Is Military Advertising Effective?

An Estimation Methodology and Applications to Recruiting in the 1980s and 90s

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This report documents research findings from a RAND project titled "The Relative Cost Effectiveness of Military Advertising," the goal of which was to develop and apply a methodology for assessing the cost effectiveness of the services' advertising programs and to provide guidance for a more efficient allocation of resources in the future. The project was sponsored by the Director for Accession Policy (Force Management Policy).

This report examines issues related to the effectiveness of recruiting advertising during the 1980s and 1990s. It describes the policy context, summarizes the current state of knowledge, and identifies several conceptual and methodological issues. In addition, it describes a framework developed for estimating advertising effects and how that framework was applied in an analysis of 1980s Army advertising programs. It also discusses how this methodology was used to analyze 1993–1997 DoD-wide information. The empirical results from the study strongly support the view that advertising has been a cost-effective recruiting tool and provide some guidance for future improvements. Data deficiencies and analytic challenges associated with recruiting environment complexity, however, made it impossible to determine the most effective mix of advertising. Nonetheless, the concepts and methods developed can help guide future advertising research, and the general policy conclusions regarding past advertising programs remain valid. Additional research is necessary if future allocations of recruiting resources, including advertising dollars, are to be made optimally.

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In recent years, the Department of Defense (DoD) has been spending more than $100 million annually on advertising to support recruiting. These expenditures are made through five programs, those of the four services and a joint advertising program.

Previous econometric studies of military advertising support the view that advertising has been effective in increasing numbers of high-quality enlistments—i.e., high-school seniors or graduates who score in the upper half of the Armed Forces Qualification Test (AFQT). However, these studies have relied on data from time periods with recruiting and advertising environments very different from those of today and used models that may be inappropriate for addressing the policy issues facing today's decisionmakers. This study develops improved methods and illustrates them by using data from the early 1980s and the mid-1990s.

In theory, advertising may confer tangible and intangible benefits on the military in both the near and longer terms. Our econometric analyses focused on short-term effects on a tangible, and crucial, outcome: numbers of enlistees. We addressed several policy issues:

- How effective has advertising been in increasing enlistments?

- What advertising media appear to be the most cost-effective?

- How much might recruiting outcomes be improved by reallocating total advertising budgets across media or over months within a year?

- How much could recruiting outcomes be improved if advertising budgets were increased?

Chapter Two provides an overview of trends in military advertising from 1986 through 1997. In nominal terms—i.e., before accounting for inflation—budgets for purchases of advertising time or space totaled about $120 million in both 1986 and 1997. In 1993, however, nominal spending was about one-half of that amount. To see what these budget trends have meant for the military's advertising purchasing power, we constructed a price index for advertising. This index shows that from 1986 through 1997, advertising prices increased much faster than the general price level did, as measured by the consumer price index (CPI). For example, while the CPI increased by 47 percent from 1986 to 1997, advertising prices increased by 79 percent. The difference was even more dramatic between 1993 and 1997: advertising prices increased by 45 percent while the CPI increased by only 11 percent. An upshot of these trends in advertising budgets and advertising prices is that the military's purchasing power for advertising declined by roughly 50 percent between 1986 and 1997.

During this period of generally declining purchasing power, allocation of the military's total advertising budget among the five programs shifted substantially. For example, between 1985 and 1995, the Army's share of the overall budget declined from 54 to 44 percent while the Navy's share increased from 12 to 28 percent. During the same period, the share of the joint program fell from 19 to 13 percent, and by the late 1990s, expenditures through the joint program had become insignificant.

Television accounts for more than 50 percent of DoD-wide advertising expenditures. The services also rely on radio, magazines, and newspapers. The proportion of the total budget allocated to each of these media has changed over time and varies considerably from program to program.

To develop improved conceptual and technical foundations for our study, we searched for promising ideas in various types of research literature. In addition to reviewing literature on military advertising, we reviewed literature in psychology, marketing, and economics pertaining to persuasion and to advertising for consumer products.

Insights from the psychology literature on persuasion suggested hypotheses about how advertising effects differ across advertising media. For example, the type of media may determine the most likely primary route through which advertising persuades—in particular, the "cognitive" versus the "emotional" route. We hypothesize, for example, that broadcast media (over-the-air and cable television, and radio) operate more through emotional responses than do the print media (magazines, newspapers). Further, the timing of the advertising in terms of where a young person is in the process of deciding whether to enlist may be very important for effectiveness. Emotional responses to broadcast advertisements might take the form of positive images of the military several months, if not years, before a youth must decide on his or her first career step after high school. In addition, emotional responses to advertisements might have quite immediate effects—for example, on youths who have already discussed options with recruiters—and may trigger enlistments within the same month as the advertisement is experienced or during the next few months. This timing, or "dynamics," of advertising effects can be very complicated and can differ fundamentally across advertising media.

We found that econometric literature on the effectiveness of advertising in promoting sales of consumer products provided limited guidance for our work. This is largely because the nonproprietary data typically available to researchers for studying consumer products are not nearly as rich as the data available for studying recruiting outcomes. In particular, military data are much less aggregated over time, media, and geographic areas than are data used in nonproprietary studies of consumer products. The econometric literature did, however, contain some potentially useful technical advances that can be applied in the military context.

A very influential, recent strand of the marketing literature on "brand equity" provided some insights more useful to advertising managers than for conducting econometric analyses of advertising effectiveness. In this literature, a brand name is viewed as an asset to be developed, protected, and carefully exploited through the use of advertising and other forms of promotion. General advice from this literature included: (a) attempt to create brand associations that give members of the target audience reasons to respond, (b) differentiate your brand from those of competitors, and (c) provide consistent

messages over time. More generally, this literature cautioned against sacrificing too much of a brand's value to promote short-term goals.

Econometric studies of advertising and military recruiting provided many lessons for developing more appropriate methods. Even the most recent studies employed, generally with some modification, methods developed in RAND work during the 1980s. The more recent studies involved some advances over and some retreats from the strengths of the earlier RAND approach. However, previous econometric studies of advertising and military recruiting were undermined by one or more of the following weaknesses in the data or the econometric models employed:

- Too much aggregation of advertising data over time, space, or media.

- Functional forms that force the estimates to conform to implausible patterns.

- Dynamic specifications that are overly restrictive.

- Failure to take into account that if advertising makes a recruiter's task less difficult, levels of recruiter effort are likely to adjust.

Our study paid substantial attention to each of these issues in a reanalysis of Army data from the early 1980s; specifically, July 1981 through June 1984. The econometric methods incorporate—at the cost of introducing considerable complexity—more defensible functional forms and dynamic patterns. Regarding functional form, our specification allows for two phenomena widely believed to characterize advertising effects on sales: threshold levels of advertising activity below which advertising has essentially no impact, and saturation levels of advertising activity above which additional activity has essentially no impact. This pattern of responses is widely referred to in the advertising literature as an "S-curve" because a plot of sales versus advertising intensity has the shape of a logistic curve (an elongated and tilted "S"). Regarding dynamics—i.e., the time patterns of advertising effects—our specification allows different media to exhibit different patterns of effects on enlistments and is very flexible regarding patterns for the first two months after advertisements reach their target audiences.

Application of the new econometric specification to the Army data for the early 1980s provided several new insights. First, the parameter estimates imply S-curves for different media that suggest both threshold and saturation effects that are highly relevant to military advertising managers. Second, the S-curves for alternative media are very different, and these differences correspond well to observed patterns in how use of alternative media relates to an organization's advertising budget, both in the consumer-product and military-recruiting contexts. Third, the dynamic patterns of effects for different media differ greatly. For example, most of the effects of television advertising on high-quality enlistments occur during the month of the advertisements or during the next month, with the within-month effect being the largest; and the effects of radio and magazine advertisements are relatively small during the first month but increase over the following two months. Fourth, while the actual allocations of spending across media are similar to the allocations that are optimal according to our estimates, our estimates also suggest that a reallocation across media could have improved recruiting outcomes by roughly 5 percent. Fifth, a 5 percent increase in advertising budgets (most of which would have been best allocated to television) might have produced a 5 to 8 percent increase in high-quality enlistments.

Efforts to reestimate these models using data for all services for fiscal years (FY) 1993 through 1997 were hampered by data deficiencies as well as conceptual challenges stemming from the existence of what is now a more complex recruiting environment. In particular, a strong economy, evolving attitudes concerning military service, increased competition among the services, and significant changes in recruiter management all tended to complicate the analysis. Efforts to replicate the new analysis of the Army data from the early 1980s, using the same conceptual models, failed to produce sensible results. However, models focusing on DoD-wide enlistments, using advertising spending aggregated across services and media, and involving less complex dynamics provided sensible results that are broadly consistent with findings from earlier time periods.

As was the case for the early 1980s, advertising appears to have been effective in increasing enlistments during the middle and late 1990s. However, actual budget allocations fell short of the levels at which

advertising is most cost-effective. Indeed, real budgets approaching those that prevailed a decade earlier could have considerably improved recruiting outcomes. In addition, advertising could have been made more cost-effective by changing the media mix—specifically, by using television more extensively—and concentrating expenditures in a few months each year rather than spending more evenly over all months. For higher budget levels, however, smoother levels of advertising activity over a year would be more appropriate, because larger budgets can enable the services to overcome threshold levels and achieve cost-effective levels of advertising productivity in each of several months of the year.

Although all four services appear to have gained considerably from advertising, the Navy appears to have benefited the most. Additional advertising appears not to have substantial differential effects during different seasons of the year or on the gender or age mix of enlistees. However, additional advertising appears to decrease slightly the fraction of high-quality men among all enlistees.

Using the econometric results, one can compute marginal cost estimates to compare alternative policies. For example, when sample mean values were used, the marginal cost of gaining one additional enlistment by adding recruiters was found to be about $15,565 per enlistee from 1993 through 1997. In contrast, the marginal cost of gaining one additional enlistment by increasing military wages was much higher—more than $70,000. Marginal costs via advertising averaged about $26,000 over the time period, which exceeds the marginal cost via recruiters. The marginal cost via advertising appears to have increased significantly relative to that of the early 1980s. This is partly the result of increases in the real price of advertising, but more importantly, it is primarily the result of lower advertising budgets that have moved expenditures to less effective (less steep) portions of advertising S-curves. Indeed, at twice the actual advertising budget for the 1990s—a level comparable to real advertising levels during the 1980s—marginal costs could have been less than $6,000 per enlistee. This level of marginal cost is closer to those costs estimated for the 1980s. In sum, in comparison with other alternatives, advertising appears to have great potential as a recruiting tool.

ACKNOWLEDGMENTS

INTRODUCTION

During the late 1990s, the Department of Defense (DoD) spent more than $100 million annually on advertising programs in support of military recruiting. These expenditures were made through five programs, those of the four services and a joint service program (Joint Recruiting Advertising Program, or JRAP). Historically, the Army has received the largest share of these dollars, averaging about 50 percent of the overall advertising budget. Over all programs, about 50 percent of media purchases were for television advertising, with the remainder spent on radio, magazine, and newspaper advertising. There has been considerable year-to-year variation in total spending, in the shares of these totals going to the different programs, in the timing of expenditures within years, and in the media mixes chosen by the individual services.

These patterns suggest that advertising managers struggle with several policy decisions. The goal of our research was to provide information to help inform these decisions. Optimal advertising policies have several aspects, or dimensions, including: How large should the overall budget be? How should this budget be allocated among the various programs? What are the best media mixes and the best seasonal and geographic allocations of expenditures?

Optimal advertising policies depend on the relative importance of multiple, sometimes conflicting, policy objectives. For example, advertising can enhance recruiting in the short run by providing information about current opportunities for job training and college benefits. But advertising can also establish a foundation for future recruiting by cultivating positive images of and perceptions about

military service. In addition, although larger investments of advertising dollars in geographic areas with the highest marginal returns to enlistments would increase national-level enlistments, more equal allocations of advertising expenditures across recruiting districts might be needed to achieve equity for recruiters and potential recruits. Indeed, some services have at times allocated extra advertising dollars to areas where recruiters were struggling with their missions, even though these dollars might have had larger returns in areas where recruiters had been more successful. The services may also have other important goals, such as improving the morale of current personnel, which in turn could have tangible benefits associated with better job performance, lower attrition, and higher re-enlistment rates.

In sum, recruitment advertising may affect various important outcomes in the short and longer terms. This report, however, focuses on enlistment outcomes in the relatively short term, because of the importance of these outcomes and the fact that they are the most tangible, measurable outcomes available. Moreover, use of this performance measure allows us to compare advertising and alternative uses of budgetary resources, such as bonuses, college benefits, pay, and recruiting personnel. And it enables us to perform cost-effectiveness analyses necessary for rationalizing and defending budget allocations.

Several important research questions concerning the effects of advertising on enlistments are addressed in this report: How much does advertising increase enlistment rates? Are the enlistment effects of advertising largely immediate, or are they delayed for several months? At current spending levels, what are the relative marginal costs of attracting a small number of new recruits using different media? How would these relative marginal costs change as budget allocations are changed? What is the optimal allocation of dollars to different media, and when is the best time to spend those dollars? In addition, the report compares the cost effectiveness of advertising with that of expenditures on other recruiting resources (such as military pay and recruiting personnel).

Chapter Two provides an overview of military advertising. Chapter Three summarizes and draws lessons from previous research on advertising effectiveness, including several recent studies on military

recruiting. Chapter Four describes the enlistment process, considers potential roles for advertising in influencing that process, and discusses conceptual and technical challenges to estimating advertising effectiveness. Chapter Five describes the early 1980s Army data we used to develop improved methods for estimating the effects of advertising on enlistment outcomes. Chapter Six then proposes a new econometric approach that addresses many, but not all, of the challenges discussed in Chapter Four. Chapter Seven applies this approach to the early 1980s Army data. Despite data deficiencies and the conceptual challenges posed by a rapidly changing recruiting environment, an analysis of advertising during the 1990s is described in Chapter Eight. Chapter Nine concludes the main report by describing the implications of our findings for advertising policy in the future. An appendix describes model specification tests and time period comparisons.

OVERVIEW OF MILITARY ADVERTISING

This chapter provides an overview of military advertising. The budget figures presented are expenditures by the five advertising programs (one for each service, and one joint-service program) to purchase advertising time on broadcast stations (over-the-air and cable television, and radio) and space in print media (newspapers and magazines). These figures exclude administrative costs, advertising agency fees, and costs for special events or promotions.

Figure 2.1 shows nominal total advertising expenditures for 1986, 1993, and 1997. As can be seen, military advertising purchases totaled $120 million for all five programs in 1997. Since then, purchases have held fairly steady. Nominal, or current-dollar, expenditures were at about the same level in 1986 but were much lower in 1993. Indeed, the 1993 budgets totaled less than $50 million dollars, a substantial difference.

The composition of advertising over time has also changed substantially. For example, while the Navy's share of total advertising increased, expenditures through the joint program declined.

These simple comparisons do not enable us to infer "cause and effect," but it is noteworthy that enlistment propensities also declined over this time period. And, as is shown below, ample evidence suggests that reductions in advertising may have played a pivotal role.

Of course, changes in nominal, or current-dollar, advertising purchases do not accurately reflect changes in advertising buying power unless advertising prices (e.g., the price to air a 30-second television commercial reaching one million viewers or for a one-page adver-

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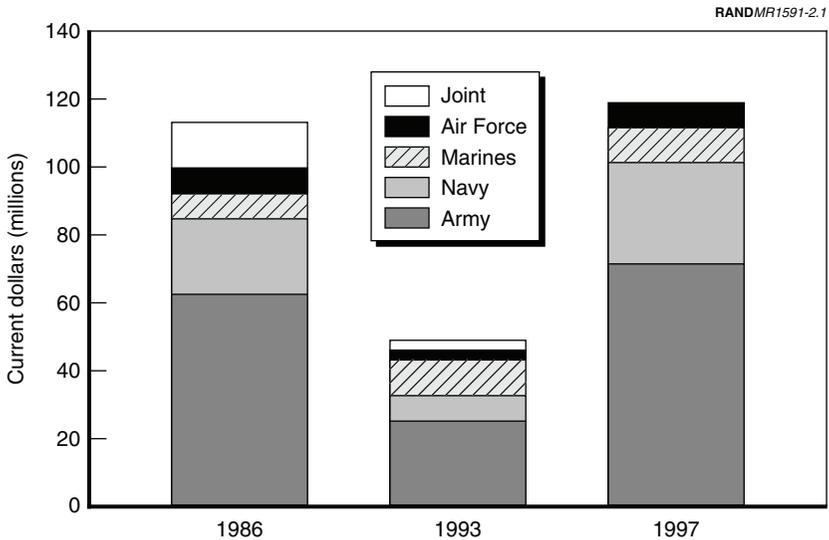
Figure 2.1—Nominal Expenditures on Military Advertising in 1986, 1993, and 1997, by Program

tisement in a newspaper with a circulation of one million) have remained constant. In fact, prices charged by broadcast stations and print media for advertising insertions[1] increased dramatically from 1986 to 1997.

Table 2.1 presents for 1986, 1993, and 1997 a standard index of the overall price level (the consumer price index, or CPI) and an advertising price index that we constructed. The latter is based on the actual media mixes in 1997 for the four services using data on cost per thousand "impressions" (CPMs)—i.e., cost per thousand people exposed to the advertisements—obtained for the whole period for broadcast and cable television, newspaper, magazine, and radio advertising.

Both of these indexes are normalized to equal 1.00 in 1997. Table 2.1 indicates that advertising prices increased much more rapidly during the period than consumer prices did. For example, from 1986 to

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[1]Television Bureau of Advertising, http://www.tvb.org/tvfacts/trends/media.

Table 2.1

Costs of Advertising in 1986, 1993, and 1997

Year	Consumer Price Index	Advertising Price Index
1986	0.68	0.56
1993	0.90	0.69
1997	1.00	1.00
% Change 1993–1997	11%	45%
% Change 1986–1997	47%	79%

1997, the advertising price index increased from 0.56 to 1.00, or by 79 percent (i.e., [1.00/0.56] = 1.785), while the corresponding rate of increase for consumer prices was 47 percent.

As a result of these increases in advertising prices, the purchasing power of the military advertising budget declined significantly after 1986. In fact, as Figure 2.2 shows, in terms of real dollars, the purchasing power of the military advertising budget had fallen by about 60 percent by 1993. Even with the substantial increases in the nominal advertising budget after 1993, the purchasing power of the 1997 budget was only about 60 percent of that in 1986. Thus, it would not have been surprising, all things being equal, to have experienced a decline in enlistments over this period.

Shares of total advertising expenditures allocated to the five programs changed considerably over this period as well (see Figure 2.3). Between 1985 and 1995, the share of the total budget allocated to the Army program fell from 54 to 44 percent. The joint program share fell by about one-third during the same period and then continued to shrink until, by the late 1990s, it was virtually nonexistent. While the Army and joint shares declined in relative terms, the Navy share increased from 12 percent in 1985 to 28 percent in 1995.

Thus, after years of relative stability, the resource shares flowing to the different services changed significantly from the mid-1980s to the mid-1990s. This suggests that the role of inter-service competition may be important for understanding changes in the enlistment outcomes of the individual services.
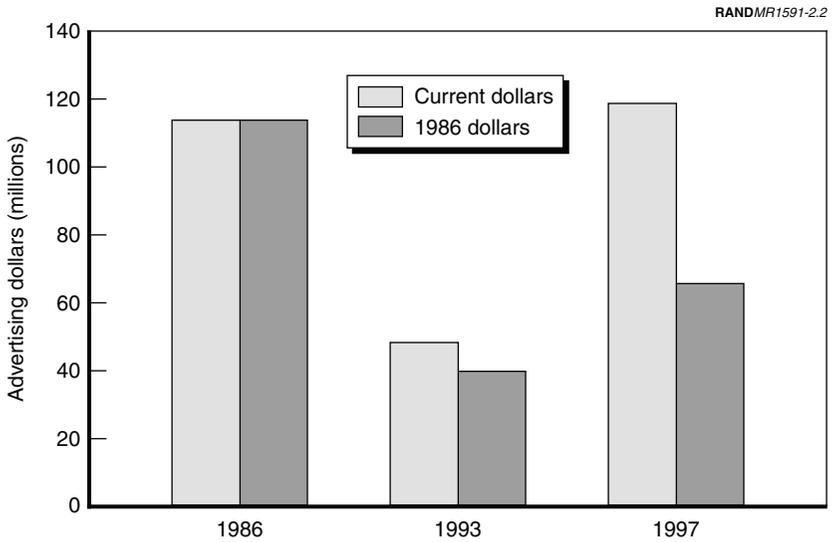
Figure 2.2—Nominal and Real Advertising Budgets for the Four Services in 1986, 1993, and 1997
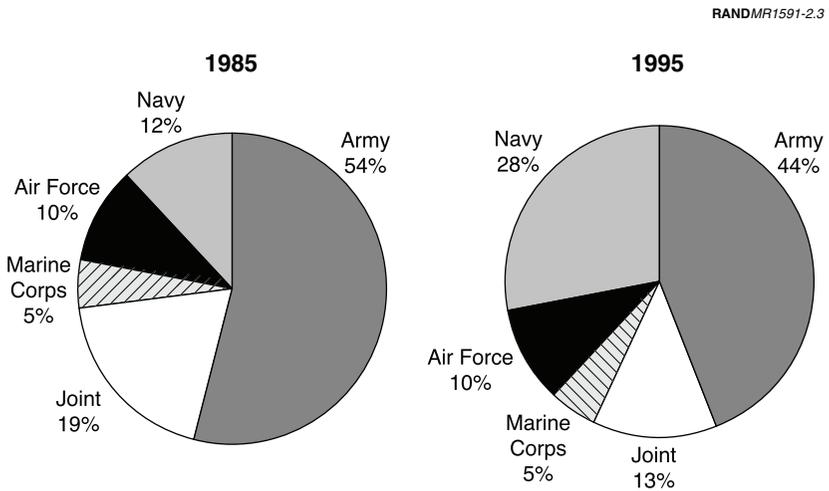
Figure 2.3—Shares of Advertising in 1985 and 1995, by Program

Table 2.2 presents data describing the 1997 distributions of advertising budgets among various advertising media. Just over 50 percent of the total budget went to television, but the degree to which the different programs relied on this medium differed greatly. The Army favored television advertising the most, spending a bit more than 60 percent of its budget for this purpose. In contrast, the Air Force spent no money on television advertising time in 1997, continuing its historic pattern.[2]

In many cases, the five programs now rely on very different media mixes than they did during the 1980s. For example, while the Navy currently spends a significant portion of its budget on television, this was not always the case; indeed, during the 1980s, the Navy relied primarily on radio. The Air Force, which spent half of its budget on radio in 1997, relied primarily on magazines during the 1980s. The joint program used to have a significant presence on television, but its more recent budgets have been too small to justify substantial reliance on this medium. In recent years, most of the joint budget has gone to direct-mail purchases.

Clearly, policymakers, in addition to setting the size of the overall budget and allocating that budget amount to competing DoD and service programs, must decide which media to use and to what extent. The appropriate allocations may depend on a variety of factors, including the total program budgets.

Table 2.2

Media Shares of Advertising Programs in 1997
(percent)

	Army	Navy	Air Force	Marines	Joint	Total
Television	61	47	0	45	5	52
Radio	8	13	50	1	0	11
Magazines	9	6	0	4	0	7
Local	16	25	32	10	0	18
Other	6	9	18	41	95	12
Total	100	100	100	100	100	100

NOTE: Sum may not equal 100 because of rounding.

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[2]In more recent years, however, the Air Force has taken advantage of increased budget levels to buy television broadcast time.

Military advertising expenditures also exhibit pronounced seasonal patterns. Figure 2.4 summarizes these patterns for all four services for FY 1997, expressing monthly advertising expenditures relative to the monthly average. Thus, the index value of 1.00 for October means that expenditures in October were at the average level for the year. The peak months are at the beginning of the calendar year, with a trough occurring during the summer. For example, July's spending was less than 40 percent of January's.

Seasonal patterns occur for several reasons. First, the annual budgeting cycle limits the ability to spend at the beginning of the fiscal year and may create incentives for advertising programs to commit funds when they are received. In addition, the spending patterns are chosen in part to maximize target-audience impressions per dollar. For example, the National Football League (NFL) playoffs in January and the National Collegiate Athletic Association (NCAA) basketball tournament in March provide large, male-dominated television audiences. According to conventional wisdom, this is also

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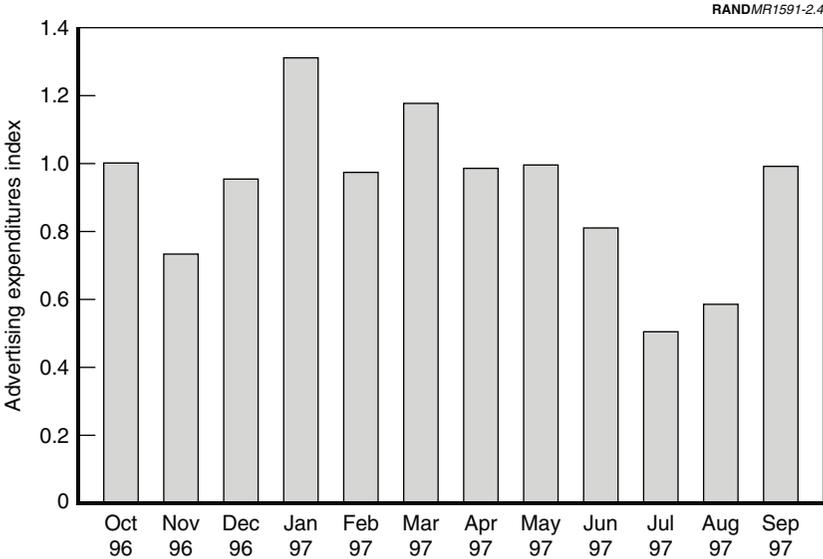
Figure 2.4—Seasonal Patterns in Advertising Expenditures for the Four Services in FY 1997

the time of year that the process of youth career decisionmaking starts. That is, many people believe that high-school seniors begin to consider career options early in the calendar year, and that television advertising at this time can make them more receptive to enlisting in the near future. Indeed, television advertising is thought to make potential recruits more interested in receiving the detailed information provided by print media and recruiters at the points of decision that occur months later. Finally, the pattern of expenditures reflects the need to smooth out accessions so that training capacity is fully used. Since accessions are relatively difficult to achieve during the school year, extra advertising dollars during the winter may help smooth out seasonal enlistment flows by reaching the graduate market, which is a harder target.

Since the vast majority of advertising dollars are spent on national media, geographic variation in the intensity of advertising penetration may be limited. However, local differences in the audiences attracted to network programming create some natural variation in the effective geographic allocation of impressions. For example, the television broadcast of the Super Bowl game between the New York Giants and the Baltimore Ravens in January 2001 attracted many more viewers (as a percentage of total audience) in the New York and Baltimore markets than it did elsewhere. However, national advertising is not the most effective way to target those local markets where incremental advertising dollars are likely to have the highest payoffs. It is, of course, possible to target broadcast messages to local audiences by placing advertisements directly with local television stations—i.e., the "spot" market—or with cable television operators. Though this approach is expensive on the basis of rate per audience, the increased costs could be justified in terms of cost effectiveness if some markets are more "receptive" to advertising or if aggregate budgets are not large enough to provide the nationwide frequency of advertising exposures required to elicit changes in enlistment behavior.

In sum, historic patterns of expenditures suggest several research questions:

• What are the enlistment effects of recruiting advertising generally?

- In terms of the marginal costs of enlistments, how does advertising compare with policy alternatives such as college benefits, pay, and recruiting personnel?
- How do these effects vary by program, and what are the interdependencies?
- Do effects differ by demographic segment—for example, high-school seniors versus graduates?
- How do effects vary by season and geographic area?

LITERATURE REVIEW

We reviewed literature related to advertising in psychology, marketing, and economics, as well as studies of advertising effectiveness in military recruiting. Insights from these materials helped us to develop new conceptual foundations and econometric specifications for estimating how recruiting advertising affects enlistment and for assessing the cost effectiveness of such advertising.

The empirical literature on advertising effectiveness in promoting sales of consumer products has generated more controversy than consensus. Most fundamentally, sometimes advertising is found to be effective and sometimes it is not.

It is very difficult to estimate reliably the sales effects of advertising. Major analytic challenges include the fact that sales depend on numerous factors other than advertising, such as product quality, price, and the price and quality of substitute products. Also, to infer the effect of advertising on sales, one must account for reverse causation. That is, given that private-sector advertising budgets are often set on the basis of sales (for example, as a fixed percentage of sales), one must use statistical methods (such as instrumental variables) capable of disentangling the effects of advertising levels on sales from the effects of sales on advertising levels.

In addition, advertising's effects on sales can be very complex. In many contexts, it is to be expected that advertising affects sales over extended periods. For example, for infrequently purchased products, such as automobiles or other consumer durables, advertising builds a reputation for high quality, which translates into higher sales only as different buyers enter the market for that type of product.

Moreover, advertising may have virtually no detectable effect unless enough potential buyers are exposed to the advertising messages (i.e., advertising's "reach" is sufficient), or particular potential buyers are repeatedly exposed to a sufficient number of messages (i.e., advertising's "frequency" is sufficient), or both. If this is so, the advertising/sales relationship could involve thresholds—i.e., levels of advertising activity below which advertising has essentially no effect on sales. At the other end of the spectrum, as the same buyers are exposed to more and more repetition in advertising messages (frequency increases, but not reach), additional messages may have no additional effect on their behavior, in which case advertising is said to have reached a saturation level.

Despite the difficulty of estimating advertising effects, a massive body of literature attempts to do so in various ways. We reviewed many such studies and various theoretical discussions of advertising effectiveness, our aim being to identify promising theoretical perspectives and empirical approaches as well as potential pitfalls. Studies were located with the aid of electronic searches of various databases indexing journal articles and monographs in fields such as marketing, economics, and psychology.

The studies most helpful for our purposes fell into four categories: theories of "persuasive communication" in social psychology developed with the aid of laboratory experiments; econometric studies of advertising/sales relationships for consumer products; relatively new and very influential literature on "brand equity"; and recent empirical studies of military recruiting advertising.[1]

ADVERTISING AND THEORIES OF PERSUASION

To formulate econometric models of the effects of military advertising, it is helpful to consider the underlying processes by which advertising may change the behavior of the young people that the services seek to enlist. While there is extensive theoretical literature on advertising in economics and marketing, we found most of it to be of

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[1]We also collected and reviewed many discussions by practitioners of institutional issues in advertising and views about advertising effectiveness. A notable, albeit somewhat dated, example is Bogart, 1995.

little help for this purpose. For example, such studies often focus on issues not relevant to recruitment advertising (e.g., repeat purchasing) or start with assumptions that represent the underlying behavioral processes without describing or illuminating them.

The theoretical literature we found most generally applicable—and therefore most helpful—was social psychology literature focusing on persuasion. Sources we found particularly useful were Petty and Cacioppo, 1981; McGuire, 1985; MacInnis, Moorman, and Jaworski, 1991; and Lord and Putrevu, 1993.

The persuasive communication literature emphasizes that advertising changes behavior by changing attitudes. It also emphasizes that while attitude change is necessary to change behavior, it is hardly sufficient. For example, McGuire (1985, p. 259) conceptualizes the process linking communication of a message to a behavioral response as twelve steps (e.g., attending to the message, agreeing with it, storing information in memory, retrieving the information, using the information to aid decisions, and taking action).

This literature also points out that changes in attitude that trigger changes in behavior may or may not involve much thinking by the recipient of the message. Some authors distinguish "cognitive" and "emotional" responses to messages; Petty and Cacioppo (1981) prefer to think in terms of "central" and "peripheral" routes to attitude change. The literature also suggests that the extent to which a response to a message is cognitive depends on the extent to which the recipient of the message has the opportunity, motivation, and ability to process the information it contains.

We find these insights useful for theorizing about the differential effects of different media. Specifically, we expect print (newspaper, magazine) messages to involve more cognitive responses than broadcast (television, radio) messages do.[2] This expectation is based on the fact that recipients often encounter print messages when not preoccupied with other tasks (as many are during a television commercial break or while hearing a message on a car radio) and therefore have a relatively good opportunity to process the information.

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[2]This hypothesis is suggested by several authors. For example, Chaudhuri and Buck (1995) state it in relatively similar terms and cite several other works.

Moreover, the motivation to process the information conveyed by a print recruiting advertisement may often be relatively high—take, as an extreme example, the case of a young person looking for a job who sees a classified newspaper advertisement. Finally, the ability to process information is likely to be relatively high with print versus broadcast advertisements, because while the information in a broadcast advertisement can be very fleeting, a print advertisement can be studied, stored, and referred to at a later date.

The literature on persuasive communication provides an abstract, and powerful, way of thinking about crucial issues for our purposes: Should we expect the timing (or dynamics) of advertising effects to differ substantially across media and, if so, how? From the hypothesis that emotional responses are very important for broadcast messages, we infer that broadcast advertisements can contribute to enlistment goals in a complex and indirect manner. More specifically, broadcast messages may create attitudes (such as that the military is an attractive career option) that make young people attend to print advertisements months (or even years) later when they are prepared to make early-career choices. But broadcast messages may also provide an emotional impetus that induces a youth to promptly sign an enlistment contract that he or she has been discussing with a recruiter or military job counselor. Thus, broadcast messages may have both long-delayed and almost immediate effects on enlistments.

In sum, the timing with which advertisements disseminated during a particular month may increase enlistments in the future should be expected to differ substantially across media, and some patterns are more plausible than others.

ECONOMETRIC STUDIES OF CONSUMER-PRODUCT ADVERTISING

We also reviewed several econometric studies of advertising effectiveness for consumer products as well as reviews of this literature.[3] The results of these studies vary widely, some suggesting that adver-

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[3]Dertouzos and Polich (1989) review several studies published at the time they wrote. Particularly useful literature reviews are also provided by Berndt (1991) and by Hanssens, Parsons, and Schultz (1990).

tising is very effective, others suggesting it is a waste of money. Among the studies that find advertising to have positive effects on sales, some suggest that the effects are very short lived while others suggest the opposite. To a large extent, the diversity of conclusions likely reflects the fact that advertising is sometimes effective and sometimes not, and that when it is effective, the timing (or dynamics) of the effects can differ greatly from situation to situation.

We also suspect that much of the diversity in results reflects methodological weaknesses in the studies. Some weaknesses are inherent in the restrictive assumptions of the econometric models used, such as failing to allow for delayed effects, failing to control for determinants of sales other than advertising, and restricting the shape of the advertising/sales relationship in implausible ways. For example, in his study of advertising effects on residential electricity sales, Lyman (1994) used a flexible functional form—the Box-Cox function—that has some attractive features. But entirely implausibly, he restricted the form of the function (i.e., the value of the Box-Cox parameter) by making it the same for roughly 20 different advertising and non-advertising determinants of sales.

In most studies, the aggregate nature of the available data is a major problem. Data are often highly aggregated over advertising media (e.g., television, magazines, newspaper), space (e.g., entire countries), and time (e.g., quarters or years). In a recent study by Duffy (1996), data are aggregated over all cigarette brands of all sellers and over all advertising media.

The time aggregation issue has been the subject of much research. The research indicates that estimates of advertising effectiveness can be greatly distorted if the advertising data are aggregated over periods (e.g., quarters, years) longer than the periods (e.g., months) for which decisions about advertising spending levels are made. Some particularly useful analyses of this issue are in Russell, 1988, and Tellis and Weiss, 1995. The latter concludes (albeit from an analysis of data for a single consumer product) that aggregation over time and households may cause one to infer—incorrectly—that television advertising increases sales in the current period.

Fortunately, the data available for our study were disaggregated to the monthly level, which appears to be within the same period used

by the services to make their advertising spending decisions. In addition, our data were disaggregated by medium and by geography (i.e., into several dozen recruiting districts).

Our review of the literature found virtually no econometric work attempting to distinguish the effects of different media, which is a major policy issue in the military context. The one exception was Seldon and Jung, 1993, which disaggregates advertising into four categories: broadcast (television and radio), print (e.g., newspapers and magazines), direct mail, and all other (e.g., billboards). Unfortunately, the level of aggregation over products—i.e., all advertised products in the U.S. economy—makes the results of almost no substantive relevance to our purposes. Consistent with our inability to locate any other econometric studies of the relative effectiveness of different media, Seldon and Jung (1993, p. 71) report: "we have been unable to find studies in the previous literature which addresses [sic] substitutability among the advertising media."

In sum, the econometric literature provided us with little in the way of substantive lessons to apply in the military context (e.g., that advertising effects can be presumed to be exhausted within a few months or that the effects of different media can be presumed to be similar). This literature did, however, provide a wealth of methodological guidance, such as a variety of potential functional forms, dynamic specifications, and strategies for econometric estimation and inference.

BRAND EQUITY

A very influential, recent strand of the marketing literature views a brand name as an asset to be built and protected through use of various promotional and marketing tools. Accounts of this "brand equity" concept that we found particularly helpful are by Aaker (1991) and Keller (1993). For our purposes, a brand could be viewed as the U.S. military generally or as any one of the individual services.

Some key dimensions of brand equity are brand awareness, which encompasses brand recognition and brand recall, and brand image, which refers to associations mentally linked to the brand (such as perceived quality). As for advertising—seen as one of the tools that can build and protect brand equity—the brand-equity literature em-

phasizes that past advertising can help build a brand name, which in turn makes current promotional and marketing tools more effective. The literature also provides practical advice to marketers:

- Attempt to create brand associations that give members of the target audience reasons to respond.

- Differentiate your brand from that of competitors.

- Provide consistent messages over time.

A very important lesson we inferred from this literature is that much of the beneficial effect of advertising on enlistments could come through building and protecting brand equity even though such long-lived effects are expected to be very hard to isolate empirically. To the extent that other recruiting tools (e.g., bonuses, extra recruiters) are less likely to have long-lived effects, this potential advantage of advertising should be kept in mind in assessing the relative cost effectiveness of different tools.

If we shift from an evaluation to a resource-management perspective, the brand-equity concept may also suggest that focusing on short-term enlistment goals in setting advertising policies could be very costly in the longer term.[4] In our context, the relatively low levels of advertising during the mid-1990s (Figure 2.2), for example, may have had long-term negative effects on recruiting opportunities in subsequent years.

RECRUITING ADVERTISING RESEARCH

RAND Research in the 1980s

In the late 1980s, two RAND studies (Dertouzos and Polich, 1989; Dertouzos, 1989) took advantage of an unprecedented opportunity to evaluate advertising using data much more detailed than the data generally available to researchers studying consumer products.

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[4]For example: "the overall conclusion . . . must be that it is long-term commitment to advertising quality that builds brand franchise" and that the "conclusions lend weight to the view that too many business decisions are made against short-term priorities" (Hollis, 1990, p. RC12).

Dertouzos and Polich (1989) analyzed the effectiveness of Army advertising. Detailed information on advertising purchases by medium was compiled on a battalion-by-battalion basis for a three-year period (July 1981 through June 1984). Although there was no experimental design, local advertising representatives were allowed to exercise considerable discretion in allocating their budgets among local media (primarily radio and daily, weekly, and high-school newspapers). As a result, the choices for local advertising varied considerably. In addition, local variation in the audiences for national programming led to variations in the effect of national advertisements.

In addition, 1984 budget proposals called for decreases in overall advertising budgets and reallocation of advertising dollars away from the services and to the joint program. A controversy resulted, leading to the congressionally mandated 1984 Advertising Mix Test, which dramatically altered advertising budgets within control and experimental groups. The allocation between the joint and the service-specific budgets was the primary focus of the planned evaluation, so the experimental design did not enable evaluation of effects of different allocations of total advertising budgets across media. The results of the RAND evaluation of the Advertising Mix Test are reported in Dertouzos, 1989.

Several important conclusions emerged from the 1989 study by Dertouzos and Polich. First, increases in Army advertising had pronounced effects on enlistments in the short run. These effects seemed to persist beyond the initial month, although they diminished over time. In addition, cost effectiveness varied by medium. For example, over the range of spending observed, print media (national magazines, newspapers) appeared to be especially cost-effective. The cost effectiveness of local radio was less clear because of imprecision in estimating the associated parameters. Finally, in terms of the estimated marginal cost of enlistments, the value of advertising compared very favorably with that of other options, such as military pay and bonuses. Specifically, advertising appeared to be roughly three times as cost-effective as other options.

The Advertising Mix Test also provided some useful policy lessons. Overall, Dertouzos's findings (1989) were remarkably consistent with those from the Army data analysis. Most fundamentally, advertising

appeared to have expanded enlistments significantly. Furthermore, these enlistments did not appear to come entirely at the expense of the other services—i.e., advertising by an individual service expanded the entire market available to the services in combination. In fact, advertising by the Army and Air Force appeared to help the other services. In particular, the market expansion effects of a service's incremental advertising were estimated to benefit the other services more than the competitive effects cost them. It also appeared that joint and service programs were, on average, similarly effective.

Other Studies of Recruiting Advertising

Three of the four most relevant studies (of which we are aware) were done for the Navy and focus on Navy recruiting. The fourth was done for the Defense Manpower Data Center (DMDC) and considers recruiting outcomes for the Army, Navy, Marine Corps, and Air Force. We describe the methods and findings of these studies.

Warner, 1991. In the first of the four studies, Warner (1991) uses a model patterned in some ways after earlier RAND work (Dertouzos, 1985; Polich, Dertouzos, and Press, 1986). More specifically, Warner's model of high-quality Navy enlistments allows for recruiters' effort levels to adjust according to the difficulty of meeting recruiting goals, and a log-linear functional form is used. Warner's data, however, are much more aggregated—both over time and media—than are those used in the RAND work. Moreover, because the data are annual, the model does not allow for any lagged effects of advertising on recruiting outcomes. An innovation in the Warner study is explicit incorporation of an interaction between (logarithms of) advertising levels and numbers of recruiters. Among other things, this allows the estimates to imply that the marginal productivity of recruiters is more sensitive to the level of advertising than is implied by a log-linear specification. Warner concludes that Navy advertisements are effective as a recruiting tool; in fact, he concludes that Navy advertisements are at least as cost-effective as additional recruiters are. He does not find evidence that advertising through the joint program is effective in increasing Navy enlistments, nor does he find empirical support for an explicit interaction between advertising levels and numbers of recruiters.

Schmitz and Boyer, 1993. Schmitz and Boyer (1993) studied total high-quality male contracts using monthly data for about three years. They consider both Navy and joint advertisement spending on disaggregated national media, but in analyzing the effects of national advertising spending, they ignore levels of spending on local newspapers and local radio. This study is difficult to describe or evaluate because the write-up of the econometric analysis omits many details of the methods and results. It seems, however, that the advertising spending data are aggregated geographically (i.e., to the level of recruiting districts), that greater-than-one-month lagged effects of advertising on contracts are assumed away, and that the reported estimates (i.e., for the "final model") result from a stepwise statistical procedure that is not described. This last feature makes it difficult to develop a sense of the level of statistical confidence that should be attached to their estimates. The reported estimates (their Table A-4) suggest that Navy and joint magazine advertisements are effective in increasing high-quality contracts, but they also suggest that increased spending on joint television advertisements and Navy radio advertisements actually decrease high-quality contracts.

Hogan, Dall, Mackin, and Mackie, 1996. In this study, for the Navy, the advertising data are very strong: monthly data for four years, disaggregated by 31 recruiting districts and four advertising media. The authors also consider two alternative functional forms and three alternative specifications for the time, or dynamic, effects of advertising. Their geometric decay (or constant depreciation rate) specification, which was also used in the earlier RAND work, involves imposition (rather than estimation, as in the RAND work) of the value of the parameter determining the rate at which stocks of goodwill due to advertising depreciate. They also consider a polynomial distributed lag specification, which we think is promising and have not seen in other analyses of advertising's effects on recruiting. Finally, they consider the possibility that television advertising impressions are jointly determined with enlistments because advertising spending is determined partly on the basis of recruiting outcomes, and they use an econometric procedure designed to take this possibility into account. They conclude that Navy advertising in all four media examined is effective in increasing high-quality enlistments, although the relative effectiveness of different media is sensitive to the choice of econometric specification. Most of their estimated elasticities of

high-quality enlistments with respect to advertising spending are in the range of 0.02 to 0.04, with the estimated elasticities for joint magazine advertising considerably smaller (their Figure 4.2).

Warner, Simon, and Payne, 2001. This study analyzes determinants of high-quality enlistments for the four services using state-level, monthly data for the 10 years from FY 1988 through FY 1997. The authors focus on the effects of enlistment incentives, not advertising, but they use rich data on advertising (that are discussed below and employed in our study) and conclude that

- "Advertising had a significant impact on high-quality Army and Navy enlistments" (p. v).

- "There was no evidence that Marine Corps or Air Force advertising has positive effects on high-quality enlistments" (p. vi).

This study was of particular interest for our purposes because it considers all four services, relies on the same advertising data we employ, and draws rather strong conclusions. We believe, however, that its conclusions about advertising effects should be treated with caution because of some specification choices driven by the study's central aims.[5] Most importantly, in modeling advertising effects, the study relies on strong assumptions about both functional form and dynamics (i.e., how lagged effects are permitted to enter). Our own analysis of these data indicates that the results are extremely sensitive to these assumptions.

Regarding functional form, Warner, Simon, and Payne (2001) enter advertising variables (expenditures or impressions) in logarithmic form. Such a specification imposes the restriction that an increase in advertising of a given amount would produce the same percentage increase in high-quality contracts regardless of the baseline level of advertising. Regarding the timing of advertising effects, the authors make two assumptions: (1) for all three of their specifications, they assume that an increase in advertising in a particular month would

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[5]For example, the authors write: "The emphasis in this study was finding broad patterns in the data rather than in finding the most accurate fit between enlistments and advertising" (Warner, Simon, and Payne, 2001, fn. 89, p. 97).

have no effect on enlistments during that same month;[6] and (2) for their first specification[7]—the only one for which estimated effects are reported[8]—they assume that an increase in advertising in a particular month has the same effect on recruiting outcomes in each of the following 11 months. Given the sensitivity of the estimates to specification choices, further research is needed before policymakers can use this study's advertising estimates with confidence.[9]

SUMMARY

Econometric analyses of effects of advertising on recruiting outcomes leave many questions unanswered. Some studies conclude that advertising is not effective, but earlier RAND work and more recent studies for the Navy conclude the opposite. We think that the differences in conclusions are likely to stem to a considerable extent from the studies' different analytic approaches. In particular, all of the studies are undermined by one or more of the following weaknesses in the data or models employed:

- Too much aggregation of advertising data over time, space, or media.

- Functional forms that force the estimates to conform to implausible patterns.

- Dynamic specifications that are overly restrictive.

- Failure to account for the fact that if advertising makes a recruiter's task less difficult, the recruiter's effort level is likely to adjust.

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[6]As we report in the Appendix, the contemporaneous level of advertising, when entered in logarithmic form, has a significant but negative coefficient.

[7]"[This] alternative defined advertising as the sum of the previous eleven months of advertising expenditure or advertising impressions" (Warner, Simon, and Payne, 2001, p. 37).

[8]After presenting the second and third specifications, the authors write: "An important and interesting finding of the analysis was that the joint significance of the advertising variables and the long-run elasticities implied by the estimates were almost identical for the three specifications" (Warner, Simon, and Payne, 2001, p. 37).

[9]The same caveats apply to our own estimates of advertising effects for the 1990s.

Our study pays substantial attention to each of these issues. The next chapter considers various conceptual issues to be confronted in developing and implementing more-promising methods.

ADDITIONAL CONCEPTUAL ISSUES

This chapter addresses several conceptual issues that have important implications for the design of an econometric strategy for assessing advertising effectiveness. First, we discuss the multiple stages of the enlistment decisionmaking process and discuss implications for dynamic properties of econometric specifications. We then describe data on Army recruiting leads and subsequent enlistments to provide additional insights about such dynamics. Additional complexities that are introduced if media alternatives complement rather than substitute for each other are described next, followed by additional discussion about the relative merits of alternative functional forms and dynamic specifications for estimation.

ADVERTISING CAN INFLUENCE YOUTH BEHAVIOR AT MULTIPLE DECISION STAGES

Young people who enlist often, and perhaps typically, go through a largely sequential process culminating with their enlistment. This process includes various steps: (a) developing early attitudes about the military, (b) initiating active consideration of employment and educational options upon finishing high school, (c) receiving and considering information from the services or their individual recruiters, and (d) signing a contract.

Advertising might affect attitudes and behavior at various stages of a youth's early-career decisionmaking. Advertising effects on enlistments may, then, occur with different lags depending on the distribution over youths (who are exposed to advertising) of the stages

they are in, what messages are conveyed by the advertisements, and what media are used for advertising.

Consider a more specific case—say, a high-school junior who is not yet actively considering career choices. For this person, advertisements may affect his or her attitudes about the military's suitability as a career but not induce him or her to enlist at that time. But a junior's future propensity to enlist might be enhanced by current-period advertising. This person might, for example, seek out or be more receptive to information in the future, when he or she is actively considering career alternatives. Advertisements might also be important after the youth—now a prospect—has spoken with one or more military recruiters. In this case, advertisements might have more immediate effects on enlistment by reinforcing what the recruiter has said and stimulating the final action of signing a contract.

In sum, a youth's decisionmaking process and the potential roles of advertising are complex. In some instances, advertising effects may be almost immediate; in others, the effects may not be observable in the data until much later.

DATA ON ARMY LEADS AND CONTRACTS PROVIDE SOME INSIGHTS ABOUT TIMING

The timing of advertising effects depends on, among other things, how long youths' decisionmaking processes take. To probe this issue, we analyzed data on Army marketing "leads" during 1994 to 1996. As defined by the Army, a lead is an individual who has responded to a direct mailing or advertisement by requesting additional information via a mail-in postcard or the 1-800 number. Leads do not include youths directly contacted by a recruiter. Most (78 percent) of the leads we analyzed were from direct mail; the rest were primarily from television by the joint advertising program and the Army program.

The leads data provide information on the time from when a prospect first expresses interest in military service—i.e., becomes a lead—until he or she signs a contract. In short, these data are informative about the elapsed times between "contact and contract," which we think of as only the back end of the complete process of early-career decisionmaking. As a result, these data were less than

ideal for our purposes. There were other pitfalls with relying on leads data for present purposes. For example, much emphasis is placed on generating leads and following up on them, but only about 5 percent of Army enlistees were officially recorded as marketing leads during the period. More importantly, only 3 to 6 percent of leads eventually signed a contract, which means that leads are not very predictive of contracts.[1]

Nonetheless, the leads data offer some interesting insights. For example, 70 percent of the leads generated by print and direct mail were high quality. In contrast, leads generated from television were only 55 percent high quality. In addition, 50 percent of the direct-mail leads were seniors at the time they signed a contract, whereas most of the other leads did not even become leads until they had graduated from high school. This suggests that different media may be more effective in reaching different target populations, an issue to which we return below.

For those who enlisted, we analyzed the distribution of the number of months that elapsed between when they became leads and when they signed contracts. Although some individuals signed up within one month of becoming a lead, the distribution peaks (i.e., the mode is) at two months and has a long "tail." That is, some individuals do not sign contracts for many months, as illustrated presently.

The distribution of time from "contact to contract" differs substantially for enlistees who were seniors versus those who were graduates when they became leads and across seasons of the year when enlistees became leads. Table 4.1 reports average elapsed times separately for seniors and graduates for selected months during which leads were generated. Depending on the month they became leads, graduates who enlisted took, on average, between 2.9 and 4.6 months to sign a contract. During certain times of the year (for example, the winter months), seniors took, on average, more time between contact and contract than did graduates. Specifically, at the beginning of the calendar year, the average time from lead to contract for seniors

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[1]This is not particularly surprising. As McGuire (1985, p. 261) writes: "the scandal of attitude research for the past half century . . . is that early output steps often have low correlations with later steps, as when attitude change poorly predicts behavioral change. . . ."

Table 4.1

**Time from Contact to Contract, by Recruit Type and
Month of Lead
(months)**

| | Month of Lead | | |
Recruit	January	September	November
Graduate	3.7	4.6	2.9
Senior	6.5	3.2	3.2

was almost seven months. This is much longer than the time for graduates, many of whom did not need to wait for a school year to end and whose average time is less than four months.

Of course, advertising effects need not all display dynamic patterns similar to those pertaining to contacts to contracts. For example, advertising might have a considerable effect on attitudes well before youths make contact with recruiters, or it might have most of its effect well after they make such contact.

To summarize, our analysis of Army leads data suggests that there can be lags of several months before advertising measurably affects prospects who are in the relatively early stages of their decision-making processes, even when the advertising media used provide relatively detailed information about career opportunities (print, direct mail). We also saw that dynamic patterns may vary considerably across individuals and seasons. In addition, these complex dynamics are likely to vary by advertising medium as well. Ideally, econometric analyses of advertising's effects on enlistments should allow for such differences.

ADVERTISING IN DIFFERENT MEDIA MAY PLAY COMPLEMENTARY ROLES

The existence of multiple stages of early-career decisionmaking suggests that alternative media may play complementary roles in influencing youth at different stages rather than simply substituting for one another. For example, relying on insights from the persuasion

literature, we infer that broadcast advertisements are likely to be high in emotional content, but that print advertisements tend to produce more cognitive responses. We also hypothesize that both emotional and cognitive responses to advertisements often play a role and that such responses can be mutually reinforcing, or complementary. For example, broadcast advertisements may be very important at early stages, because youths are then forming general impressions about the attractiveness of military service, and favorable early impressions are expected to make them more receptive to information (from print advertising, recruiters, etc.) later in the process.

ADVERTISING REALITIES REQUIRE COMPLEX ANALYSIS

The various conceptual issues we have discussed so far make it clear that a complex analysis is likely to be necessary if cost-effectiveness comparisons are to be valid. We have seen that both the overall effectiveness of advertising and the timing of effects are likely to vary by medium, target audience, and time of year. Thus, functional forms must be flexible enough to accommodate a broad range of patterns (such as both diminishing and increasing returns to additional advertising) and to enable projections over a wide range of budget allocations.

Previous work by RAND and other researchers suffered from several methodological limitations that we have attempted to overcome. For example, the log-linear specifications used, which impose on the estimates that the elasticity of enlistment with respect to advertising effort be constant no matter what the level of advertising effort is, were quite restrictive. They involved, for example, hazards in predicting effects of advertising levels substantially different from the average levels observed in the data used for estimation.[2] In addition, the dynamics (or patterns of the sizes of effects at different lag lengths) were assumed to be the same for all media, and effects were

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[2]Simulations of policy changes beyond the range of sample averages yielded implausible outcomes using estimates from the earlier RAND work. More specifically, the estimates imply implausibly large gains associated with resource reallocation and implausibly large, persistent declines in enlistments caused by temporary reductions in advertising levels.

constrained to be the highest in the month the advertising occurred. Effects were also not allowed to vary by season or by recruit category.

Figure 4.1 illustrates some of the problems with log-linear models, which have been widely used. When effects are estimated separately for different media, this functional form imposes that the elasticities of contracts with respect to advertising spending levels be a constant for each medium. That is, a given percentage increase in advertising through a particular medium will yield the same percentage increase in enlistments no matter what the baseline level of spending on that medium. As is apparent from the figure, an implication is that if one medium is estimated to produce more enlistments per dollar than another medium at low levels of spending, it must also be estimated to produce more enlistments at high levels of spending.

This hypothesis appears to be substantially at odds with reality. For example, private firms with relatively large advertising budgets typically use substantially different media mixes, some relying much more heavily than others on network television because of threshold and saturation effects, volume discounts, etc. Similarly, the Army,

RAND*MR1591-4.1*
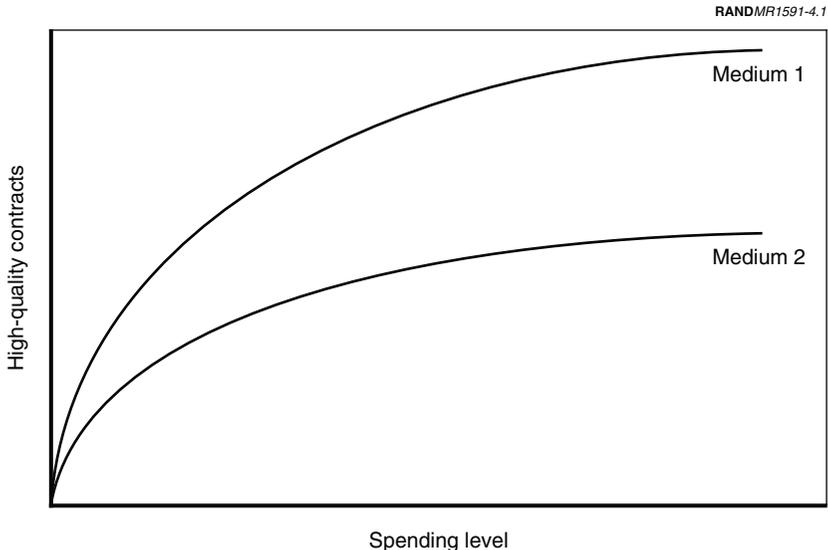
Figure 4.1—Problems with Constant Elasticity (Log-Linear) Specification

which has larger media budgets than the other services, has historically spent considerable amounts to advertise on network television, whereas the Air Force did not pay to advertise on television until the late 1990s.[3] If the world were well characterized by the widely used constant-elasticity model, these starkly different allocative choices would not make sense.

The constant-elasticity form also has very strong and implausible implications for cost-effectiveness comparisons. The marginal cost of an enlistment at any level of spending is the reciprocal of the slope of a curve such as those depicted in Figure 4.1. Since such curves flatten out as spending levels increase, a log-linear model imposes that marginal costs be very low when spending levels are small and very high when spending levels are large, because it takes more and more additional dollars spent on advertising to obtain any particular number of additional enlistments.

In sum, the log-linear functional form may be a useful approximation for analyzing effects of small spending variations in the neighborhood of average spending levels in the data used for estimation. If, however, one wishes to predict the effects of spending allocations much different from the sample averages, use of this functional form is hazardous.

Now consider some undesirable features of the dynamic specifications used in previous studies. Recall that most of these studies made very simple assumptions about the dynamics of advertising effects, if they allowed for dynamics at all (many ignored the effects of advertising subsequent to the period in which the advertising took place). The specifications used in previous RAND work, for example, often assumed that advertising effects decline geometrically over successive months—i.e., that the stock of goodwill due to advertising depreciates at a constant rate over time—and that these rates of decline are the same for all media. These features are illustrated in Figure 4.2. As we suggested earlier, however, these restrictions are very likely to substantially distort reality. Thus, use of this specification is

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[3]Earlier Air Force advertisements broadcast on television were public service announcements (PSAs), with the time provided by television networks or stations at no charge to the Air Force.

Largest effects for
the shortest lags

Medium 1

Medium 2

Additional high-quality contracts this month

Months since additional advertising
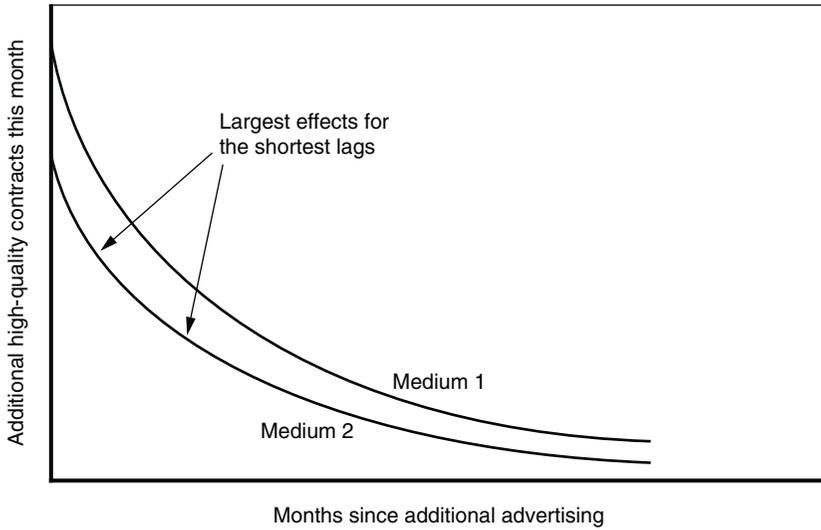
Figure 4.2—Problems with a Constant Depreciation Rate Model

likely to obscure important differences among media alternatives
and to mischaracterize the overall efficacy of advertising, as well as
the effectiveness rankings of advertising through different media.

DATA USED TO DEVELOP NEW METHODS
FOR THIS STUDY

The goal of our study was to develop improved methods for estimating advertising effects and to apply those methods to recent data. As an interim step, we applied new methods to the monthly data for the Army for July 1981 through June 1984 (36 months) that Dertouzos and Polich (1989) used. The unit of observation was a Military Entrance Processing Station (MEPS) area during a month. There were 66 MEPS areas during this period, so we had 2,376 month-MEPS pairs available for analysis.

We used as the outcome measure the number of high-quality contracts signed during a month regardless of accession date. Data were also constructed on a MEPS-area basis for high- and low-quality enlistment targets, or missions, and numbers of active production recruiters.[1] To control for alternative employment opportunities of potential enlistees, we used MEPS-level measures of the average hourly wage rate in manufacturing and the unemployment rate.[2] We also included dummy variables for two sets of MEPS areas in which

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[1]Data on contracts, missions, and recruiters are reported at the battalion level. Battalion borders do not always coincide with MEPS area borders. When necessary, MEPS-area figures were estimated from battalion-level data using county-level population figures from the 1980 Census.

[2]Wage rates were obtained from the Bureau of Labor Statistics (BLS) employment and earnings reports, and unemployment rates were constructed from state-level Current Population Survey (CPS) data. Although these rates are not ideal measures of wage opportunities for youth, they were the best available by month and county.

enlistment-bonus experiments were in effect during the period studied.[3]

The advertising data we used were unusually detailed. They were much less aggregated over time, geographic area, and medium than are advertising data typically available to researchers outside the military context.[4] The advertising measures were constructed from very extensive information provided by N. W. Ayer, the Army's advertising agency during the period covered by the data. Most Army advertising was carried by major media and purchased on a nationwide basis.[5] For advertising purchased nationally—on television and radio[6] and in national magazines—the agency provided media-specific data on monthly spending at the national level and media-specific data on monthly impressions (a measure of audiences potentially exposed) for each of 210 Areas of Dominant Influence (ADIs).[7] The impressions data were derived by N. W. Ayer using geographically detailed information on the ratings of individual television and radio programs on which the Army advertised and the circulation of individual magazines in which the Army advertised.[8] Dollars were allocated to the month in which the advertisement ap-

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[3]Two experimental treatments were applied in MEPS areas accounting for approximately 15 percent of the national youth population. See Polich, Dertouzos, and Press, 1986.

[4]The previous studies of military recruiting that used similarly disaggregated data were by Hogan, Dall, Mackin, and Mackie (1996) and Warner, Simon, and Payne (2001). Chapter Three discusses these studies.

[5]During the period covered by our data, about 85 percent of Army advertising spending on television, radio, magazines, and newspapers was at the national level.

[6]National television and radio include advertising through broadcast networks and nationally purchased spot advertisements.

[7]During the early 1980s, ADIs were the standard geographic reporting areas for measuring dissemination of advertising messages. ADIs are sets of counties chosen to represent distinct advertising markets, with each county assigned to the ADI including the location of the television stations accounting for the most viewing within the county.

[8]The fraction of national-level spending on a particular advertising medium allocated to a particular MEPS area varies considerably over time and across MEPS areas because of changes over time in the programs and magazines carrying the Army's advertisements and differences across areas in the audience penetration levels of different programs and magazines. Due to sampling error in the television ratings, television and radio impressions are probably measured with less accuracy than circulation data for print media.

peared. Total dollars spent on each national medium were allocated to ADIs in proportion to impressions and then allocated to the 66 MEPS areas using 1980 county-level Census population figures. Monthly data on local media purchases, from local radio stations and daily and weekly newspapers, were obtained at the battalion level. Monthly spending levels by county were then computed and converted to MEPS areas by aggregating over counties.[9]

Data on daily and weekly newspapers were combined, as were data on network and local radio. The result was monthly advertising data at the MEPS-area level for four media—television, radio, magazines, and newspapers—measured in dollar terms (see Table 5.1). For reasons discussed in Chapter Six, these spending data are expressed in the econometric model in per-capita terms—specifically, per 1,000 young males in the population of the MEPS area.

Table 5.1

Descriptive Statistics for Army Data, July 1981 Through June 1984

Variable	Mean	Standard Deviation
Number of recruiters	73.8	48.3
Civilian wage rate (hourly)	8.62	1.19
Unemployment rate (percent)	8.85	2.30
Television spending, per thousand young males	123.2	85.4
Radio spending, per thousand young males	41.3	33.2
Magazine spending, per thousand young males	20.3	11.8
Newspaper spending, per thousand young males	7.7	9.40
High-quality contracts	71.0	49.3
Low-quality contracts	78.9	55.5
High-quality quota	64.0	44.5
Low-quality quota	72.5	48.8

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[9]For MEPS areas that did not coincide with sets of ADIs, ADI-level spending data were disaggregated to the county level using data on ratings for individual radio programs (from Arbitron Rating Company) and circulation figures for individual newspapers (from *Circulation '83/'84*, the N. W. Ayer Directory of Publications, and the *National Directory of Weekly Newspapers*). They were then aggregated over counties comprising MEPS areas.

NEW ECONOMETRIC SPECIFICATION

The goal of our econometric analysis was to estimate the effects of advertising on potential high-quality enlistments.[1] We examined both a structural version and a reduced-form version. In the former case, we estimated the effects of advertising on high-quality youths who signed contracts in a given month, holding both recruiter levels of effort and number of low-quality recruits constant. In the reduced-form version we also estimated the effects of advertising on the number of high-quality enlistments, but in this case we held recruiter effort constant and allowed the number of low-quality enlistments to adjust to changes in recruiting opportunities. This chapter presents our econometric specifications and methods.

RECRUITING POSSIBILITY FRONTIER

The conceptual foundation for our analysis is the "recruiting possibility frontier," or RPF, which is analogous to a production possibility frontier in the economics literature. Given the values of other variables, this function depicts the tradeoff between the *potential* (and unobservable) numbers of high-quality recruits (H_t^*) and low-quality recruits (L_t^*) in any MEPS area in any month. A point on the frontier would be achieved—i.e., recruiting potential would be attained—

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[1]Our econometric approach builds on that developed in Dertouzos, 1985, and Dertouzos and Polich, 1989. In particular, we improved the specifications in the earlier work by incorporating more theoretically satisfactory functional forms and dynamic specifications. The earlier work employed log-linear functional forms and geometrically declining lags over all lag lengths. We discuss the unattractive aspects of these model features in Chapter Four.

only if recruiter effort were maintained at a constant level. In a graphical representation, the height of this frontier at any value of L_t would be interpreted as the maximum number of high-quality prospects who can be signed to contracts in any month (given recruiting opportunities) if the given number of low-quality contracts are signed, holding recruiter effort constant. Three sets of factors determine MEPS-area recruiting opportunities and hence the height of the RPF:

1. Local economic conditions, which affect the willingness of youths to enlist.

2. Resources allocated to recruiting, such as numbers of recruiters and enlistment incentives.

3. Recruitment advertising messages received by youths in the area.

OBSERVED NUMBERS OF CONTRACTS

The RPF specifies a relationship between potential levels of high- and low-quality contracts that can be signed in a given area in a given month. Direct empirical relationships between advertising and actual contracts may, however, give a misleading picture of advertising effectiveness—e.g., if advertising enhances recruiting opportunities but recruiters are not sufficiently motivated (or are unable) to capitalize on enhanced opportunities to increase enlistments.

Our interest centered on how advertising affects recruiting *opportunities* because it is these effects that are most relevant to understanding advertising potential and how policy can best exploit that potential. Suppose, for example, that advertising substantially enhances recruiting opportunities, but that much of the potential enlistment gains go unexploited because recruiter effort declines as it becomes easier to achieve quotas. Then a direct empirical relationship between advertising and enlistments will suggest that advertising is largely ineffective when, in fact, advertising is effective in increasing opportunities, and from the policy point of view, increases in advertising should be accompanied by initiatives to maintain recruiter effort or to increase the numbers of recruiters.

Let the numbers of contracts actually signed in month t, which are observed in the data, be denoted by (L_t, H_t). These levels depend on recruiting opportunities, the level of recruiter effort (which determines how close the recruiting unit comes to the RPF), and the allocation of recruiter time and effort to recruiting high- and low-quality prospects.

The tradeoff between actual levels of high- and low-quality contracts for each MEPS area[2] in month t—i.e., the tradeoff given the actual level of effort—is derived from the RPF by introducing an unobserved level of recruiter effort, E_t^*.

$$\ln H_t + \psi \ln L_t = E_t^* + \beta_0 + \sum_i \beta_i X_{it} + \sum_j \kappa_j f_j\left(a_{jt}\right)$$
$$+ \sum_j \kappa_{j1} f_j\left(a_{jt-1}\right) + \sum_j \theta_j \sum_{s=2}^{\infty} \rho^s f_j\left(a_{t-s}\right) + \varepsilon_t \tag{6.1}$$

where

$$X_{it} =$$ observable, nonadvertising variables that affect recruiting possibilities[3]

$$a_{jt} =$$ MEPS-area spending in month t per 1,000 young males on advertising medium j = 1,2,3,4[4]

$$\left(\psi, \beta_i, \kappa_j, \kappa_{j1}, \theta_j, \rho\right) =$$ parameters to be estimated

$$f_j\left(a_{jt}\right) =$$ functions of advertising spending on different media (introduced presently) that differ over media according to parameter values to be estimated

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[2]To avoid cluttering the notation, we do not explicitly distinguish MEPS in the exposition.

[3]Specifically, the variables X_1, X_2, and X_3 equal the logarithms of numbers of recruiters, civilian wage rate, and local unemployment rate, respectively; and the variables X_4 and X_5 are dichotomous indicators taking a value of 1 if the respective bonus tests were in operation in the MEPS area in month t.

[4]The media are indexed as follows: j = 1 for television, j = 2 for radio, j = 3 for magazines, and j = 4 for newspapers.

$$\varepsilon_t \; = \; \text{a disturbance term assumed to have a zero}$$

mean and to include fixed effects specific to MEPS–calendar month combinations[5]

To interpret Equation 6.1, we invoke the normalization on unobserved effort that $E_t^* = 0$ corresponds to maximal effort.[6] Thus, Equation 6.1 without the E_t^* term gives the equation for the RPF (which is defined in terms of maximal effort).

The parameters of Equation 6.1 can then be interpreted as the effects of the observable right-hand-side variables on the tradeoff between actual high- and low-quality contracts, holding effort level constant. Note also that Equation 6.1 incorporates the assumption that reductions in effort decrease actual high-quality enlistments by the same percentage for all levels of actual low-quality recruits.

Advertising effects depend on parameters explicit in Equation 6.1 and parameters imbedded in the functions $f_j(a_{jt})$. The parameters κ_j are coefficients of these functions evaluated at current-month spending levels and thus relate to effects of advertising in a particular month on enlistments during the same month. The parameters κ_{j1} pertain to effects of spending in a particular month on enlistments in the immediately following month. Given that the κ's are free parameters, Equation 6.1 allows for complete flexibility in dynamic patterns of advertising effects over the first two months. Unfortunately, the data seem incapable of enabling usefully precise estimation of specifications involving flexible dynamic patterns over more months. Thus, as can be seen from Equation 6.1, beginning with lags of two months (t–2), the dynamic pattern of effects for advertising medium j is assumed to be an infinite distributed lag with geometrically declining media-specific coefficients that are proportional to the values of θ_j. The rates of monthly decline depend on the parameter ρ, the monthly rate of carryover of advertising effects beginning with month t–2. This parameter is assumed, admittedly implausibly,

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[5]These fixed effects are expected to capture various factors affecting MEPS-level recruiting opportunities that are nearly constant over time during the three-year period, such as the size of military-eligible youth population, youth attitudes toward military service, and MEPS-specific seasonal patterns of recruiting opportunities.

[6]The normalization involves no loss of generality because of the presence of β_0 in the equation.

to be the same for all media. This assumption is made because it appears impossible to derive an estimable form if we allow ρ to differ across media. In short, the dynamic specification employed is as general as appears feasible given the forms of the functions $f_j(a_{jt})$ that we employ, an issue to which we now turn.

The effects of advertising spending on $\ln H_t$ (holding $\ln L_t$ constant) depend on the parameters just discussed and the functions $f_j(a_{jt})$. The functional form we specify to link advertising to high-quality contracts allows for the market threshold and saturation phenomena widely discussed in the advertising literature while introducing only a single additional parameter per advertising medium. The literature often refers to these phenomena in terms of the "S-curve." The basic idea is that advertising should be expected to have no effect below some level of spending (i.e., there is a threshold level of spending) and should be expected to have no additional effect above some level of spending (i.e., the market becomes saturated).[7]

Effects of advertising are typically conceptualized in terms of the expenditure levels required to deliver repeated messages to individual members of a target audience, the number of messages an individual must receive for his or her attitude and behavior to change, and the number of messages beyond which advertising has no additional impact. We express advertising spending in per-capita terms because the extent to which advertising messages (impressions) at any

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[7]For example, as Simon and Arndt (1980, p. 13) write: "the great majority of persons interested in advertising—advertising practitioners, media salesmen, economists, and laymen—seem to believe that the advertising response function has an inflection point and is S-shaped." There is considerable empirical evidence of a concave relationship between advertising and sales, which is consistent with the idea of saturation, but little if any direct evidence of thresholds (Hanssens, Parsons, and Schultz, 1990, pp. 178–182; Simon and Arndt, 1980). The lack of direct empirical evidence of thresholds—or, more generally, convex regions of advertising response functions—may be largely attributable to advertisers typically choosing to advertise at levels above any inflection point (i.e., choosing not to advertise in a region of increasing marginal returns) (Hanssens, Parsons, and Schultz, 1990; Simon and Arndt, 1980). We use a functional form allowing for—but not imposing—an S-shaped response function, relying more on theoretical arguments than direct empirical evidence. We do so because an S-shape is most appealing theoretically and because we seek to assess the *total* effectiveness of advertising in addition to its marginal effectiveness in some limited range. As it happens, our data have considerable fractions of observed (per capita) spending levels on both the convex and concave segments of the S-curves that we estimate.

level of spending reach the same individuals repeatedly will be lower the larger the total number of individuals in the audience.[8]

Specifically, we assume

$$f_j(a_{jt}) = 1/[1 + \exp(5 - \mu_j a_{jt})], \tag{6.2}$$

with the parameters μ_j to be estimated.

For $a_{jt} = 0$, this function is very close to zero.[9] In addition (as long as $\mu_j > 0$), the function for medium j increases monotonically and approaches a limit of 1 as a_{jt} increases. Thus, in view of Equation 6.1, the parameters $(\kappa_j, \kappa_{j1}, \theta_j)$—which are multiplied by the $f_j(a_{jt})$ during the current month, previous month, and all earlier months, respectively—determine the saturation levels, or ceilings, on effects (on $\ln H_t$) of advertising spending on any medium in any month.[10] The μ_j's determine how rapidly these saturation effects are approached as per-capita spending levels increase. And the estimated values of the parameters $(\kappa_j, \kappa_{j1}, \theta_j, \mu_j, \rho)$ determine whether the terms in Equation 6.1 representing the effects of advertising spending through medium j increase or decrease with spending and whether the effects exhibit the hypothesized S-curve shape over the range of advertising spending observed.

We believe that our functional form is very advantageous relative to alternatives such as the widely used log-linear form critiqued in Chapter Four. We note, however, that the particular form we use is less general than other functions that can take on an S-shape. In particular, the S-curve we estimate for a given medium must (because of the functional form) meet two requirements: have its inflection point at one-half of the maximal (or saturation) number of

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[8]This is because prices for a television or radio sport or print ad insertion will be higher the greater the audience or circulation.

[9]In estimation, the value 5 is specified to ease estimation while effectively imposing the logical requirement that zero advertising spending has (essentially) no effect on enlistments. In particular, f(0) = 1/[1+exp(5)] is roughly 0.0067, and in view of the sizes of the estimates of $(\kappa_j, \kappa_{j1}, \theta_j, \rho)$, effects of zero spending on recruits are an order of magnitude or two below 1 percent of monthly high-quality enlistment totals.

[10]For lags of two months or more, the effects of advertising spending also depend on the length of the lag and the value of ρ.

high-quality contracts achievable through advertising spending on that medium, and be symmetric about its point of inflection.[11] It seems, however, that relaxing these restrictions requires estimation of additional parameters and that the data cannot support such estimation without giving up other attractive features of the specification, such as the completely general dynamics for the first two months for each medium.

To control for variation in recruiter effort level across observations and to develop a specification in terms of observable variables only, we assumed (as in Dertouzos and Polich, 1989) that

$$E_t^* = \gamma_H \ln\left(H_t/HQ_t\right) + \gamma_L \ln\left(L_t/LQ_t\right) \tag{6.3}$$

where (HQ_t, LQ_t) are the recruiting unit's goals ("missions," in Army vocabulary) for high- and low-quality contracts, respectively, in month t. The basic idea behind Equation 6.3 is that (assuming γ_H and γ_L are negative) the lower the actual contracts relative to the amounts required to meet the unit's quotas, the higher the recruiting unit's effort level. Viewed another way, γ_H and γ_L are partial derivatives of effort with respect to the logarithms of high- and low-quality missions, respectively.

DEVELOPING AN ESTIMABLE FORM

Substituting Equations 6.2 and 6.3 into Equation 6.1 gives an expression involving only observable variables and parameters to be estimated but involves an infinite number of lagged terms. To move toward an estimable form, we employ the well-known Koyck method to eliminate the infinite sequence of geometrically declining lagged terms in advertising. Specifically, we lag the relationship obtained by combining Equations 6.1, 6.2, and 6.3 by one month, multiply this by ρ, and subtract the resulting expression from the relationship. This process eliminates the lagged advertising terms beyond month t–2, but it results in an equation with a disturbance term of the form $v_t \equiv \varepsilon_t - \rho\varepsilon_{t-1}$, which is serially correlated. As is well known, when a

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[11]These features of the S-curves we estimate can be seen in Figures 7.1 and 7.2, in the next chapter.

serially correlated disturbance term is combined with a lagged de-
pendent variable as a regressor, standard estimators (such as ordi-
nary or generalized least squares) produce biased and inconsistent
estimates of regression coefficients.

To eliminate this serial correlation, then, we lag the equation involv-
ing v_t, multiply by $\lambda = -\rho/(1+\rho^2)$, and subtract, which results in the
following equation with a serially uncorrelated disturbance u_t:

$$\ln H_t = \left(\lambda + \rho\right)\ln H_{t-1} - \lambda\rho\ln H_{t-2}$$

$$+\left(\frac{\left(\gamma_L - \psi\right)}{1-\gamma_H}\right)\left[\ln L_t - (\lambda + \rho)\ln L_{t-1} + \lambda\rho\ln L_{t-2}\right]$$

$$+\left(\frac{1}{1-\gamma_H}\right)\left[\begin{array}{c}-\gamma_H\left(\ln HQ_t - (\lambda + \rho)\ln HQ_{t-1} + \lambda\rho\ln HQ_{t-2}\right)\\ -\gamma_L\left(\ln LQ_t - (\lambda + \rho)\ln LQ_{t-1} + \lambda\rho\ln LQ_{t-2}\right)\end{array}\right]$$

$$+\left(\frac{1}{1-\gamma_H}\right)\left[\sum_i \beta_i\left(X_{it} - (\lambda + \rho)X_{it-1} + \lambda\rho X_{it-2}\right)\right]$$

$$+\left(\frac{1}{1-\gamma_H}\right)\left[\sum_j \kappa_j f_j(a_{jt}) + \sum_j (\kappa_{j1} - (\rho + \lambda)\kappa_j)f_j(a_{jt-1})\right] \tag{6.4}$$

$$+\left(\frac{1}{1-\gamma_H}\right)\left[\sum_j \begin{array}{c}\left(\rho^2\theta_j + \lambda\rho\kappa_j - (\rho + \lambda)\kappa_{j1}\right)f_j(a_{jt-2})\\ -\sum_j \lambda\left(\rho^2\theta_j - \rho\kappa_{j1}\right)f_j(a_{jt-3})\end{array}\right] + u_t$$

Equation 6.4 is nonlinear in the parameters of Equations 6.1, 6.2, and
6.3, and in λ, the parameter introduced by the second round of lag-
ging and differencing. The first row on the right-hand side of Equa-
tion 6.4 involves lagged values of the dependent variable. The sec-
ond row of terms involves the current-month and two lagged values
of the logarithm of low-quality contracts. The third row involves cur-
rent and two lagged values of missions. The fourth row involves cur-
rent and two lagged values of the nonadvertising variables assumed
to affect the position of the RPF. Finally, the last two rows of terms
involve per-capita advertising spending on the various media, where
the functions are the media-specific logistic functions detailed in
Equation 6.2.

For estimation purposes, we worked with annual differences in Equation 6.4 to account for MEPS-level fixed seasonal effects that are constant over years for the same calendar month. Since the actual levels of contracts (H_t, L_t) are jointly determined, we require an instrument for $\ln L_t$, the only endogenous, contemporaneously determined regressor in Equation 6.4. As instruments, we use 22 monthly dummy variables, one for each of the 36 sample months for which data are available to estimate Equation 6.4 after annual differencing and allowing for three lags. We believe that these are valid instruments. First, the monthly dummies should be correlated with $\ln L_t$ because of recruiter-management policies implemented at the national level that vary over time and affect numbers of low-quality contracts—for example, by changing how difficult it is for recruiters to get the U.S. Army Recruiting Command (USAREC) to offer contracts to low-quality recruits. Second, the monthly dummies should be uncorrelated with the disturbance term in the estimated equation, which reflects factors that vary over MEPS areas in any given month. The parameters of Equation 6.4, which we refer to as the "structural version," are estimated by nonlinear instrumental variable methods using estimation routines in SAS. The number of observations available for estimation, after constructing lagged variables and performing the annual differencing, is 1,452.

REDUCED FORM

We also estimated a reduced-form version of Equation 6.4, for two reasons: the statistical validity of instrumental variables is generally subject to some doubt, and the structural estimates involve some anomalies. Specifically, the reduced-form equation that we estimated is obtained by eliminating the terms involving $\ln L_t$ and it first and second monthly lags from Equation 6.4. This equation is estimated, in annual-difference form, by nonlinear least squares regression. (No instrumental variables are required because the regressor $\ln L_t$ does not appear.) The interpretation of the reduced-form equation is that it determines actual values of $\ln H_t$ (holding effort constant), allowing the values of $\ln L_t$ to adjust to differences in recruiting opportunities. This contrasts with the interpretation of the structural form, in which the value of $\ln L_t$ is also held constant.

ESTIMATES FOR THE ARMY IN THE 1980s AND THEIR IMPLICATIONS

We begin this chapter by reporting econometric estimates of the parameters introduced in Chapter Six based on the Army data for the early 1980s that were described in Chapter Five. We then use graphical methods to explore implications of the estimates for the functional form and dynamic patterns of advertising effects on high-quality enlistments. We also analyze the extent to which enlistment potential might have been improved by reallocating advertising spending across media and by increasing total spending. Finally, we consider the implications of sampling variability for the confidence we can attach to estimates of the effectiveness of advertising and optimal allocations of spending across media.

PARAMETER ESTIMATES

Table 7.1 reports estimates of the parameters of Equation 6.4 and its reduced-form variant and of Equations 6.2 and 6.3. First, consider the estimated effects of the nonadvertising variables reported in the lower portion of the table. The elasticity of high-quality contracts with respect to the number of recruiters is estimated to be rather small (0.166 and 0.150 for the structural and reduced forms, respectively) and of marginal statistical significance. The two estimated elasticities of high-quality enlistments with respect to the civilian wage rate are much higher (both just about 1.0) and are statistically significant. The elasticities with respect to the local unemployment rate are roughly 0.6 to 0.7 and are highly significant. In this specifi-

Table 7.1

Estimated Determinants of the Logarithm of High-Quality Enlistments and Recruiter Effort for the Army in the Early 1980s

Variable description	Parameter	Structural Form		Reduced Form	
		Estimate	t-ratio	Estimate	t-ratio
Advertising effects on potential recruits:					
Television spending	κ_1	0.159	4.53	0.122	4.90
	κ_{11}	0.0492	1.65	0.00758	0.34
	θ_1	0.0458	0.38	0.215	2.48
	μ_1	0.0575	7.54	0.0505	8.96
Radio spending	κ_2	0.00809	0.37	−0.000968	−0.05
	κ_{21}	0.0574	2.69	0.0622	3.29
	θ_2	0.319	2.90	0.210	2.50
	μ_2	0.103	3.54	0.0936	6.01
Magazine spending	κ_3	−0.0212	−1.12	−0.0125	−0.71
	κ_{31}	0.0343	1.82	0.0549	3.15
	θ_3	0.180	1.86	0.125	1.61
	μ_3	0.395	2.94	0.443	4.37
Newspaper spending	κ_4	0.0371	0.78	0.0119	0.84
	κ_{41}	−0.0584	−1.11	−0.0138	−0.97
	θ_4	0.260	0.97	0.0537	1.01
	μ_4	175	0.67	3.11	1.32
Ad carry-over rate	ρ	0.461	13.06	0.489	14.98
Other determinants of enlistments:					
Intercept	β_0	−0.000350	−0.02	−0.00872	−0.45
Log (recruiters)	β_1	0.166	1.65	0.150	1.45
Log (civilian wage)	β_2	1.01	1.91	1.06	1.94
Log (unemployment rate)	β_3	0.589	8.73	0.703	11.08
Bonus B	β_4	−0.00623	−0.22	−0.0107	−0.36
Bonus C	β_5	0.0127	0.46	0.0204	0.70
Slope RPF	$-\psi$	0.0597	1.17	NA	NA
Determinants of recruiter effort					
High-quality mission	γ_H	−0.163	−2.79	−0.178	−3.04
Low-quality mission	γ_L	0.112	2.70	0.0457	1.17
R square		0.5892		0.5931	
Sample size		1,452		1,452	

cation, the experimental bonus programs did not have statistically significant results.[1]

The estimated coefficients of Equation 6.2 suggest that higher quotas for high-quality contracts increase recruiter effort, with statistically significant estimated elasticities of about 0.17 in both the structural and the reduced form.[2] The estimated effects of low-quality quotas on effort are puzzling, however. The direction of the estimated effect is opposite to what would be expected in both versions, with the estimate in the structural version being sizable and statistically significant. The estimated slope of the RPF (minus ψ—see Equation 6.1), which appears only in the structural form, is positive, contrary to expectations, albeit not statistically significant. We interpret the estimates of ψ (essentially zero) as indicating that the difficulty of attracting low-quality enlistees is very low compared with that of attracting high-quality enlistees.[3]

Turning to the estimated effects of advertising spending, recall that effects for each of the four media depend on four media-specific parameters $(\kappa_j, \kappa_{j1}, \theta_j, \mu_j)$ and ρ, the monthly carryover rate of effects two months and longer after advertising spending. None of these parameters is expected to be negative a priori, and, in fact, 15 of 17 of the point estimates are positive for the structural form, and 14 of 17 are positive for the reduced form. Moreover, none of the negative estimates is statistically significant.

The monthly carryover rate is estimated to be a bit less than 50 percent in both the structural and the reduced form, and both estimates are highly statistically significant. Regarding the media-specific parameters, we first review qualitative patterns from Table 7.1, after which we use graphical methods to gauge quantitative implications.

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[1]It is worth noting that the estimated bonus effects were sensitive to the specification used. Namely, when accounting for advertising's lagged effects, the "differences of differences" form of the model made it impossible to estimate the bonus effects with any degree of precision. This contrasts with results published in Polich, Dertouzos, and Press, 1986.

[2]Recall from Equation 6.2 that the logarithms of quotas enter the effort equation with minus signs; thus, the negative estimate parameters correspond to positive effects of quota on effort levels.

[3]The surprising estimates of γ_L and ψ provide part of the motivation for considering the reduced form variant of Equation 6.4.

The estimates of κ_1 for both the structural and the reduced form indicate that spending on television advertising increases potential high-quality enlistments during the month in which the advertisements run. For example, the sizes of these coefficients, roughly 0.16 and 0.12, suggest that saturation spending levels on television advertising can increase high-quality contracts by 12 to 16 percent during the same month. The structural estimate of κ_{11} (which is marginally significant) suggests a substantial effect one month later, about 5 percent for saturation spending levels, whereas the reduced-form estimate of this parameter does not. Moreover, the structural and reduced-form estimates of θ_1 suggest very different conclusions about whether effects of television advertising persist for two and more months, with the structural estimates suggesting at most quite small effects and the reduced-form estimates suggesting important ones. This evidence seems consistent with the notion that television advertisements appeal primarily to emotion and that a major role for television advertising is to encourage potential enlistees who have already been through the early stages of the recruiting process to make the enlistment commitment. The reduced-form estimates of long-lived effects suggest that television advertising might also lead potential recruits to contact recruiters and initiate the enlistment process.

The estimated effects of radio and magazine advertising on enlistments have time patterns similar to each other but quite different from the time pattern for television. For both radio and magazines, there is (a) no evidence of effects during the month that the advertising messages are transmitted, (b) some indication of moderate-sized effects one month later, but (c) substantial and consistent evidence of long-lived effects. These estimates suggest that both radio and magazine advertising largely induce youths to contact a recruiter or take subsequent steps in the enlistment process, but relatively rarely induce youths to quickly make commitments to sign contracts. The differences in time patterns between television and radio conflict with our hypothesis that time patterns for the two broadcast media should be similar because they appeal largely to emotion. In sum, television advertising, on the one hand, and radio and magazine advertising, on the other, may primarily affect different stages of the decisionmaking process youths pass through before signing enlistment contracts.

Finally, none of the four medium-specific parameters determining effects of newspaper advertising is estimated to be statistically significant for either the structural or the reduced-form specification. If there is a quantitatively important effect of newspaper advertising, the data provide at most a hint that it operates with at least a two-month lag. Specifically, the estimate of θ_4 in the structural version is sizable, albeit not statistically significant.

RELATIONSHIPS OF ENLISTMENTS TO ADVERTISING SPENDING ON DIFFERENT MEDIA

The potential enlistment effects of an increment in spending on any medium are spread out over the course of several months and depend on a combination of the parameters estimated for that medium. Figures 7.1 and 7.2 use the point estimates reported in Table 7.1 to illustrate the effects of spending on television, radio, and magazine advertising[4] on numbers of high-quality contracts that could be signed in a MEPS area, if recruiter effort levels do not adjust to changes in recruiting opportunities. Specifically, Figure 7.1 uses the point estimates from the structural model to plot predicted additional contracts, over a six-month time horizon, as a function of spending per 1,000 young males (relative to zero spending), assuming a baseline level of high-quality contracts of 70 per month, which is roughly the sample mean of 71.[5] Figure 7.2 presents analogous information for the reduced-form estimates.

As can be seen from these figures, the estimated relationships between advertising spending on a medium and potential additional enlistments are S-shaped in the ranges of observed per-capita spending (see Chapter Five, Table 5.1). Moreover, the estimated S-curves for the three media are not very sensitive to whether estimates from the structural or the reduced-form specifications are employed. For

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[4]These figures ignore newspaper advertising because the corresponding curves for newspaper spending based on the point estimates would not be visible given the spending scales used. See Table 7.2, below, for information about predicted effects of newspaper spending.

[5]According to our estimates, virtually all effects of additional spending in any month are realized within six months. For example, effects seven months out are proportional to ρ^6, which is of the order of 0.01.
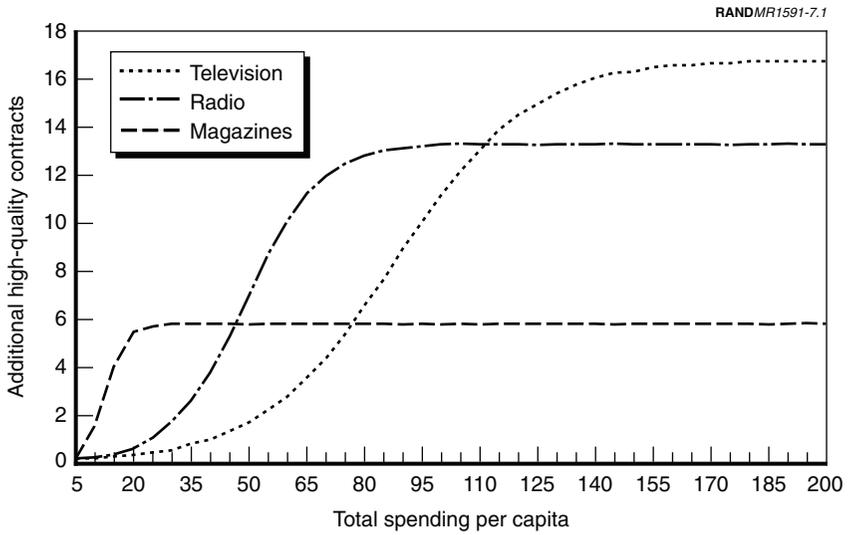
Figure 7.1—Effects over Six Months of One-Time Levels in Spending, Structural Estimates
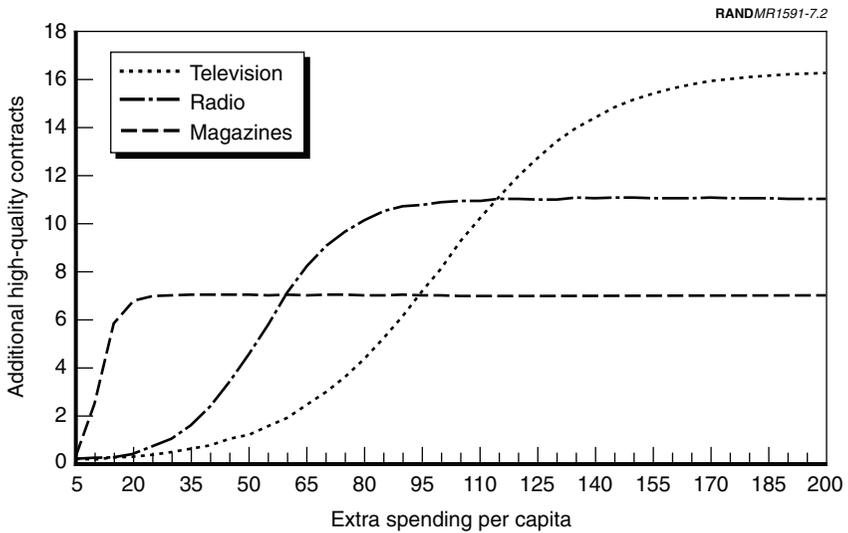
Figure 7.2—Effects over Six Months of One-Time Levels in Spending, Reduced-Form Estimates

example, as detailed in Table 7.2, the structural and reduced-form estimates have similar implications for media-specific saturation spending levels[6] and additional contracts from spending at these levels for television, radio, and magazine advertising. In contrast, however, key features of the estimated S-curves for newspaper advertising are very sensitive to whether the structural or the reduced-form approach is employed. More specifically, the structural estimates for newspaper advertising suggest an implausibly low level of saturation spending (a mere 5 cents per 1,000 young males per month) and a very considerable effect (almost 6 per month) on contracts. These features of the S-curve are traceable to the very large

Table 7.2

Estimated Effects on High-Quality Contracts of Actual and Saturation Spending Levels for Different Media

	Structural		Reduced Form	
	Spending Level ($ per capita)	Additional High-Quality Contracts	Spending Level ($ per capita)	Additional High-Quality Contracts
Television				
Actual	123.20	15.0	123.20	12.5
Saturation	190.00	16.8	195.00	16.3
Radio				
Actual	41.30	3.8	41.30	2.6
Saturation	105.00	13.3	110.00	11.0
Magazines				
Actual	20.30	5.5	20.30	6.8
Saturation	30.00	5.8	25.00	7.0
Newspaper				
Actual	7.70	5.7	7.70	1.5
Saturation	0.05	5.7	3.00	1.5
Total				
Actual	192.50	30	192.50	23
Saturation	325.00	42	333.00	36

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[6]Strictly speaking, potential high-quality contracts increase with additional spending and approach a ceiling asymptotically. For numerical purposes, media-specific saturation levels are defined as spending levels for which an additional $5 per 1,000 young males would increase high-quality contracts by less than 0.02 contracts over the six-month period.

structural estimates of μ_4 (175) and θ_4(0.26), neither of which is statistically significant. The estimates from the reduced form are more plausible, especially the estimated saturation spending level of $3 per 1,000 young males per month, and suggest a more modest potential effect of an additional 1.5 contracts.

How much could the actual advertising budget, as allocated across the media, have contributed to potential enlistments of high-quality youth? According to the two sets of point estimates, the actual average monthly spending levels and allocations could have produced 30 (structural) or 23 (reduced form) additional high-quality contracts per MEPS area per month (43 or 33 percent, respectively, of the base of 70 contracts).[7]   Finally, the estimates suggest that a budget (appropriately allocated across media) of roughly $330 per 1,000 young males per month (a 71 percent increase) would achieve all of the potential benefits of advertising—namely 42 or 36 additional high-quality contracts per MEPS area per month according to the structural and reduced-form estimates, respectively.

Figures 7.1 and 7.2 strongly suggest that the S-curves for the three media differ across media. In particular, as we move from magazines to radio to television, both saturation spending levels and saturation effects of spending on contracts increase. If only a small budget were available—e.g., $20 per 1,000 young males—the estimates suggest that magazines would be the medium of choice because it is the only medium of the three that is estimated to offer appreciable enlistment effects for such small spending levels. For larger budgets—e.g., $75 per 1,000 young males—a mix of magazine advertising (which achieves its maximum effect for $25 or $30 per 1,000 young males) and radio advertising appears to be the best choice. Only when even larger budgets are available does television advertising appear to be worthwhile. For example, for television spending levels below $85 per 1,000 young males or so, the enlistment effects available from television advertising are smaller than those available from magazines for only one-third the expenditure. However, if enough money is expended, television can achieve larger enlistment effects than can be achieved with radio or magazine advertising.

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[7]The difference between the structural and reduced-form estimates is largely attributable to the (imprecisely) estimated effects of newspaper advertising.

TIME PATTERNS OF EFFECTS OF DIFFERENT MEDIA

According to our estimates, the effects illustrated in Figures 7.1 and 7.2 and in Table 7.2 are spread out over several months. Figures 7.3 and 7.4 illustrate the time patterns of effects implied by our estimates for television, radio, and magazine advertising. Specifically, these figures decompose the effects (over six months) of spending an additional $5 per 1,000 young males on each medium starting at the observed mean levels for each medium (see Chapter Five, Table 5.1). As before, effects are calculated assuming a baseline of 70 high-quality contracts per month.

Note first the geometrically declining effects for all media starting with month 3; these shapes are imposed by the specification in Equation 6.1. Next consider how the figures illustrate qualitative patterns described in reviewing the estimates in Table 7.1. In particular, the curves for radio and magazine are inverted-U shaped, indicating that current-period effects for these media are relatively unimportant. In contrast, the most important effects for television appear to be during the same month the advertising messages are broadcast.

Finally, Figures 7.1 and 7.2 provide a first glimpse at the issues to which we now turn: How might advertising spending be reallocated across media to improve enlistment outcomes? How much might a budget increase improve enlistment outcomes?

POTENTIAL GAINS FROM REALLOCATING OR INCREASING SPENDING

Figures 7.1 and 7.2 suggest that additional spending—starting at the mean, actual levels of spending—on television, radio, and magazines could have increased the numbers of high-quality enlistments. Moreover, Figures 7.3 and 7.4 suggest that additional radio advertising would have been more productive at the margin than would have additional spending on television or magazine advertising.[8] How

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[8]The total effect on contracts over six months of additional spending of $5 per 1,000 young males on radio is 1.5 and 1 according to the structural and reduced-form estimates, respectively. The corresponding effect is considerably smaller for television (about 0.40 and 0.65 for the two sets of estimates) and smaller still for magazines (about 0.25 and 0.10).
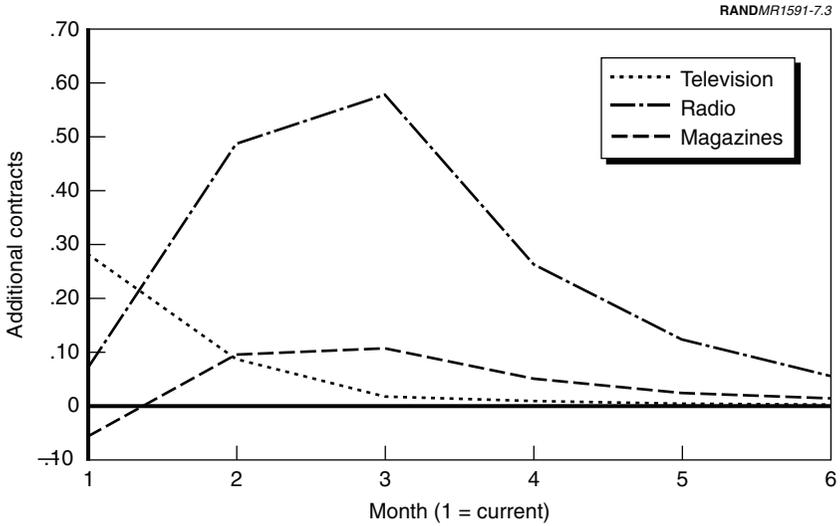
Figure 7.3—Effects of $5 per Capita Extra Spending from Actuals on Additional High-Quality Contracts, by Month, Structural Estimates
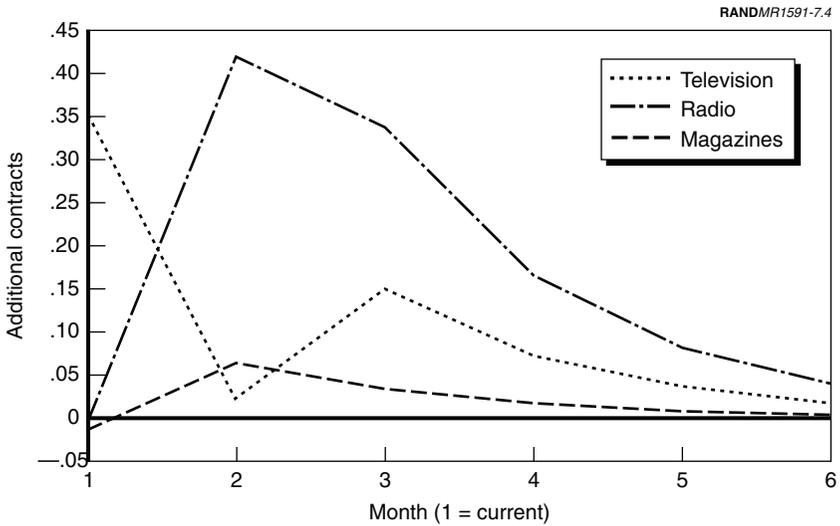
Figure 7.4—Effects of $5 per Capita Extra Spending from Actuals on Additional High-Quality Contracts, by Month, Reduced-Form Estimates

much might have been gained by reallocating the Army's actual advertising budget across media? How much might have been gained by increasing the budget?

Table 7.3 reports estimates bearing on these questions. The middle panel pertains to the effects of reallocating the actual budget; the last panel pertains to the effects of increasing the budget. More specifically, the middle panel reports spending levels for television, radio, and magazines that maximize the total contribution of these media to potential high-quality enlistments with total spending maintained

Table 7.3

Optimal versus Actual Per-Capita Spending Levels—Potential High-Quality Contributions from Reallocating and Increasing Budget

	Actual Allocation		Optimal Allocation		Optimal Allocation for Actual Budget + $10/capita	
	Structural	Reduced Form	Structural	Reduced Form	Structural	Reduced Form
Television ($/capita)	123.20	123.20	105.90	107.40	112.50	115.10
Radio ($/capita)	41.30	41.30	65.10	65.10	67.70	66.80
Magazine ($/capita)	20.30	20.30	18.60	17.10	19.30	17.60
Newspaper ($/capita)	7.70	7.70	3.00[a]	3.00[a]	3.00[a]	3.00[a]
Total ($/capita)	192.50	192.50	192.50	192.50	202.50	202.50
Total high-quality contracts from ads	30.23	23.56	34.52	25.93	36.20	27.83
Additional high-quality contracts, reallocation	NA	NA	4.29	2.37	NA	NA
Additional high-quality contracts, budget increase	NA	NA	NA	NA	1.68	1.90

NOTE: NA = not applicable.

[a]Newspaper spending constrained to $3 per 1,000 young males.

at \$192.50 per 1,000 young males in the MEPS area.[9] To calculate these values, we set spending on newspaper advertising at \$3 per 1,000 young males, which corresponds to the saturation spending level suggested for that medium by the reduced-form estimates.[10] Thus, in view of average actual spending on newspapers of about \$7.70 per 1,000 young males, we allocate \$4.70 more per 1,000 young males to the three other media in addition to their total mean actual spending levels. The right-most panel reports the analogous information assuming that the budget is \$10 per 1,000 young males higher and (again) spending on newspaper advertising is fixed at \$3 per 1,000 young males.

First, the middle panel of Table 7.3 shows that optimal spending levels are remarkably insensitive to whether the reallocation is based on the structural or the reduced-form estimates. Second, the actual allocation of spending across media accords reasonably well with the optimal allocations. For example, the ranking of actual spending levels is the same as the ranking of optimal levels. Third, the estimates suggest nonetheless that there was room for improvement through reallocation of spending across media. In particular, our estimates suggest that during the early 1980s, for the Army's actual advertising budget, spending was roughly \$20 per 1,000 young males too high for television, about \$25 too low for radio, and a few dollars too high for magazines.

How much might such reallocations of spending across media have yielded in terms of additional high-quality enlistments? The second-to-last row of the middle panel of Table 7.3 reports increases in monthly levels of potential high-quality contracts predicted to result from optimal reallocation of spending across media. These calculations (again) assume a baseline level of 70 contracts per MEPS area per month. The estimates for the structural form suggest an additional 4.3 contracts per month (a 6 percent improvement on 70 contracts) was attainable from this reallocation. This figure is interpreted as the effect of improved allocation across media on the

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[9]These optima were calculated using a grid-search (brute-force) method because the function to be maximized is not globally concave.

[10]Varying assumed spending on newspapers by a few dollars cannot have important effects on the optimal spending on the other media because the scales of spending for the other media are one or two orders of magnitude larger than that for newspapers.

potential number of high-quality contracts if both recruiter effort and the number of low-quality contracts were held constant. The reduced-form estimate of an additional 2.4 contracts (about 3.5 percent of the baseline of 70) is interpreted as the effect of holding recruiter effort constant but allowing the allocation of recruiter effort between high- and low-quality youth to adjust to changing recruiting opportunities. Most importantly, in both cases the estimates suggest considerable potential to improve enlistment outcomes without increasing total advertising budgets.

Now consider how a budget increase might best have been allocated and how much the increase might have contributed to high-quality enlistments. The estimates reported in the last panel of Table 7.3 examine this question for a hypothetical budget increase of $10 per 1,000 young males (5.2 percent of the actual budget level). First, according to both the structural and reduced-form estimates, most of a $10 budget increase would have been best used to increase television advertising ($6.60 and $7.70 for the two sets of estimates, respectively), with most of the remainder allocated to increased radio advertising. Second, the extra $10 per 1,000 young males per month is predicted to increase potential high-quality enlistments—relative to the levels implied by the *optimal* allocation of the actual budget—by 1.7 and 1.9 high-quality contracts per month. Thus, a 5.2 percent increase in the budget is predicted to increase potential high-quality enlistments by 4.9 percent (structural estimate) or 7.3 percent (reduced-form estimate). Finally, the predicted increments due to the hypothetical budget increase are 39 and 80 percent of the corresponding estimates of the potential gains from reallocating the actual budget. This suggests that improved allocation of the actual budget could have resulted in more improvement than a 5 percent increase in total advertising spending would have.

SAMPLING VARIABILITY AND ITS IMPLICATIONS

To this point, we have ignored uncertainty due to sampling variability in our parameter estimates. Once we consider sampling variability, questions such as the following arise: How much sampling uncertainty is involved in our estimated optimal spending levels? Does consideration of uncertainty lead to different estimates of optimal spending levels? How much uncertainty is there in our estimates of

both the effectiveness of advertising generally and the improvements available from reallocating spending?

Tables 7.4 and 7.5 report results bearing on these questions that are based on simulations we ran of the sampling distributions of the estimators of the structural and reduced-form parameters. More specifically, for each specification and the associated estimators of the 17 parameters determining advertising effects, we generated a sample of 500 realizations from a multi-normal distribution with mean vector equal to the point estimates (Table 7.1) and variance-covariance matrix as estimated from the (nonlinear) regression.[11]

Columns 1, 2, and 3 of Table 7.4 repeat information from Table 7.3 to aid comparison with the new information contained in columns 4 and 5. We developed the estimates in columns 4 and 5 by calculating for each of the 500 realizations of the parameter sampling distribution the optimal levels of spending on television, radio, and magazines when newspaper spending was assumed to equal $3 per 1,000 young males and the total monthly budget was assumed to be

Table 7.4

Optimal Constant-Budget Spending Levels Conditional on Various Parameter Estimates
(Army, Early 1980s)

	1	2	3	4		5	
		Optimal Allocation for Point Estimates		Optimal Allocation over Samples			
	Actual Allocation	Structural	Reduced Form	Structural		Reduced Form	
				Mean	Std. Dev.	Mean	Std. Dev.
Spending							
TV	123.2	105.9	107.4	122.0	28.8	125.6	32.0
Radio	41.3	65.1	65.1	52.4	29.1	46.2	34.4
Magazines	20.3	18.6	17.1	15.0	11.7	17.7	7.87
Newspaper	7.7	3[a]	3[a]	3[a]	0	3[a]	0

[a]Spending on other media optimized given newspaper spending constrained to $3 per capita.

[11]Use of the normal distribution relies on asymptotic normality of the estimators. In view of the number of observations relative to parameters, the normal approximation should be quite accurate.

Table 7.5

Performance of Constant-Budget Spending Policies over 500 Draws from Sampling Distributions of Parameters
(Army, Early 1980s)

	1		2		3		4		5		6	
	Actual				Optimal for Point Estimates				Average over Samples			
	Structural		Reduced Form		Structural		Reduced Form		Structural		Reduced Form	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Spending												
TV	123.2	0	123.2	0	105.9	0	107.4	0	122.0	0	125.6	0
Radio	41.3	0	41.3	0	65.1	0	65.1	0	52.4	0	46.2	0
Magazines	20.3	0	20.3	0	18.6	0	17.1	0	15.0	0	17.7	0
Newspaper	7.7	0	7.7	0	3	0	3	0	3	0	3	0
Additional high-quality contracts												
TV	14.7	4.08	12.3	3.56	12.07	4.18	9.70	3.26	14.6	4.07	12.6	3.58
Radio	4.46	2.88	2.74	1.34	9.77	4.13	7.66	2.80	7.28	3.79	3.73	1.77
Magazines	4.62	3.49	6.8	3.73	4.31	3.46	6.30	3.68	3.55	3.10	6.43	3.70
Newspaper	7.10	8.23	1.23	2.11	6.24[a]	7.90	1.03	1.96	6.38[a]	8.09	1.03	1.96
Total	30.8	9.07	23.0	5.32	32.7[a]	9.55	24.7	5.32	31.7[a]	8.71	23.8	5.27

[a]Based on 469 (of 500) sampled values of μ_4 that did not lead to an overflow or underflow upon exponentiation.

$192.50 per 1,000 young males.[12]   For example, averaged over 500 draws from the sampling distribution of the estimator of the structural parameters, the optimal monthly levels of per-capita spending on television, radio, and magazines are $122.00, $52.40 and $15.00, respectively. As the standard deviations associated with these optimal allocations indicate, however, there is considerable sampling variation associated with these estimates. For example, a confidence interval constructed for optimal levels of radio and magazine spending (the mean plus and minus roughly two standard deviations) would both contain zero. Similar comments apply to the estimates in column 5, which pertain to the reduced-form estimates. In sum, these results indicate that even if the econometric model is assumed to be correct, sampling variability in the parameters leads to considerable uncertainty about the optimal allocation of spending across the three media.

Clearly, sampling uncertainty might limit our confidence in an analysis of several other practical questions, including the following. Is advertising effective overall? Which media are most effective on the margin? What are the relative effectiveness levels of media alternatives at different budget levels? Table 7.5 reports results bearing on these questions. Specifically, these results pertain to the performance over sampling realizations of three spending policies, or budget allocations, for both the structural and the reduced-form estimates. In subjective probability or Bayesian decision-theoretic terms, the questions explored presently can be interpreted as comparisons of the expected performance of the three spending policies given a subjective distribution over parameter values.[13]

As detailed in the upper ("spending") panel of Table 7.5, the three spending policies are the *actual* (average) monthly spending levels

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[12]These calculations were somewhat computer intensive, with the optimizations requiring 1,000 separate grid searches (one for each draw from a sampling distribution). Spending levels were varied in $1 increments, and each optimization entailed evaluating the objective function (total contribution of advertising to potential high-quality contracts) for roughly 6,500 combinations of values for spending on television, radio, and magazines.

[13]To put it a bit more formally, to use the Bayesian interpretation, we would interpret the sampling distribution as the posterior distribution of the parameter values, an interpretation that can be rationalized (loosely) by assuming that the prior distribution of the parameters is uninformative.

observed in the data; the *optimal* spending levels assuming that the point estimates in Table 7.1 are correct (and assuming spending of $3 per 1,000 young males on newspapers, as first presented in Table 7.3); and the *average* optimal spending levels given each of the realizations of the sampling distribution of the parameters as reported in column 5 of Table 7.4. The second of these spending policies can be described as optimizing spending conditional on the estimated parameter values, and the third can be described as allocating spending according to the means of the optimal levels conditional on various realizations of the sampling distribution. It seems unclear a priori which policy should perform better over repeated samples.

The bottom ("additional contracts") panel of Table 7.5 reports estimated contributions to monthly high-quality contracts (assuming a base level of 70 contracts per MEPS area per month), averaged over repetitions of a sampling distribution, of the spending level for each medium indicated in the upper panel, the total contribution of advertising, and the standard deviations associated with these estimates. For example, the actual spending level is estimated to have contributed 30.8 and 23.0 additional potential high-quality contracts per MEPS area per month for the structural and reduced-form estimates, respectively. Moreover, the standard deviations of these estimates are, respectively, less than one-third and less than one-quarter of the corresponding means, indicating that actual spending levels did indeed contribute to recruitment of high-quality candidates.

The corresponding estimates reported in the last row of columns 3 to 6 provide a refined indication of how much better the Army might have done by reallocating spending across media, as well as which of the two reallocations is more advantageous. The spending levels determined as optimal given the point estimates (columns 3 and 4) outperform the spending levels determined by averaging optimal spending levels over various repetitions of the sampling experiment (columns 5 and 6). Specifically, the first of these two reallocations is estimated to increase monthly high-quality contracts—relative to actual spending levels—by 1.9 (structural specifications) and 1.7 (reduced-form specifications); the corresponding improvements for the second spending policy are 0.9 and 0.8 high-quality contracts, or just about half as large. In view of the sizes of the standard deviations, however, we cannot reject hypotheses involving equal effects of any two pairs of spending policies.

The predicted improvements from the optimal spending policy considered in the middle portion of Table 7.5—namely, 1.9 and 1.7 high-quality contracts per MEPS area per month for the structural and reduced-form estimates, respectively—are considerably smaller than the corresponding improvements projected in Table 7.3 for the same spending policy—4.29 and 2.37 contracts, respectively. It is instructive to consider why. The estimates reported in Table 7.3 assume that the point estimates are correct, whereas the estimates in Table 7.5 use the same allocations of spending per medium but evaluate the effects of that spending (and average its performance) over various values of the parameters. It should not be surprising that the predicted benefits of a fixed spending policy are not as high on average over various sets of parameter values as they appear to be when evaluated using only the point estimates for which the spending policies are, in fact, optimal.[14]

What do the estimates in Table 7.5 suggest about our degree of confidence in the contributions of the individual media? The mean estimates of television advertising's contribution are considerably more than twice their standard deviations for all three spending policies; those for radio exceed 1.9 times their standard deviations for all but one of the six cases, including all four involving optimal spending across media; but those for magazines and newspaper never exceed twice their standard deviations. Thus, the hypothesis that television spending is unproductive can be confidently rejected for all spending levels considered, and the corresponding hypothesis for radio can be rejected for all optimal spending levels. We cannot, however, reject the hypotheses that magazine advertising and newspaper advertising are unproductive.

Finally, how much sampling variability is there in our estimates of the benefits of increasing the budget by $10 per 1,000 young males (representing an approximately 5 percent increase in the overall budget)? Recall that in Table 7.3 (last panel, bottom row), we reported point estimates of 1.68 and 1.90 additional potential contracts from optimal use of the budget increment (relative to optimal use of the actual budget). To examine the sampling uncertainty surround-

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[14]For example, for some realizations of the sampling experiment, the actual spending levels can appear to be better than the alternative spending policy. This cannot happen if we optimize conditional on each realization of the sampling distribution.

ing these predictions, we recalculated them for each of 500 realizations of the parameters. For the structural version of the model, the result is an average increment in potential contracts of 1.52 with a standard deviation of 0.51 and a range of 0.12 to 2.96; for the reduced-form version, the result is 1.70 contracts with a standard deviation of 0.36 and a range of 0.53 to 2.88. Moreover, the mean estimates for the contribution of the additional television spending easily exceed twice their respective standard deviations.[15] In sum, the sampling variability in our parameter estimates is not nearly large enough to undermine the conclusion suggested by the point estimates that a budget increase of roughly 5 percent would have increased opportunities for the Army to recruit high-quality youths and that the associated increments in spending on television advertising would have been productive.

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[15] The means (standard deviations) for the predicted contributions of television, radio, and magazines are, respectively, 1.06 (0.41), 0.35 (0.25), and 0.09 (0.13) for the structural version; and 1.35 (0.33), 0.28 (0.13), and 0.11 (0.10) for the reduced-form version.

ADVERTISING EFFECTIVENESS FROM 1993 TO 1997

Results based on the 1980s Army data may be of limited value to today's policymakers because of various developments since the early 1980s. This chapter reports on analyses of data for all four services from FY 1993 through FY 1997, the latest period for which detailed advertising data are available.[1]

There are several reasons the detailed results for the 1980s may not provide a reliable basis for designing advertising policies today. Specifically, those results describe outcomes of Army advertising policies implemented during the early 1980s, when the creative content, seasonal timing of expenditures, and mix of media were quite different from what they are now. In addition, the recruiting environment has changed in various ways, and so have the marketing options available. We begin by elaborating on these two sets of changes.

1990s CHANGES IN RECRUITING AND MARKETING ENVIRONMENTS

The recruiting environment changed after the early 1980s and continues to evolve. From 1993 to 1997, the strong economy meant that returns to education were relatively high and jobs for inexperienced youths were plentiful, and thus that many potential recruits had attractive educational and nonmilitary employment options after graduating from high school. During this period, there were also large

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[1]The military does not routinely gather detailed information on advertising programs.

declines in youth crime and welfare participation rates. Social scientists attribute these changes partly to a more robust economy, but efforts to explain them empirically have only been partially successful. The upshot is that American youths are now behaving differently, and for the most part, researchers cannot explain why.[2]

Youth attitudes about military service are also likely to have changed because of Desert Storm, the end of the Cold War, and the downsizing of the military. In addition, many years of lower advertising expenditures (see Chapter Two) may have had detrimental effects on DoD-wide and service-level brand equity that have persisted, even as advertising budgets have increased.

At the same time, substantial changes in the mass media may have altered the cost effectiveness of recruiting advertising. First, private-sector firms are using a variety of new marketing strategies, including direct marketing (which emphasizes an immediate "call to action"), infomercials, and mailings. In part, the increased use of these advertising strategies stems from technological change having led to more "space" on cable television and more efficient ways to process information and to target, contact, and screen audiences—all of which make such approaches more cost-effective. Also, the removal of regulatory barriers and the development of alternative sources of programming and information have reshaped the media landscape and influenced advertising markets. In addition to the wide diffusion of cable television and the increasing numbers of channels, satellite services and the Internet have increased dramatically in importance, although private-sector use of the Internet for advertising dropped off after seeing rapid growth during the 1990s.

And as new participants have entered the market, traditional media outlets have become less attractive advertising options. Most apparent is the decline and fragmentation of television audiences. Prime-time viewing of the three major networks, which used to represent 90 percent of all viewers, has fallen to below 70 percent.

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[2]Given that 1997 marked the end of the economic boom and the onset of a downturn, data from the early 1980s may be more informative about current relationships than about relationships during the mid-1990s.

DATA FROM 1993–1997

Table 8.1 reports sample means and standard deviations for the key variables for FY 1993–1997. As in our earlier analysis, these variables represent monthly observations from areas corresponding to Military Entrance Processing Stations (MEPS).[3] The mean level of total contracts for the four services combined was just over 260 per MEPS area per month, with a standard deviation of 140. Of these, on average, 50 percent were male high-school graduates or seniors with AFQT scores in the upper 50 percent—i.e., high-quality male enlistments. The Army had the largest share of these high-quality

Table 8.1

Descriptive Statistics for Data for MEPS-Months Pairs, FY 1993 Through FY 1997

Variable	Mean	Standard Deviation
Total contracts, all services	260.7	140.4
High-quality contracts, all services	168.9	86.7
High-quality male contracts, all services	134.4	69.3
Army high-quality male contracts	46.0	25.4
Navy high-quality male contracts	30.9	18.5
Air Force high-quality male contracts	26.6	13.3
Marine high-quality male contracts	30.9	18.2
Mission, total contracts, all services	288.8	155.4
Production recruiters, all services	181.8	96.0
Unemployment rate	5.53	1.58
Average hourly earnings	12.60	1.57
Qualified military available population	45,475	27,522
Total ad dollars, per capita, all services	723.0	286.2
Total television advertising	417.7	269.0
Army advertising, all media	471.5	184.8
Navy advertising, all media	176.8	108.2
Air Force advertising, all media	28.4	33.8
Marine advertising, all media	46.2	76.2
Joint program advertising, all media	58.0	131.5

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[3]Results based on data organized by battalions (the Army's 41 recruiting districts) are very similar to those organized by MEPS area and reported here.

male enlistments, averaging 34 percent of the total. The Marines and Navy averaged 23 percent each; the Air Force, about 20 percent.

During this period, the total (all-services, low- and high-quality) contract mission averaged 288.8 contracts per month. Comparing this figure with that for average contracts per month indicates that, on average, the services failed to meet monthly contract goals. The Army experienced the largest shortfalls, particularly during the later part of FY 1997, when there were substantial increases in its missions. The average number of production recruiters was 181.8, indicating that the average monthly contracts per recruiter, or write rate, across all services was about 1.4. This contrasts with write rates that exceeded 2.0 in the mid-80s.

The average unemployment rate across the MEPS areas was 5.53, which is considerably lower than the average rate of almost 9 percent during the 1980s (see Chapter Five, Table 5.1). Manufacturing wages averaged $12.60 an hour. The average MEPS area contained more than 45,000 males deemed "qualified military available" (QMA).

Detailed advertising data by medium and geographic area for FY 1993–1997 were constructed along the lines of the Army advertising data described in Chapter Five. In particular, advertising expenditures were allocated to different geographic areas based on the impressions (i.e., the viewers, readers, or recipients) of the media time, space, or pieces delivered in these areas. For example, an expenditure for a national television network buy was allocated to each MEPS area in proportion to the area's share of the number of households that viewed the program nationally.

The average monthly advertising spending for all media and services combined was more than $100,000 per MEPS area during the 1993–1997 period. For econometric purposes, the spending data were expressed on a per-capita basis, with the denominator (population) equal to the 1,000s of male youths between the ages of 17 and 21. On a per-capita basis, advertising expenditures for all four services averaged $723 per MEPS area per month. The Army budget was more than 60 percent of the total; the Navy budget was next largest, at over 20 percent; and expenditures through the Air Force, Marine, and joint programs were considerably lower.

ECONOMETRIC APPROACH

Our initial estimation strategy was to estimate service-specific models similar in structure to the ones developed for the 1980s Army data. This effort was unsuccessful,[4] seemingly because of several factors, including (a) advertising data that were incomplete or exhibited very little variation, (b) changes in recruiter management and media environments (such as those discussed above), (c) turbulence in recruiting markets during the mid-1990s because of the drawdown, and (d) relatively low levels of real advertising expenditures, which may have resulted in the services typically operating on only the lower portions of their advertising S-curves.[5] We elaborate here on the first two of these factors:

- *Available advertising data were incomplete or inadequate.* We were not able to obtain Marine data on advertising other than for national television or Air Force data for local media purchases, and geographic distributions for local advertising expenditures were not available for the Navy. In addition, most media purchases were made nationally, so geographic variation in the data reflects only the extent to which television network viewing patterns differed over geographic markets.[6]

- *The recruiting environment changed substantially.* As discussed earlier, a strong economy during the mid-1990s made the military less attractive relative to other options available to high-quality youths. Traditional supply measures, such as military

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[4]For example, estimation routines often failed to converge, and when they did converge, estimated parameter values were often implausible (e.g., advertising effects were sometimes large and negative). In addition, estimated parameter values were very sensitive to changes in estimation strategy that should not be important for a well-specified model and reliable data.

[5]To successfully estimate an S-curve, it is very advantageous for the spending data to be distributed over all portions of the curve.

[6]In contrast, geographic variation in the early 1980s advertising data was enhanced by two factors. First was the implementation of the Advertising Mix Experiment, which systematically and significantly altered levels of service-specific and joint advertising in different regions of the country. Significantly, the test and control cells were chosen to avoid correlations between levels of spending and other explanatory variables. Second, the Army maintained a local advertising program in which individual battalions (and local advertising representatives) had independent discretion over fund allocations.

versus civilian wage differentials and unemployment rates, fail to capture these effects adequately.[7]   In addition, it seems likely that during 1993–1997, unlike in the early 1980s, the services were competing for a more-or-less fixed pool of potential enlistees because of attractive alternatives available to youths.[8] Finally, there have been major changes in recruiter management, particularly in the Army. Most importantly, perhaps, levels of missions relative to market potential increased substantially during the 1990s. Recruiter motivation, morale, and productivity could have been adversely affected.[9]

We thus have been unable to estimate advertising effects for the mid-1990s separately for different services and media while using the logistic functional form given by Chapter Six's Equation 6.2 and the relatively flexible dynamic specifications detailed in Equation 6.1. We have, however, developed results for the military advertising programs as a whole. Focusing on aggregate enlistments avoids the need to model and sort out the complex cross-service enlistment flows stemming from competition for a largely fixed pool of potential recruits. Our results appear to provide insights that can help guide policymakers in the future.

Our estimating equation is

$$\log(E_t) = \sum_i \beta_t X_{it} + \kappa / [1 + \exp(5 - \mu a_t)] \tag{8.1}$$

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[7]For example, we will see that the statistical model that predicts year-to-year changes in high-quality contracts (as a function of changes in supply variables such as unemployment rates, civilian wages, recruiters, and advertising expenditures) explains only about 15 percent of the variation in enlistment outcome data in the 1990s. In contrast, our models for the 1980s explain nearly 60 percent.

[8]In previous recruiting environments, this was not the case. In fact, evidence from the Advertising Mix Test (Dertouzos, 1989) suggests that advertising investments by individual services expanded the market for all the services.

[9]In addition, the Army changed its methods of missioning (its model for allocating national missions to brigades and battalions) and the detail with which missions are specified (i.e., the number of mission box categories has contracted from 17 to 3); and in FY 1995 (under Success 2000), the unit for performance measurement changed from individual recruiters to teams of recruiters (stations).

where the dependent variable, $\log(E_t)$, is expressed as the year-to-year change in the logarithms of all-service enlistments.[10] This outcome is assumed to depend on (a) X_{it}, market and resource factors that are also expressed as differences in the logarithms, including the unemployment rate, civilian earnings, QMA population, numbers of black and Hispanic males, number of recruiters, and total mission for each of the four services; and (b) a_t, the contemporaneous level of per-capita advertising for the four services and all media combined. As with the models discussed in Chapters Six and Seven, the advertising expenditures enter through the logistic function detailed in Equation 8.1, with two parameters (κ and μ) determining the shape of the S-curve describing how enlistments vary with contemporaneous advertising spending.

RESULTS

Table 8.2 reports estimated coefficients and standard errors for six regressions.[11] The first regression examines determination of high-quality male enlistments. Enlistment supply is estimated, as would be expected, to be an increasing function of unemployment rate, QMA population, level of all-service missions, and number of all-service recruiters. Advertising, expressed as contemporaneous (per-capita) spending by all four services on all media, is estimated to have a statistically significant positive effect on high-quality male enlistments. The estimate of κ suggests that saturation levels of advertising would increase enlistments by more than 11 percent. Similar results (column 2), were obtained for total enlistments using the independent variables shown in column 1.

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[10]The annual differencing is consistent with our estimation approach for the early 1980s Army data. We emphasize, however, that the results reported here are sensitive to whether this differencing is implemented. Assessing the performance of this specification in comparison to alternatives is quite challenging and warrants future research.

[11]The Appendix provides information on the relative performance of the logarithmic and S-curve functional forms for advertising effects and compares the early 1980s estimates for the Army to the FY 1993–1997 estimates for all services combined.

Table 8.2

Determinants of Enlistments, All Services, FY 1993–1997
(standard errors in parentheses)

Independent Variable		High-Quality Males	Total	High-Quality Males	High-Quality Males	High-Quality Males	High-Quality Males
Intercept	β_0	−0.0578	−0.0191	−0.0513	−0.0557	−0.0555	−0.0555
		(0.0072)	(0.0064)	(0.0074)	(0.0072)	(0.0071)	(0.0071)
log(unemployment)	β_1	0.1506	0.1752	0.1405	0.1437	0.1428	0.1424
		(0.0302)	(0.0270)	(0.0301)	(0.0304)	(0.0301)	(0.0301)
log(earnings)	β_2	−0.3588	−0.4805	−0.3683	−0.3537	−0.3547	−0.3510
		(0.1704)	(0.1527)	(0.1707)	(0.1706)	(0.1706)	(0.1708)
log(QMA)	β_3	1.7868	1.7530	1.8275	1.8062	1.8011	1.8061
		(0.1764)	(0.1579)	(0.1768)	(0.1778)	(0.1766)	(0.1769)
log(black males)	β_4	−0.0158	0.0034	−0.0190	−0.0159	−0.0158	−0.0158
		(0.0182)	(0.0163)	(0.0183)	(0.0183)	(0.0182)	(0.0182)
log(Hispanic males)	β_5	0.2938	0.1753	0.2486	0.2894	0.2912	0.2949
		(0.1080)	(0.0967)	(0.1103)	(0.1082)	(0.1081)	(0.1083)
log(total missions)	β_6	0.2087	0.1632	0.2134	0.2146	0.2150	0.2164
		(0.0176)	(0.0158)	(0.0176)	(0.0177)	(0.0175)	(0.0178)
log(total recruiters)	β_7	0.1089	0.1686	0.1046	0.1022	0.1017	0.0988
		(0.0278)	(0.0249)	(0.0278)	(0.0281)	(0.0278)	(0.0281)
Total advertising ($ per capita)	κ	0.1168	0.1782	—	—	0.0753	0.0698
		(0.0628)	(0.1415)			(0.0306)	(0.0234)
	μ	0.0038	0.0033	—	—	0.0062	0.0051
		(0.0009)	(0.0010)			(0.034)	(0.0012)
Television advertising ($ per capita)	κ_1	—	—	0.1408	0.0083	—	—
				(0.0435)	(0.0374)		
	μ_1	—	—	0.0055	0.0051	—	—
				(0.0006)	(0.0011)		
Other (not TV) advertising ($ per capita)	κ_2	—	—	—	0.4965	—	—
					(3.8744)		
	μ_2	—	—	—	−0.0025	—	—
					(0.0127)		
Interactions with per-capita advertising:							
Veteran population	μ_3	—	—	—	—	−0.0003	—
						(0.0010)	
Summer months	μ_4	—	—	—	—	—	0.0011
							(0.0017)
R-squared		0.1429	0.1599	0.1433	0.1423	0.1423	0.1423

Column 3 reports results for high-quality males using television expenditures only. Column 4 reports results for high-quality males using both television advertising and all other expenditures, allowing for separate effects. The nontelevision advertising expenditures are not statistically significant, and the large standard errors preclude any strong conclusions. Incomplete data for local advertising categories (discussed earlier) might account for this imprecision.

In the last two columns of Table 8.2, per-capita total advertising expenditures are interacted with the veteran population (expressed as a percentage of the general population) and season, alternatively, to examine two issues. The first issue is whether advertising is more effective in better recruiting areas. The insignificance of the parameter corresponding to the interaction term indicates that the marginal impact of advertising expenditures does not depend on the size of a market area's veteran population. This finding provides no basis for favoring more or less fertile recruiting areas in the allocation of advertising resources.[12] The second issue concerns whether summer is more productive than other seasons are. As indicated in the table, advertising dollars spent during the summer months appear to be no more or less productive at the margin than dollars spent during other times of the year. This has implications for the timing of expenditures—an issue we examine below.

Efforts to estimate lagged effects of advertising were not successful. Introducing lagged advertising expenditures did not substantially alter the estimates pertaining to contemporaneous advertising effects, but the estimated effects of lagged expenditures were not statistically significant. Given the imprecision of the latter estimates, however, one should not infer that lagged effects are unimportant. Recall that information about spending on media other than television was missing or incomplete. As we found in our analysis of the 1980s Army data, it was these media that had the strongest lagged effects. Thus, the conclusions we drew for the 1980s might well hold up if more reliable advertising data were available.

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[12]This possibility was raised by advertising consultants retained by DoD to review the overall advertising strategy. See "Recruitment Advertising Review: Topline Findings," Bozell/Eskew Advertising, August 4, 1999.

We used parameter estimates from the first three columns of Table 8.2 to estimate average and marginal costs of using advertising to increase enlistments. Table 8.3 reports such estimated average and marginal costs for different levels of advertising expenditure. As expected from an S-curve relationship, low levels of per-capita expenditures are not very effective and thus involve high average and marginal costs. Substantively, this is because the requisite frequency of exposure to a message is not achieved at low levels of spending. For example, total enlistments (see middle set of three columns of Table 8.3) are estimated to increase by only 0.28 percent by spending only $200 per capita (less than 30 percent of the actual average monthly level). The marginal cost of an enlistment at $200 per capita is over $100,000. For high-quality enlistments (first set of three columns), the marginal cost is, not surprisingly, more than twice as high.

As expenditures approach average spending levels of $723 per capita, however, advertising becomes much more effective on the margin. For total enlistments, for example, marginal cost falls to below $10,000 for spending of $700 per capita and continues to fall as spending reaches levels that are 40 percent above average spending over the 1993–1997 period. For high-quality males, marginal costs are estimated to decrease until the spending levels reached are twice as high as the mean spending levels. Thus, advertising seems to be most effective at real spending levels comparable to the higher budgets of the 1980s. But beyond a certain spending level, advertising is no longer cost-effective at the margin.

We also analyzed a series of linear regressions of shares of enlistments flowing to the individual services and shares of enlistments of different types. The results are presented in Table 8.4. The first four columns examine the effect of advertising (and other variables) on the Army, Navy, Air Force, and Marine shares of high-quality enlistments, respectively. Results pertaining to the percentage of males, high-quality males, and graduates (vs. seniors) are reported in the last three columns.

Table 8.5 looks at the quantitative significance of the estimated effects of advertising on the services' shares. The first two columns report the estimated marginal effects of a $100 increment in per-capita spending. The simulations—whose results are summarized in the

Table 8.3

Total Effects of Advertising on Enlistments, and Average and Marginal Costs for Various Per-Capita Spending Levels

Per-Capita Ad $	Total Advertising Effects on High-Quality Males			Total Advertising Effects on All Enlistments			TV Advertising Effects on High-Quality Males		
	Increased Enlistments (%)	Average Cost ($)	Marginal Cost ($)	Increased Enlistments (%)	Average Cost ($)	Marginal Cost ($)	Increased Enlistments (%)	Average Cost ($)	Marginal Cost ($)
200	0.17	140,181	221,890	0.28	83,925	100,348	0.23	70,285	125,119
300	0.24	144,154	152,818	0.48	73,687	59,235	0.32	75,925	90,437
400	0.35	132,172	105,792	0.81	58,094	35,535	0.44	73,048	65,593
500	0.51	114,112	73,784	1.34	43,658	21,894	0.61	66,068	47,797
600	0.74	95,173	52,011	2.17	32,339	14,083	0.85	57,578	35,055
700	1.05	77,856	37,221	3.39	24,233	9,678	1.16	49,033	25,937
800	1.48	63,155	27,202	4.99	18,796	7,312	1.58	41,183	19,419
900	2.06	51,266	20,457	6.86	15,370	6,252	2.13	34,357	14,771
1,000	2.79	41,993	15,980	8.76	13,375	6,169	2.83	28,642	11,470
1,100	3.69	34,979	13,099	10.43	12,363	7,037	3.72	23,994	9,148
1,200	4.72	29,829	11,386	11.71	12,008	9,124	4.80	20,303	7,542
1,300	5.82	26,169	10,584	12.61	12,084	13,080	6.05	17,437	6,473
1,400	6.93	23,674	10,573	13.19	12,439	20,130	7.44	15,261	5,821
1,500	7.96	22,077	11,352	13.55	12,972	32,462	8.92	13,652	5,512
1,600	8.86	21,160	13,037	13.77	13,619	53,902	10.39	12,499	5,513
1,700	9.60	20,754	15,879	13.90	14,336	91,099	11.78	11,709	5,824
1,800	10.18	20,728	20,304	13.98	15,097	155,592	13.04	11,206	6,478
1,900	10.61	20,984	26,973	14.02	15,886	267,388	14.11	10,928	7,550
2,000	10.93	21,446	36,882	14.05	16,692	461,166	15.00	10,823	9,159
2,100	11.16	22,059	51,513	14.06	17,508	797,036	15.70	10,853	11,487
2,500	11.56	25,345	116,259	14.08	20,817	2,622,936	17.21	11,788	21,510
3,000	11.66	30,157	594,654	14.08	24,977	28,068,416	17.71	13,751	82,152

Table 8.4

**Effects of Advertising on Enlistment Shares of High-Quality Youth,
Regression Estimates
(standard errors in parentheses)**

Independent Variable	Army Share	Navy Share	Air Force Share	Marine Share	Percent Male	Percent High Quality	Percent Graduate
Intercept	–0.0146	–0.0329	0.0027	0.0186	–0.0167	–0.0199	0.0310
	(0.0098)	(0.0146)	(0.0018)	(0.0133)	(0.0030)	(0.0040)	(0.0051)
log(unemployment)	–0.1135	0.2978	0.0031	–0.0509	–0.0258	–0.0126	0.0506
	(0.0389)	(0.0580)	(0.0072)	(0.0528)	(0.0117)	(0.0157)	(0.0201)
log(earn)	0.3913	0.3046	0.0208	0.3687	0.0517	0.0379	–0.1485
	(0.2200)	(0.3283)	(0.0408)	(0.2990)	(0.0663)	(0.0887)	(0.1137)
log(QMA)	0.5421	1.9349	0.0750	–1.0249	0.2175	–0.3740	–0.0224
	(0.2377)	(0.3547)	(0.0441)	(0.3230)	(0.0717)	(0.0958)	(0.1229)
log(black males)	–0.0511	–0.0194	–0.0129	0.0085	–0.0215	0.0020	–0.0137
	(0.0235)	(0.0351)	(0.0044)	(0.0320)	(0.0071)	(0.0095)	(0.0122)
log(Hispanic males)	–0.4427	–0.1339	–0.0412	0.3027	–0.0126	0.1073	–0.2164
	(0.1404)	(0.2094)	(0.0260)	(0.1907)	(0.0423)	(0.0566)	(0.0726)
log(Army mission)	0.0600	0.0390	–0.0031	–0.0534	0.0152	0.0116	–0.0383
	(0.0106)	(0.0158)	(0.0020)	(0.0144)	(0.0032)	(0.0043)	(0.0055)
log(Air Force mission)	–0.0603	–0.0435	–0.0008	–0.0039	–0.0033	–0.0234	0.0295
	(0.0162)	(0.0241)	(0.0030)	(0.0220)	(0.0049)	(0.0065)	(0.0084)
log(Navy mission)	0.0123	0.0806	0.0021	–0.0362	0.0023	0.0104	–0.0099
	(0.0161)	(0.0241)	(0.0030)	(0.0219)	(0.0044)	(0.0058)	(0.0075)
log(Marine mission)	–0.0709	0.0040	–0.0026	0.1222	–0.0198	0.0120	0.0116
	(0.0144)	(0.0215)	(0.0027)	(0.0196)	(0.0049)	(0.0065)	(0.0083)
Total ad $ per capita	–0.0070	0.0181	–0.0002	–0.0054	0.0009	–0.0025	–0.0009
	(0.0023)	(0.0035)	(0.0004)	(0.0032)	(0.0007)	(0.0010)	(0.0012)

last two columns—examined the impact of doubling the advertising budget. The Navy appears to benefit the most from such a doubling, its share predicted to increase from 23 to 25.9 percent. The Army share is predicted to decline by more than 1.5 percentage points; predicted changes for the Marines and Air Force are smaller and not significantly different from zero.

While all services appear to gain from advertising, the Navy appears to gain the most. Whether this is because the Navy's advertising program is especially effective or because the Navy benefits more than the other services from the other services' advertising programs cannot be determined from these results. It may simply be that the Navy's budget levels allow the Navy to more rapidly reach portions of

Table 8.5

Simulated Effects of Advertising on Enlistment Mix

Category	Impact of $100 Increase		Distribution of Enlistments (%)	
	Coefficient	Standard Error	Before Ad In-crease	Double Ad Budget
Navy share	0.0181[a]	0.0035	23.0	25.9
Army share	−0.0070[a]	0.0023	34.0	32.3
Air Force share	−0.0002	0.0004	20.0	20.0
Marine share	−0.0054	0.0032	23.0	22.1
Males	0.0009	0.0007	80.0	80.5
High quality	−0.0024[a]	0.0010	64.4	63.3
Graduates	−0.0009	0.0012	67.2	66.7

[a]Significantly different from zero.

its S-curves that achieve efficiencies more rapidly than is the case for the other services. Whatever the reason, the Navy appears to have been the greatest beneficiary of the advertising budget increases during FY 1993–1997.

Table 8.5's results suggest that any effects of advertising expenditures on the services' shares of males and graduates are inconsequential. This suggests that these markets, from an advertising targeting perspective, may not require different creative approaches or media purchase plans. However, advertising has a statistically significant, albeit small, effect on enlistee quality mix. Other things being equal, high-quality enlistments are projected to decrease from 64.4 to 63.3 percent with a doubling of the advertising budget. Any such tendency could probably be overcome with appropriate goaling and job allocation algorithms that make it more difficult to enlist individuals with less desirable credentials.

Table 8.6 presents seasonal indices—i.e., service-specific monthly means are scaled to equal 1.0—of advertising dollars for DoD as a whole and for each of the four services. For FY 1993–1997, DoD-wide advertising expenditures peaked in the months of January and September and were lowest in the summer months. As reported ear-

Table 8.6

**Seasonal Distribution of Advertising Purchases, FY 1993–1997
(indexes: 1 = service-specific monthly mean)**

Month	DoD	Army	Navy	Marines	Air Force
January	1.41	1.09	1.51	4.39	1.39
February	0.96	0.90	1.19	0.50	1.43
March	1.19	1.21	1.33	0.37	1.43
April	1.08	1.18	1.06	0.00	1.46
May	1.09	1.26	0.82	0.00	1.61
June	0.75	0.92	0.46	0.24	0.57
July	0.56	0.71	0.34	0.02	0.25
August	0.64	0.75	0.21	0.00	2.46
September	1.25	1.20	1.84	0.04	0.36
October	1.15	1.04	1.27	2.24	0.54
November	0.97	0.89	1.00	2.00	0.39
December	0.97	0.85	0.94	2.22	0.25

lier (see last column of Table 8.2), the marginal effects of advertising, holding baseline spending levels constant, may not vary seasonally.[13]

Seasonal spending patterns differ substantially by service. Over months from 1993 to 1997, the Army appears to have had a smoother pattern of spending than the other services did, while Marine activity was highly concentrated during the first four months of the fiscal year (especially in January), and the Air Force favored high levels of spending in August.

Using the S-curve estimates for total enlistments as a function of aggregate advertising, we analyzed the projected change in enlistments that would result from various redistributions of spending over the year. In doing these simulations, we alternatively assumed the average observed monthly spending level ($723 per capita) and twice that

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[13]This results from the S-curve shape. Specifically, the low-levels of spending seen during the summer months render advertising relatively ineffective because they do not enable the services to reach the relatively steep portions of their S-curves, whereas marginal productivity is higher for the increased spending during September and January. We emphasize that this difference in efficacy stems from different levels of spending across seasons rather than from anything inherently different about the seasonal effects of advertising, which are not allowed for in our econometric specification.

Table 8.7

**Simulated Effects on Enlistment of Changes in Advertising Expenditure
Timing for Different Budget Levels and Media Mixes**

Budget Level	Increase in Enlistments from Advertising (%)							No. of Monthly Pulses
	DoD Timing	Army Timing	Navy Timing	Marine Timing	Air Force Timing	Smooth Timing	Pulse Timing	
Maintain level and mix	1.4	1.3	1.8	4.0	2.6	1.2	5.4	4
Double level, maintain mix	8.4	8.2	8.7	6.2	8.5	8.1	10.8	9
Maintain TV only	1.0	0.9	1.3	3.0	1.9	0.9	4.1	4
Reallocate funds to TV	4.3	4.0	4.9	4.7	5.5	3.7	7.1	7

level. We also analyzed the effect of switching dollars from "other" media (radio, newspaper, etc.) to television. The results are presented in Table 8.7.

For the first column of Table 8.7, we combined various aggregate annual spending scenarios with the seasonal pattern of spending that prevailed, on average, across DoD during FY 1993–1997 (see Table 8.6). Our simulations indicate that the increase in DoD-wide enlistments resulting from the actual levels and timing of spending was 1.4 percent. Doubling the advertising budget—while maintaining the media mix and time pattern of spending—might have produced an additional 7 percent increase in DoD-wide enlistments, reflecting movement to steeper (more productive) portions of the S-curve. Projections were also done under the assumptions that nontelevision advertising was eliminated completely (and budgets were reduced) and, alternatively, that only television spending was doubled.

The DoD timing estimates (column 1) indicate that maintaining only television advertising would result in an aggregate enlistment effect of 1 percent, or 71 percent of the total estimated impact of actual advertising (i.e., of 1.4 percent). Thus, since television averaged 57 percent of the budget over this period, it was about 25 percent more ef-

fective than other media.[14] The last entry of column 1 in Table 8.7 provides projections for funds reallocated to the television budget from other media. The predicted gain in enlistments is almost 3 percent (4.3 percent minus 1.4 percent). Thus, the estimates suggest that about half of the gain associated with doubling the entire advertising budget could have been achieved by using a more effective mix.

The other columns of Table 8.7 examine alternative timing strategies for spending. For example, columns 2 through 5 simulate the effect of patterns observed for the Army, Navy, Marine Corps, and Air Force, respectively. In other words, we assumed that DoD monthly patterns changed to reflect the pattern favored by the individual services (see Table 8.6). Note that the productivity of the actual budget level and media mix is improved the most by employing the seasonal pattern observed for the Marines. Specifically, spending concentrated in a few months would exploit the steepest portions of the S-curve and increase the enlistment gains from 1.4 percent to 4 percent. In contrast, equal spending over all 12 months would lower the total productivity of advertising from 0.014 to 0.012, or by 16 percent—see column labeled "smooth timing." Lastly, "pulse timing"— concentrating spending in selected months to fully exploit the S-curve relationship—would increase the total productivity of advertising to 5.4 percent.

The key lesson about expenditure timing is that actual advertising budgets were not large enough for constant levels of advertising expenditures over time to be cost-effective. Dollars should have been concentrated in selected months. Which months are chosen depends on other service goals, such as the need to match accession flows to training capacity.

For different budget levels, the preferred time pattern of spending can change considerably. Note that a larger budget—specifically,

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[14]Recall that the overall impact of nontelevision advertising was estimated to be insignificantly different from zero, probably because of incomplete data and the resulting large standard errors of the estimates. The data suggest nonetheless that there is some productivity associated with the other media, on average. Certainly, some portions of the budget, such as those for radio or magazines, could be especially valuable at lower levels of spending, as indicated by the results for the early 1980s Army data.

doubling nominal spending to achieve levels of real spending achieved a decade earlier—implies a smoother pattern of expenditures. That is, one can achieve effective levels of spending during more months of the year when budgets are higher. For example, applying DoD-wide the Marine pattern of allocating most advertising expenditures to only four months of the year would waste money if the DoD budget were twice its actual level, because the S-curves' saturation levels would be approached and the marginal effects of much of the incremental spending in particular months would be quite small. The other services' time patterns, as well as a complete smoothing, yield about 8 percent increases in enlistments when the budgets are doubled. But even at the doubled spending levels, there is some gain associated with pulse timing: advertising would be roughly 25 percent more productive if all dollars were allocated to about nine months of the year.

The optimal timing also depends on the media mix. For example, at twice the television budget, the Air Force pattern would be the most effective of the four service patterns, albeit less effective than pulsing during seven months (with no advertising in five months).

In sum, the results suggest that more smoothing over time is desirable for higher budget levels than those that existed during 1993–1997 because advertising is most cost-effective when spending reaches the relatively steep portions of the S-curves, but not far beyond. Apparently, the services' advertising agencies over this period were aware of this, as evidenced by the fact that the Army, with the highest of the services' budgets, had the smoothest allocation, and the Marines, with its lower budget, concentrated its spending during four months of the year. However, the results indicate that at actual budget levels, large improvements might have been achieved by allocating more dollars to fewer time periods.

CONCLUSIONS

Advertising appears to have been effective in increasing enlistments both in the early 1980s and during the mid-1990s. Although substantial improvements might have been achieved during the mid-1990s by changing the mix of the media used to advertise—specifically, by using more television—and by concentrating expenditures in fewer months, advertising compares quite favorably with other options for attracting young men and women into the Armed Forces.

Using the elasticity estimates reported in Chapter Eight (in column 2 of Table 8.2), we computed marginal cost estimates so that we could compare alternative policies. These estimates are provided in Table 9.1. Under the assumption that the annual cost of adding a recruiter is about $45,000 (salary plus other expenses), the estimated recruiter elasticity, when evaluated at the sample mean values, indicates that the marginal cost of gaining an additional enlistment by increasing the recruiting force was about $15,565 during FY 1993 to FY 1997. In contrast, the marginal cost of gaining an extra enlistment by increasing military wages was much higher, at $72,917.[1] As with earlier estimates, this cost is high primarily because any wage increase has to be paid to all first-term enlistees, regardless of whether they would have entered the Armed Forces without a pay increase.

The marginal cost of increasing enlistments via advertising averaged about $26,000 during FY 1993–1997, which exceeds the cost via addi-

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[1]This estimate assumes that the increase is for one year only, applied to a base of $35,000. This assumption is conservative and thus likely to understate the true cost of attracting new enlistments via salary increases.

Table 9.1

Comparison of Marginal Costs

Policy Change	Marginal Cost of Enlistments ($)
Advertising budget at mean levels	25,937
Advertising budget at twice mean level	5,821
Television budget only (at mean)	9,678
Increase in recruiters	15,565
Increase in military wages	72,917

tional recruiters. And, in comparison to the 1980s, the marginal cost associated with advertising appears to have increased significantly. While this is partially because of increases in the relative price of advertising, it is primarily the result of the services' reduced nominal advertising budgets having moved spending to less effective (less steep) portions of the S-curve. Indeed, at twice the actual advertising budget—a level comparable to the 1980s spending levels—marginal cost falls below $6,000. This cost compares quite favorably with costs during the 1980s and indicates that advertising still has great potential as a recruiting tool in comparison with other alternatives.

Moreover, even at current budget levels, advertising dollars could be spent more effectively, driving marginal costs below those of other policy options. For example, the marginal cost of expanding the television budget only (evaluated at actual budget levels) would be under $10,000, significantly below the marginal costs of increasing wages or the size of the recruiting force. We have also seen that the services could make their advertising more productive by implementing a different expenditure pattern (pulsed timing) that enables spending to achieve large effects during the months in which it is concentrated. Such changes could reduce marginal costs even further.

Despite these findings, many puzzles remain. As indicated by the 1980s results, additional productivity enhancements via budget reallocations among media are likely to be possible, although there are difficulties (discussed in Chapter Eight) that preclude any updated analysis of media (or program) mix. It would be useful to (a) evaluate the effects of using alternative media, such as the Internet, direct

marketing, and cable television; (b) estimate separate relationships for the individual services, using richer models that account for competitive interactions, more general dynamics, and synergies between types of media; and (c) reconsider the effects of advertising in the context of the recruiting environment changes likely to have resulted from the events of September 11, 2001, and its aftermath, as well as from the economic downturn.

Such analyses are possible, but perhaps only if there are careful efforts to generate more-useful variation in advertising activities and systematically gather complete and accurate advertising data in a timely fashion. Correlations between advertising and other factors likely to affect enlistments make it very difficult to disentangle the effects of advertising from those of other factors. Future research efforts and military advertising policy could be considerably enhanced if controlled experiments similar to the 1980s Advertising Mix Test were implemented. Indeed, experimentation may be necessary to understand the especially complex issues, such as inter-service effects of advertising, and to develop estimates that are reliable enough to guide relatively subtle decisions, such as those involving media mixes and expenditure timing.

Despite the data problems, major conceptual and econometric challenges, and unstable recruiting environments, we reached a key policy conclusion concerning military advertising that appears to be robust: Advertising still appears to be a cost-effective alternative for promoting enlistments and should play a central role in DoD's portfolio of tools for meeting enlistment objectives.

MODEL SPECIFICATION TESTS AND TIME PERIOD COMPARISONS

This appendix presents results for some simple descriptive models for the 1980s and 1990s databases. Due to data differences, the results presented in the report are not directly comparable. Certain explanatory variables were not available in the 1980s data set, and our reported results for the 1980s pertained to the Army only, whereas our analysis of the 1990s period was for all four services.

This exercise was conducted for two reasons. First, we hoped to standardize the model so that the two time periods could be compared. Second, we hoped to assess the advantages of our specification for advertising. In particular, we wished to compare results from a conventional logarithmic specification to those from a specification using the "S-curve" formulation that is more consistent with the marketing literature and the underlying theory of advertising effectiveness.

Table A.1 presents the results from the simple models, which compared differences of logs for each time period. Three outcomes are particularly striking. First, the S-curve formulation significantly outperformed the simple model. The ability of the newer models to explain variation in enlistment outcomes (as indicated by the respective R-squared statistics) was somewhat higher. In addition, the qualitative nature of the results can be dramatically altered by the alternative specification. Indeed, for the 1990s, the estimated advertising effect was actually negative using the log-linear model. Lastly, the advertising results for the two periods are quite similar. The total

Table A.1

Specification Tests and Comparison of 1980s and 1990s Results

		High-Quality Male Contracts in 1980s, Army Only		High-Quality Male Contracts in 1990s, All Services	
Intercept	β_0	0.0230	0.0230	–0.0448	–0.0582
		(0.0184)	(0.0184)	(0.0077)	(0.0072)
log(mission)	β_1	0.2254	0.2298	0.2214	0.2096
		(0.0377)	(0.0376)	(0.0176)	(0.0177)
log(recruiters)	β_2	0.1099	0.1099	0.0901	0.1084
		(0.0753)	(0.0753)	(0.0279)	(0.0279)
log(earnings)	β_3	0.3911	0.3911	–0.3376	–0.3276
		(0.3768)	(0.3768)	(0.1716)	(0.1713)
log(unemployment)	β_4	0.7377	0.7377	0.1392	0.1525
		(0.0363)	(0.0363)	(0.0304)	(0.0302)
log(QMA)	β_5	—	—	1.800	1.820
				(0.1801)	(0.1777)
log(per-capita ad dollars)	β_6	0.0894	—	–0.0202	—
		(0.0032)		(0.0093)	
Total advertising	κ	—	0.1468	—	0.1135
($ per capita)			(0.0190)		(0.0577)
	μ	—	0.0406	—	0.0039
			(0.0024)		(0.0009)
R-squared		0.5039	0.5063	0.1383	0.1414

effects of advertising (given the chosen media mix and creative content) for the two periods are not significantly different.

Note that the saturation effects (given by the parameter κ) are 14 percent of high-quality Army contracts and 11 percent of high-quality total service contracts for the two periods. In addition, the estimate of μ indicates that saturation levels were achieved considerably more rapidly for the Army in the 1980s. In fact, the estimates suggest that the maximum effect for the Army occurred at monthly per-capita levels of spending of just over $300. For all services in the 1990s, this level was seven times higher, or $2,100. As we have noted, however, advertising costs doubled from the 1980s to the 1990s. Thus, in real 1986 dollars, the saturation point was $1,050 in 1996. Also, the Army advertising budget was about one-third of the total budget in 1996. This suggests that the Army saturation level was about one-third of $1,050, or about the same as during the 1980s.

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