability of other insurance (usually through employment) to CHAMPUS eligibles, the CHAMPUS cost-sharing regulations, and the paperwork burden in filing a CHAMPUS claim. In addition, 30 percent of beneficiaries report that they have medical problems that go untreated because of both the cost of CHAMPUS and the lack of available MTF providers. Both of these survey results suggest that as the availability of MTF care improves—as it would with increased staffing—many of the new cases will not come from CHAMPUS.

The regression results point in a similar direction. Using new data that include measures of MTF staffing, we employ two methodologies to estimate MTF-CHAMPUS trade-off factors—the number of additional patients that must be seen in the MTF to decrease CHAMPUS care by one patient. The regression results consistently show that production of health care (outpatient visits and inpatient admissions) in the MTFs is characterized by decreasing returns to scale. Furthermore, the overwhelming majority of the new patients seen do not come from CHAMPUS. The implied trade-off factors are all well above one for both outpatient and inpatient care.

Trade-off factors greater than one are consistent with our theoretical model. The naive model of cost savings from increasing MTF staffing notes that MTF costs are below CHAMPUS costs. Implicitly, this argument assumes that the additional utilization would otherwise have been handled through CHAMPUS. The theoretical model and the survey results suggest that some of the utilization might previously have been financed by other non-CHAMPUS insurance and Medicare (for retirees over 65) or might have been for care that would otherwise have been forgone because of the long MTF wait. The regression results suggest that these alternative sources of demand should not be ignored.

Inefficient staffing and capital availability provide an additional possible reason for the high trade-off factors. The regression results imply that for a given MTF, each additional doctor sees fewer patients than did the existing staff. One possible explanation for this finding is that different inputs (doctors, nurses, capital) are not being expanded in the appropriate ratios. Additional doctors without enough additional support personnel, waiting rooms, and lab facilities will not be fully utilized.

The trade-off factors are consistent with the prediction of the economic model; all seem plausible except for the inpatient surgery estimate, which is implausibly high. This is most likely due to the differences in caseload definition between MTF and CHAMPUS care providers. At the very least, the regression estimates of the change in CHAMPUS caseload for a change in MTF staffing imply that whatever trade off exists is not incredibly strong.

Taken together, these results cast doubt on the potential cost savings that would result solely from increasing MTF staffing. Such cost savings would be the joint result of lower costs of delivery health care in the MTF (compared to CHAMPUS) and the ability to shift cases from CHAMPUS to the MTFs without simultaneously attracting large numbers of non-CHAMPUS patients. While it seems plausible that CHAMPUS costs are above MTF costs, it seems unlikely that they are three times the properly allocated MTF costs,[25] as would be necessary to justify such a policy in the face of trade-off factors of three and above. This analysis is not meant to imply that the MTFs should be shut down. As noted in Section 1, the MTFs have a role in both the readiness and the benefits mission of the military health care systems. The analysis merely suggests that increasing the size of the MTFs—or not decreasing them in concert with the downsizing of military forces—will not necessarily cut costs.

DoD has embarked on a major effort to introduce managed care in the military health care system. The managed care concept, called Tricare, allows CHAMPUS beneficiaries to enroll in a health maintenance organization (HMO) or to stay in the standard plan, which now includes a CHAMPUS preferred provider option. There is little cost sharing in the HMO, but enrollees are covered only for services provided in the MTF or by a network of contracting civilian providers, and retirees pay a modest enrollment fee for the HMO only. HMO enrollees seeking care are directed to the most cost-effective MTF or civilian network referring primary care providers. Active-duty personnel continue to be treated in the MTFs as before, and Medicare eligibles also continue to be eligible for MTF care. The MTF commander is responsible for managing both programs in his or her catchment area in partnership with regional civilian contractors.

Tricare could provide mechanisms for improving the trade-off factors that have characterized the system to date. The key to managed care's success in decreasing the trade-off factors is the incentive it gives to MTF commanders and to beneficiaries. To control their costs, MTF commanders will need to target increased resources to services that the MTF can provide at less cost than civilian health care providers and on beneficiaries who would otherwise obtain civilian care at DoD expense. In theory, holding MTF commanders accountable for total DoD costs in their areas could give them an incentive to dump Medicare eligibles. However, the strong commitment to these older retirees and their political effectiveness make such dumping less likely. Finally, in designing the MTF-based and CHAMPUS options, special care should be taken to discourage those beneficiaries who have other insurance from using the MTF or billing CHAMPUS, or to develop effective programs for collecting from the other insurance for MTF-provided services. Developing the sophisticated data systems,

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[25]When such cost calculations are done, it is important to consider all MTF costs including depreciation of capital, special pay bonuses to the medical staff, and costs incurred through nonmedical budgets. Current MEPRS data exclude some depreciation and nonmedical budget costs and underestimate special pay. In another supporting report for the MHCS study, IDA (Institute for Defense Analyses) researchers found that these excluded costs add 11 percent to outpatient costs and 14 percent to inpatient costs.

costing methods, and benefits designs needed to operate the military health care system effectively will take some time, but all of these elements are obtainable and are currently planned under the proposed system.

Appendix A:
1992 DoD HEALTH CARE SURVEY ANALYSIS

The survey results discussed in Sections 2 and 3 of the body of the report were derived from an analysis of the 1992 DoD Health Care Survey. This appendix serves two purposes. First, it describes the survey in more detail. Second, it describes the coding scheme and rationale behind the results presented in the body of the report.

THE SURVEY

The 1992 DoD Health Care Survey was conducted as part of the Comprehensive Study of the Military Medical Care System which Congress requested as part of Section 733 of the National Defense Authorization Act for Fiscal Years 1992 and 1993. The survey gathered information from military health care recipients on their access to and use of medical care services and on their attitudes and knowledge regarding military health care services.

In late 1992 and early 1993, the Survey was mailed to 45,000 households whose members included active-duty personnel with and without dependents, active and reserve retirees, and survivors of military personnel. The households were randomly selected from within each of 73 population strata, with different strata having different sampling rates. Survey data were weighted to account for different sampling and nonresponse rates to estimate the military population as a whole (see Hosek, et al. [1995] for a more detailed description of sampling weights). All information reported from the survey is weighted.

THE CODING SCHEME

First, this report uses the 1992 DoD Health Care Survey to determine whether individuals are CHAMPUS eligible. To obtain information about a random member of the household, the survey asked questions about the member of the household with the most recent birthday. We used Q49 to determine whether the random person in the household interviewed was eligible to receive CHAMPUS. Note that active-duty personnel are not CHAMPUS eligible, so these statistics apply only to active-duty dependents, retirees, and retirees' survivors. Also note that Medicare eligibles—only those 65 and older—are not CHAMPUS eligible. We included the random member in the sample for subsequent tables based on the 1992 DoD Health Care Survey only if the random member was CHAMPUS eligible.

We use the survey to determine whether CHAMPUS-eligible individuals used the MTF, CHAMPUS, or both MTF and CHAMPUS, or used civilian care but did not use CHAMPUS to pay for the care represented in Figures 1 and 2. We use Q47 and Q48 from the survey to classify respondents in these categories. Q47 asked how many times in the past 12 months the random member had visited a medical care provider at any of the following places: military hospital or clinic, sick call visit, civilian medical provider, PRIMUS or NAVCARE clinic, Veterans Administration (VA) hospital or clinic, or another type of place (specify). Next, Q48 asked how many nights the random family stayed overnight at military hospitals, civilian hospitals, VA hospitals, or another type of place (specify).

The survey also asked the reasons that individuals did not get needed medical care. If the respondent answered no to Q100—“During the past 12 months, did members of your family always see a doctor or other health care provider when they wanted to?”—we used the reply in Q101 to create Table 2.

To determine the number of calls needed to make an appointment in MTFs versus civilian medical facilities, we used information from Q58 and Q61. Using Q58, we determined whether the household's random member visited a military or civilian medical facility and then used Q61 to determine the number of respondents who walked in, made one or two calls, or made three or more calls for both MTFs and civilian care facilities. We report this information in Figure 3. Similarly, we used both Q58 and Q65 to determine the time spent waiting for a doctor in the two sectors in Figure 4.

The survey also reports reasons for not filing a CHAMPUS claim for civilian care used. Using Q25, we first deleted respondents who had not received care, did not have to file a claim for payment, and were not eligible for CHAMPUS. Using the remaining respondents, we determined whether the respondent did not file a claim for administrative reasons, because other insurance paid for the visit, because CHAMPUS did not cover the visit, or for some other reason.

Table A.1

MTF-CHAMPUS Sector Choices
(Among Those Using the Military Health Care System)

	All	Active Duty Dependents	Retirees and Their Dependents
		(Percent)	
MTF	61.3	69.7	54.3
CHAMPUS	23.4	13.1	32.0
Both	15.3	17.2	13.7

NOTE: All percentages are weighted.
SOURCE: 1992 DoD Health Care Survey.

Table A.2

Health Care Choices in Past 12 Months by Sector

	All	Active Duty Dependents	Retirees and Their Dependents
		(Percent)	
Military system only	37.8	58.9	25.6
Civilian system only	19.6	5.6	27.6
Both military and civilian system	20.7	16.1	23.3
Other combinations including VA	3.9	0.5	6.0
None	18.0	18.9	17.5
N	15,499	7,174	8,325

SOURCE: 1992 DoD Health Care Survey.
NOTE: All percentages are weighted. Those people who used civilian care but did not specify how it was paid for are not included in this table.

Table A.3

Phone Calls for Most Recent Appointment (Percent by Category and Sector of Care)

	Active-Duty Dependents			Retirees and Their Dependents			All		
	MTF	Civ	All	MTF	Civ	All	MTF	Civ	All
Walk-in	8.2	3.8	7.4	8.5	3.1	5.5	8.3	3.3	6.2
1–2 calls	47.1	66.7	51.0	48.3	80.6	66.3	47.6	78.0	60.2
3+ calls	37.0	12.8	32.2	39.5	9.4	22.7	38.1	10.0	26.5
Don't know	7.7	16.6	9.4	3.8	6.9	5.5	5.9	8.7	7.1

SOURCE: 1992 DoD Health Care Survey.

Table A.4

Waiting Time to See a Health Professional (Percentages)

	Active-Duty Dependents			Retirees and their Dependents			All		
Minutes	MTF	Civ	All	MTF	Civ	All	MTF	Civ	All
≤ 15	23.3	44.8	27.9	25.2	46.2	38.2	24.1	46.0	34.1
16–30	37.5	32.8	36.5	39.3	33.5	35.7	38.3	33.4	36.0
31–45	15.6	10.9	14.6	19.5	11.5	14.5	17.3	11.4	14.6
46–60	7.3	6.3	7.1	6.1	4.4	5.0	6.8	4.7	5.9
> 60	16.2	5.2	13.9	9.9	4.4	6.5	13.5	4.5	9.4
N	4217	1323	5540	2544	3084	5628	6761	4407	11168

SOURCE: 1992 DoD Health Care Survey. Those people who used civilian care but did not specify how it was paid for are not included in this table.

Appendix B
DATA SOURCES FOR REGRESSION ANALYSES

In this appendix, we describe in detail the source and derivation of the variables used in the regression analysis. All of the data sets were downloaded from the on-line DMIS, the Defense Medical Information System. This data system, which serves as a central repository for all military medical data, is maintained by the Defense Medical Systems Support Center (DMSSC). For this report, we used data on (1) the size of the beneficiary population, (2) the level of MTF staffing, (3) the level of inpatient and outpatient MTF utilization, (4) the level of inpatient and outpatient CHAMPUS utilization, and (5) the number of operating beds in a Medical Treatment Facility (MTF).

The data set is organized with one record per MTF per year. The formal extraction was done on the basis of DMISID, a DMIS provider hospital and clinic identifier. These data usually included clinics that operate as part of the hospital.

SOURCE OF INFORMATION

The following paragraphs summarize the source of information for the regressions.

MTF Utilization

The data on MTF utilization were drawn from the MEPRS (Medical Expense and Performance Reporting System). The data are reported to DMIS quarterly. The on-line system includes annual information for FY 1987 to FY 1992. Data are available at least at the two-character UCA (Uniform Chart of Accounts) level—i.e., specialty or clinic. No data broken down by beneficiary category are available.

MTF Staffing

The data on MTF staffing are also drawn from the MEPRS, which covers only the period FY 1987 to FY 1992 (six years). The data are reported in annual Full Time Equivalents (FTEs).

CHAMPUS Utilization

CHAMPUS data are reported in DMIS on an annual basis by catchment area and by state noncatchment area. The data are available for the period FY 1982–FY 1992.

Visits are broken down only into obstetrics/ gynecology, medical, surgical, and psychiatric categories.

CHAMPUS Population

The DMIS records contain detailed data on the eligible population derived from DEERS (Defense Eligibility Enrollment Reporting System). The data nominally cover the period 1982–1992. The figures for the period 1982 to 1984 are estimates. In that period, beneficiaries were not required to enlist in DEERS. The data for 1987 to 1992 are considered to be more reliable.

DATA SET CONSTRUCTION

As noted by VRI and several other recent analysts, there is a lack of congruence between the specialty codes in the CHAMPUS and the MTF reporting systems. After comparing the two listings of specialties and plausible arguments for different trade-off factors, we divided the caseload into three parts: obstetrics-gynecology, medical, and surgery. Because the MTFs provide almost no psychiatric care for nonactive duty beneficiaries, we did not analyze psychiatric care.

We also aggregated the beneficiary data into total counts for active-duty individuals (mostly males, who must use the MTF) and the total eligible population. We found no difference in the results when we distinguished between different groups in the nonactive eligible population.

The staffing data reports FTEs for doctors, nurses, professionals, paraprofessionals, and administrators. We tried using doctors alone, doctors and nurses, all types of caregivers, and a simple aggregate created by summing the numbers of doctors and nurses. In the analysis of medicine and surgery, we found that the specification that included doctors' FTEs yielded only results similar to the other specification, so we present results for this more parsimonious representation. For obstetrics/gynecology, however, doctors only did not serve as an adequate proxy for the production process, and we include doctors and nurses for this specialty group.

As mentioned in the text, we include the number of HMOs in a catchment area as a proxy for the availability of civilian health care plans. This statistic comes from the area resource file which reports characteristics of catchment areas.

In some MTFs, the military contracts with civilian doctors to provide care at the military facility—these contractual arrangements are known as "partnerships." While this arrangement may be transparent to patients, the MEPRS system records the FTEs and utilization of these contracted doctors differently from how it records military doctors. The contracted doctors' FTEs are not counted as part of the MTF FTEs, and the visits to these doctors are counted with the CHAMPUS utilization. In this study we are using CHAMPUS utilization to represent the choice of CHAMPUS care versus MTF care by eligible individuals, and, therefore, we subtract the utilization in a catchment area due to partnerships from the CHAMPUS utilization total in each catchment area.

As is discussed in Appendix C, we adopted a Cobb-Douglas specification. All of the variables are specified in deviations from the mean of the logarithm of the variable. Thus, all of the regression coefficients have the same interpretation: a 1-percent change in the exogenous variable causes a β change in the endogenous variable.

ADDITIONAL DATA CONSIDERATIONS

In conducting the analysis, we were concerned that events that transpired over the 1988–1992 period might bias our results or that MTFs with special characteristics might influence the results. These events included Operation Desert Storm (ODS) in 1991 and base closings throughout the period. During ODS, some of the health care staff from the MTFs were removed from their bases and reservists replaced them. Many of the potential MTF patients left the bases at this time, as well. Thus, it was possible that the relationship between health care provider hours and utilization during this period was not representative of the typical peacetime relationship. We tested whether the coefficients in 1991 were significantly different from the coefficients in all the other years combined and found that we could not reject the hypothesis of coefficient stability (1991 versus earlier years).

Base closings also had the potential to obscure the relationship between care providers and utilization. During the process of closing a base, the accounting of base population and health care provision was not always temporally accurate. For example, we observed hospitals' utilization dropping dramatically while population numbers held steady and vice versa. We estimated our models excluding bases that closed and did not find that the coefficients were statistically different from estimates that included all bases. This outcome is reassuring, because such swings in doctor-patient ratios are exactly the type of "experiment" we are trying to evaluate.

We also examined whether MTFs with certain characteristics might influence the results. These included MTFs with large medical centers and MTFs with NAVUS/PRIMCARE clinics in their jurisdiction. MTFs with large medical centers often attract patients from other catchment areas who cannot receive the specialized services available in these larger treatment facilities in the catchment area where the patients live. Hence, we might find that the utilization of treatment in an MTF with a large medical center had little relationship to the population in its own catchment area. In addition, increasing staff at medical centers might reduce CHAMPUS use in other catchment areas. Also, if the mix of services provided at the medical centers was dramatically different from that in other MTFs, the relationship between providers and utilization might be altered beyond that which prevailed at nonmedical centers. We tested for this possibility by examining whether the coefficients differed for estimates with and without medical centers and found that they did not. Finally, we tested whether MTFs with PRIMUS/NAVCARE clinics in their catchment areas differed from other MTFs and found no statistical difference between the two.

REGRESSION SPECIFICATION AND RESULTS

We include a clinician FTE in the medicine and surgery estimates and clinician and a registered nurse (RN) FTE in the obstetrics/gynecology estimates. We experimented with including different combination of caregiver FTEs—registered nurses, professionals, paraprofessionals, and administrators. We found that there was no statistical difference in the specifications that included clinician FTEs only and the specifications that included the FTEs of other caregivers, with one exception: including RNs in the obstetrics/gynecology estimates significantly improved the fit of the model.

Table B.1

Detailed Cross Section Regression Results: Medicine

	Outpatient		Inpatient	
	MTF	CHAMPUS	MTF	CHAMPUS
Ln clinician	0.318	–0.361	0.779	–0.615
	(13.84)	(–9.21)	(19.36)	(–10.83)
FY88	0.124	–0.206	0.181	0.082
	(3.40)	(–3.31)	(2.84)	(0.91)
FY89	0.094	–0.139	0.093	–0.055
	(2.56)	(–2.23)	(1.46)	(–0.61)
FY91	0.016	0.012	–0.086	0.026
	(0.57)	(0.24)	(–1.71)	(0.36)
FY92	0.029	–0.039	–0.137	–0.042
	(0.983)	(–0.77)	(–2.66)	(–0.58)
Ln active	0.013	–0.599	0.169	–0.417
	(0.43)	(–12.01)	(3.30)	(–5.78)
Ln eligible	0.157	2.157	–0.078	1.809
	(4.79)	(38.71)	(–1.37)	(22.41)
Navy	–0.266	0.493	–0.791	0.453
	(–9.423)	(10.23)	(–16.01)	(6.50)
Air Force	–0.242	0.156	–0.415	–0.161
	(–9.822)	(3.70)	(–9.60)	(–2.65)
HMOs	–0.002	–0.002	0.017	–0.027
	(–0.54)	(–0.28)	(2.40)	(–2.59)
Small	0.042	0.102	–0.175	0.040
	(1.29)	(1.82)	(–3.02)	(0.49)
Medical center	0.210	–0.139	0.395	–0.396
	(4.84)	(–1.87)	(5.20)	(–3.69)
Constant	8.061	–7.039	4.043	–7.383
	(37.50)	(–19.19)	(10.74)	(–13.90)
R^2	0.802	0.876	0.846	0.679
N	601	601	601	601

NOTE: t-statistics in parentheses.

Table B.2

Detailed Cross Section Regression Results: Surgery

	Outpatient		Inpatient	
	MTF	CHAMPUS	MTF	CHAMPUS
Ln clinician	0.629	–.253	.699	–.315
	(24.52)	(–7.23)	(34.84)	(–8.92)
FY88	–0.135	–.006	.150	.272
	(–2.11)	(–.07)	(2.99)	(3.08)
FY89	–.180	–.011	–.022	.035
	(–2.80)	(–.12)	(–.44)	(.40)
FY91	–.033	.063	–.026	.065
	(–.66)	(.91)	(–.65)	(.93)
FY92	–.033	.019	.007	–.039
	(–.64)	(.27)	(.18)	(–.54)
Ln active	–.309	–.715	.039	–.467
	(–5.98)	(–10.10)	(.97)	(–6.58)
Ln eligible	.554	2.345	.216	1.806
	(9.47)	(29.16)	(4.72)	(22.44)
Navy	–.358	.613	–.325	.346
	(–7.15)	(8.98)	(8.29)	(5.02)
Air Force	–.325	.254	–.311	.200
	(–7.67)	(4.39)	(9.38)	(3.43)
HMOs	–.014	.008	–.009	–.031
	(–2.01)	(.85)	(1.60)	(–3.15)
Small	–.109	.076	.013	–.053
	(–1.87)	(.96)	(.29)	(–.67)
Medical center	–.547	–.170	–.108	–.543
	(–7.24)	(–1.65)	(–1.83)	(–5.22)
Constant	5.836	–9.382	3.503	–9.510
	(13.04)	(–15.37)	(10.01)	(–15.43)
R^2	.870	.791	.933	.643
N	601	593	601	601

NOTE: t-statistics in parentheses.

Table B.3

Detailed Cross Section Regression Results: Obstetrics/Gynecology

	Inpatient	
	MTF	CHAMPUS
Ln clinician	0.053	–0.209
	(1.79)	(–2.82)
Ln RN	0.719	–0.424
	(27.750)	(–6.580)
FY88	0.010	–0.222
	(0.14)	(–1.26)
FY89	–0.089	–0.246
	(–1.31)	(–1.39)
FY91	–0.08	–0.078
	(–1.41)	(–0.56)
FY92	–0.113	–0.005
	(–2.06)	(–0.34)
Ln active	0.244	0.592
	(4.01)	(3.78)
Ln eligible	0.070	1.071
	(1.22)	(7.16)
Navy	–0.530	0.771
	(–10.02)	(5.64)
Air Force	–0.183	0.140
	(–3.70)	(1.10)
HMOs	0.003	–0.029
	(0.34)	(–1.30)
Small	–0.015	–0.022
	(–0.25)	(–0.14)
Medical center	0.013	–1.402
	(0.18)	(–7.30)
Constant	2.421	–11.028
	(6.46)	(–11.05)
R^2	0.882	0.528
N	571	571

NOTE: t-statistics in parentheses.

Table B.4

Detailed Fixed Effects Regression Results: Medicine

	Outpatient		Inpatient	
	MTF	CHAMPUS	MTF	CHAMPUS
Ln clinician	0.154	–.087	0.199	–.151
	(3.36)	(–1.89)	(3.62)	(–2.22)
FY88	0.065	–0.305	0.159	0.082.
	(2.55)	(–12.02)	(5.23)	(2.16)
FY89	0.0411	–0.173	0.102	0.028
	(1.78)	(–7.45)	(3.70)	(0.81)
FY91	0.020	0.034	–0.056	0.049
	(0.84)	(1.47)	(–2.02)	(1.40)
FY92	0.024	–.001	–0.088	0.001
	(0.97)	(–0.02)	(–2.97)	(0.03)
Ln active	–0.127	–0.119	0.413	0.011
	(–1.44)	(–1.36)	(3.93)	(0.08)
Ln eligible	0.117	0.763	–.425	0.374
	(0.78)	(5.09)	(–2.38)	(1.68)
R^2	.899	.951	.963	.952
N	617	601	617	617

NOTE: t-statistics in parentheses.

Table B.5

Detailed Fixed Effects Regression Results: Surgery

	Outpatient		Inpatient	
	MTF	CHAMPUS	MTF	CHAMPUS
Ln clinician	0.373	–.014	0.358	–0.106
	(10.07)	(–0.24)	(9.65)	(–2.48)
FY88	–0.039	–0.090	0.147.	0.305
	(–1.37)	(–1.99)	(5.17)	(9.27)
FY89	–0.036	–0.024	–0.009	0.137
	(–1.40)	(–0.59)	(–0.35)	(4.57)
FY91	–0.030	0.092	–0.031	0.095
	(–1.16)	(2.22)	(–1.19)	(3.16)
FY92	–0.011	0.065	0.021	0.013
	(–0.41)	(1.45)	(0.74)	(0.41)
Ln active	–0.099	–0.119	–0.007	0.050
	(–1.00)	(–0.76)	(–0.07)	(0.44)
Ln eligible	0.121	1.020	0.274	0.525
	(0.72)	(3.83)	(1.62)	(2.69)
R^2	.973	.950	.977	.952
N	617	609	617	615

NOTE: Estimated with fixed-effects estimator controlling for catchment area; t-statistics in parentheses.

Table B.6

Detailed Fixed Effects Regression Results: Obstetrics/Gynecology

	Inpatient	
	MTF	CHAMPUS
Ln clinician	0.106	–0.121
	(3.14)	(–1.96)
Ln RN	0.515	–0.163
	(15.31)	(–)
FY88	0.097	0.091
	(2.46)	(1.15)
FY89	–0.019	0.015
	(–0.53)	(0.21)
FY91	–0.093	–0.036
	(–2.60)	(–0.50)
FY92	–0.102	–0.025
	(–2.68)	(–0.33)
Ln active	–0.144	–0.002
	(–1.04)	(–0.01)
Ln eligible	0.149	0.376
	(0.65)	(0.80)
R^2	.958	.904
N	587	584

NOTE: Estimated with fixed-effects estimator controlling for catchment area; t-statistics in parentheses.

Appendix C
DERIVATION OF TRADE-OFF FACTOR

In this appendix, we present some simple analytics of military health costs. We then demonstrate formally how the fixed-effects estimator eliminates catchment-area effects. The arguments date back at least to Mundlak (1961, 1978). A more complete discussion of the issues may be found in Hsiao (1986). We then derive the relation stated in the text between the estimated parameters β and the parameters of interest: the trade-off factor.

SIMPLE ANALYTICS OF MILITARY HEALTH CARE COSTS

We begin with a simple identity for military health care costs:

$$TC = TC_{MTF}\left(U_{MTF}\right) + TC_{CHA}\left(U_{CHA}\right)$$

Total military health costs are the sum of total MTF costs and total CHAMPUS costs. Each of these costs is a function of utilization (U, i.e., visits and admissions). Assuming that costs in both sectors are linear in quantities,[26] we have:

$$TC = U_{MTF}\,AC_{MTF} + U_{CHA}\ AC_{CHA}$$

where the MTF subscript refers to direct care (in the MTF) and the CHA subscript refers to CHAMPUS care. Now consider a change that affects both MTF and CHAMPUS utilization. The effect on total costs will be:

$$\Delta TC = \Delta U_{MTF}\,AC_{MTF} + \Delta U_{CHA}\,AC_{CHA}$$

The change in total costs is equal to the change in MTF utilization times the average cost of MTF care, plus the change in CHAMPUS utilization times the average cost of CHAMPUS care.

From this equation, we can derive a simple formula for the change in total costs of increasing the staffing of the MTF (and drawing cases from CHAMPUS). Dividing

[26] This is the constant returns-to-scale assumption of the body of the report. We reject it there. That result implies that the criteria given below for the conditions under which expanding MTF staffing will result in cost savings are optimistic. Even in some cases in which the simple formula implies that cost savings exist, the less than constant returns-to-scale result implies that they do not.

both terms to the right of the equals sign in the formula for the change in total costs by the expression $-AC_{MTF}\,\Delta U_{CHA}$ yields:

$$\left[-\frac{\Delta U_{MTF}}{\Delta U_{CHA}}\right]-\frac{AC_{CHA}}{AC_{MTF}}=TOF-CF$$

where the equality is definitional. We define the terms to the right of the equality (*TOF* and *CF*) below. Note that $-AC_{MTF}\,\Delta U_{CHA}$ is positive[27] so the division does not affect the sign for change in total DoD costs for health care. Therefore, the sign of the net effect of shifting care from CHAMPUS to the MTFs is given by the sign of this expression: $TOF-CF$.

The first term (in the brackets) is the trade-off factor (*TOF*). It is the number of additional MTF cases that is required to decrease the CHAMPUS load by one case. Note that the two changes will in general have opposite signs; i.e., an increase in MTF utilization will cause a decrease in CHAMPUS utilization. The minus sign imposes the conventional positive sign of the trade-off factor. As is discussed extensively in the body of the report, the possibility of new MTF cases that would not have been treated under CHAMPUS leads us to expect a trade-off factor greater than one.

The second term is the ratio of CHAMPUS costs to MTF costs. The assumption that CHAMPUS is more expensive than direct care implies that this ratio will also be positive and greater than one.

Both terms are positive. Thus, if the trade-off factor is larger than the cost factor, increasing MTF staffing will raise costs (new non-CHAMPUS cases swamp the cost differential). Alternately, if the cost factor is larger than the trade-off factor, then increasing MTF staffing will save money (new non-CHAMPUS cases are not important enough to swamp the cost differential).

RELATION OF TRADE-OFF FACTOR TO ESTIMATED PARAMETERS

The trade-off factor (*TOF*) is the number of additional patients visits/admissions that must occur in the MTF to decrease CHAMPUS visits/admissions by one. Define *U* as a measure of utilization (visits or admissions) with the subscript denoting CHAMPUS or the MTF. Then:

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[27]To see this, note that average costs are positive. For the case of MTF staff expansion, CHAMPUS utilization is expected to shrink, so the second term is negative. Therefore, the negative sign makes the whole expression positive.

$$TOF = \frac{\partial U_{MTF}}{\partial U_{CHA}}$$

Note from the equation in the levels (not differenced) that the ßs in our regression equation have a partial derivative interpretation:

$$\beta = \frac{\partial lnU}{\partial lnS} = \left[\frac{\partial U}{\partial S}\right]\left[\frac{S}{U}\right]$$

Therefore, we can write:

$$TOF = \frac{\partial U_{MTF}}{\partial U_{CHA}} = \left[\frac{\partial U_{MTF}}{\partial S}\right]\left[\frac{\partial S}{\partial U_{CHA}}\right] = \left[\frac{\beta_{MTF}}{\beta_{CHA}}\right]\left[\frac{U_{MTF}}{U_{CHA}}\right]$$

which is the result claimed in the text. Note that the last term is simply the ratio of utilization in the MTF to utilization in CHAMPUS.

EFFECT OF MEASUREMENT ERROR

In this section, we discuss the effects of measurement error on the parameter estimates and on the estimated trade-off factor. Consider the case of a regression with a single independent variable measured with error (in terms of the observed, not the true value):

$$y = \tilde{x}\beta + u$$

where the observed x, $\tilde{x}$, is related to the true x by:

$$\tilde{x} = x + v$$

Then the ordinary least squares estimate of β will be (Fuller, 1987, p. 3):

$$\hat{\beta} = \frac{\beta\sigma_{xx}}{\sigma_{xx} + \sigma_{vv}} = \beta\delta$$

where β is the true regression coefficient for the correct (not the mismeasured) variable and δ is the bias (the second equals sign is definitional). Since variances $(\sigma_{xx}$ and $\sigma_{vv})$ are always positive, δ will be positive, but less than one. Thus, our estimate of β will be biased toward zero. Note, however, that δ is only a function of x, and the function is multiplicative. Thus, the ratio of two βs measured corresponding to the same exogenous variable will be unaffected by the measurement error. The trade-off factor is just such a ratio of regression coefficients and should therefore be unaffected by measurement error (see Thomas, 1991).

THE FIXED-EFFECTS ESTIMATOR

The equations in the model have a double log specification:

$$lnU_{CHA,t} = \alpha_{CHA} + \beta_{CHA} lnS_{MTF,t} + \lambda_{CHA}\ X + \gamma_{CHA} Z_t + \delta_{CHA} d_t + \varepsilon_{CHA,t}$$

$$lnU_{MTF,t} = \alpha_{MTF} + \beta_{MTF} lnS_{MTF,t} + \lambda_{MTF}\ X + \gamma_{MTF} Z_t + \delta_{MTF} d_t + \varepsilon_{MTF,t}$$

where S is staffing level, the t subscript refers to the time period, and d_t is a dummy variable equal to 0 in the first period and 1 in the second period.[28] The Xs are time-invariant base characteristics (e.g., service, teaching hospital status, type of forces stationed in catchment area); thus, the lack of a t subscript and the Zs are time-varying base characteristics (in our example, the size and characteristics of the beneficiary population); thus, the t subscript. By taking the deviations from the catchment-area means in each period, we have:

$$lnU_{CHA,i,t} - \overline{lnU_{CHA,i}} = \beta_{CHA}\left(lnS_{MTF,i,t} - \overline{lnS}_i\right) + \gamma_{CHA}\left(Z_{i,t} - \overline{Z}_i\right) + \delta_{CHA}\left(d_t - \overline{d}_t\right) + \left(\varepsilon_{it} - \overline{\varepsilon}_i\right)$$

$$lnU_{MTF,i,t} - \overline{lnU_{MTF,i}} = \beta_{MTF}\left(lnS_{MTF,i,t} - \overline{lnS}_i\right) + \gamma_{MTF}\left(Z_{i,t} - \overline{Z}_i\right) + \delta_{MTF}\left(d_t - \overline{d}_t\right) + \left(\varepsilon_{it} - \overline{\varepsilon}_i\right)$$

Therefore, as claimed in the text, α and λX drop out of the equation, and any time-invariant characteristics of the base drop out of the estimating equation. The only things we need to control for are things that do change over time: the Zs (e.g., population) and staffing, S. This result is particularly important because standard linear regression theory implies that if we do not include all relevant X or Z, our estimates of β will be biased. Differencing controls for missing Xs.

One potential disadvantage of using a fixed-effects estimator is that if we expect that measurement error might be a problem, fixed effects will exacerbate the typical bias of parameter estimates (toward zero) due to measurement error (see Freeman, 1984). We believe that measurement error is probably an issue with these data and, as a result, that our parameter estimates are biased toward zero. However, the argument of the previous section (that since the trade-off factor is a ratio of two parameter estimates

[28] Hsiao (1986) describes the generalization of this class of estimators to more than two periods. In that case, we would include dummy variables for each period. Instead of differencing, we would subtract the within-catchment area mean.

which have the same multiplicative error term, the errors cancel out) continues to hold, so there should be no effect on the estimated trade-off factor.

Another way of interpreting the fixed-effects estimator is that in controlling for—in this case eliminating—individual MTF effects that do not vary across time, it is equivalent to including a dummy variable for each MTF or equivalently a different intercept for each MTF. A way to test for the validity of a fixed-effects estimation strategy, then, is to test the assumption that all the intercepts for the different MTFs are equal. We did this test, and rejected this hypothesis, which supports the use of the fixed-effects strategy.

Also in support of the fixed-effects approach is the doubt that our data include all relevant base-varying characteristics. If we had adequate data to control for across-MTF variation, we could employ ordinary least squares (OLS) to obtain estimates. Unobserved time-invariant characteristics are accounted for in fixed-effects estimates by an intercept for each MTF, and, hence, as explained in the text, unobserved *X*s do not bias the estimates as they would in OLS regressions.

Appendix D

AN ALTERNATIVE DERIVATION OF THE VRI ESTIMATOR

The body of the report discusses the VRI estimator (Roehrig and Meyer, 1987). It is designed to estimate the trade-off factors from cross-sectional data on per-capita MTF and CHAMPUS utilization. In this appendix, we provide an alternative derivation of that estimator and an interpretation.

We begin by providing a simpler notation. We denote the observed quantities by:

P —total state population

V_M —total MTF visits

V_C —total CHAMPUS visits

Per-capita quantities are then denoted in lower case:

$v_M = V_M / P$—per-capita MTF visits

$v_C = V_C / P$—per-capita CHAMPUS visits

The VRI model proceeds on the assumption (which is doubted in the text) that the beneficiary population can be divided into two groups, those who use the MTF and those who use CHAMPUS. Those who use neither are classified according to what they would use if they used care. Denote the size of these two populations as P_M and P_C respectively (where $P_M + P_C = P$). The VRI model further assumes that the utilization rates among the two populations are constant across states. Denote those rates by r_M and r_C.

In this notation, some algebra shows the VRI nonlinear regression in R_M and R_C (Equation 4.6) can be expressed as:

$$v_M + v_C = r_M + \frac{[r_C - r_M]V_C}{V_C + \left(\frac{r_C}{r_M}\right)V_M} = r_M + \frac{[r_C - r_M]v_C}{v_C + \left(\frac{r_C}{r_M}\right)v_M}$$

The first two terms are exactly VRI's Equation 4.6. The last term simply replaces VRI's total utilization numbers (the capital *V*s) with per-capita utilization numbers (the lower case *v's)*. Simply multiplying through the numerator and denominator of the middle expression by *1/P* and simplifying yields the second equality.

The term to the left of the equal sign is total utilization (across both the MTF and CHAMPUS), an observed quantity. The first term in the far right expression is the unobserved utilization rate for pure MTF users. The second term is a nonlinear combination of the unobserved utilization rates for pure MTF users, the unobserved utilization rate for pure CHAMPUS users, and the observed total utilization rates for the MTF and CHAMPUS (where we could write them in per-capita terms without changing the equation). This yields a nonlinear regression of total per-capita utilization on total per-capita MTF utilization and total per-capita CHAMPUS utilization.

This expression can be rewritten (after some algebra) as:

$$l = \frac{v_C}{r_C} + \frac{v_M}{r_M}$$

This expression can be derived in a more straightforward and intuitive way. We begin with the population identity:

$$P = P_C + P_M$$

Dividing both sides by P yields the first equality (below). Multiplying the numerator and the denominator of the first term by V_C and the second term by V_M yields the second equality. Rearranging yields the third equality. Applying the definitions of v_C, v_M, r_C, and r yields the final equality:

$$l = \frac{P_C}{P} + \frac{P_M}{P} = \frac{P_C V_C}{P V_C} + \frac{P_M V_M}{P V_M} = \frac{V_C/P}{V_C P_C} + \frac{V_M/P}{V_M/P_M} = \frac{v_C}{r_C} + \frac{v_M}{r_M}$$

The resulting expression is exactly our simplified expression for the VRI nonlinear estimator.

Note that this expression can be solved for v_M to yield an alternative and more easily interpretable nonlinear regression:

$$v_M = r_M - v_C\left(\frac{r_M}{r_C}\right) = \alpha + v_C \beta$$

where $r_M = \alpha$ and $r_C = -a/\beta$. The trade-off factor r_M/r_C is estimated by β. Thus, we have an equivalent nonlinear regression of per-capita CHAMPUS utilization on per-capita MTF utilization. It could just as easily have been the other way around, MTF utilization on CHAMPUS utilization. The regression is now linear in the variables but nonlinear in the parameters.

This equivalent nonlinear regression allows us to interpret the VRI estimator. The assumed constancy of the rates given the size of the exclusive-use subpopulations implies a linear relation. If we could find a region with only CHAMPUS visits ($v_M = 0$), we would know r_C exactly ($r_C = v_C$). If we could find a region with only MTF visits

($v_C = 0$), we would know r_M exactly ($r_M = v_M$). In fact, we observe no regions with pure usage; however, the assumed linearity allows us to derive the values of r_M and r_C from the scatter plot of v_C and v_M.[29]

This framework also provides an interpretation of the generalization of the VRI approach in the OSD(HA) report (Bircher, 1989). Unlike VRI, who had one year of data, Bircher had two years of data. He allowed the trade-off factors to vary from year to year. He describes his method as follows:

> Using this approach, trade-off factors for each fiscal year were obtained. The assumption of a constant ratio between direct care and CHAMPUS does not imply that there is only one direct care rate and only one CHAMPUS rate which are constant over states as implied by the old methodology. Each state (or combination of states) has its own unique utilization level. (Bircher, 1989, p. 8).

In terms of our simple regression, we have:

$$v_{Mit} = r_{Mi} - v_{Cit}\left(\frac{r_M}{r_C}\right)_t = \alpha_i + v_{Cit}\beta_t$$

where the i subscript denotes the states and the t subscript the period. Thus, he has $2*N$ observations (where N is the number of states). From these observations, he estimates $2*N+2$ parameters: one, a level of utilization, r_M, for each state and one trade-off factor, β, for each year.

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