NAVAL POSTGRADUATE SCHOOL
Monterey, California

19980611 022

**A STATISTICAL ESTIMATION OF NAVY ENLISTMENT
SUPPLY MODELS USING ZIP CODE LEVEL DATA**

by

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March, 1998

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE March 1998	3. REPORT TYPE AND DATES COVERED Master's Thesis

4. TITLE AND SUBTITLE A STATISTICAL ESTIMATION OF NAVY ENLISTMENT SUPPLY MODELS USING ZIP CODE LEVEL DATA	5. FUNDING NUMBERS
6. AUTHOR(S) Hostetler, David L.	

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000	8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.	12b. DISTRIBUTION CODE Unclassified/A

13. ABSTRACT *(maximum 200 words)*

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14. SUBJECT TERMS RECRUITING, MANPOWER SUPPLY	15. NUMBER OF PAGES 48
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT Unclassified/A	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL

NSN 7540-01-280-5500

Standard Form 298 Rev. 2-89)
Prescribed by ANSI Std. 239-18

A STATISTICAL ESTIMATION OF NAVY ENLISTMENT SUPPLY MODELS USING ZIP CODE LEVEL DATA
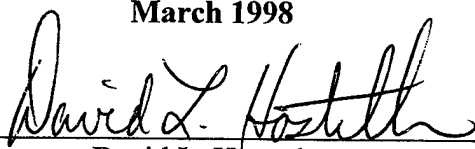
David L. Hostetler
Lieutenant Commander, United States Navy
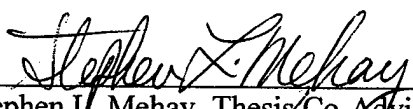B.S., United States Naval Academy, 1986

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
March 1998

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ABSTRACT

The Department of Defense has relied greatly upon active duty members assigned to recruiter positions to achieve enlistment goals. The Commander, Navy Recruiting Command (CNRC) is tasked with ensuring that Navy recruitment goals are attained in order to maintain the supply of personnel to support prescribed force size. This thesis examined the Navy Recruiting Stations and their respective production of new contracts using zip code level data from the Standardized Territory Analysis Management (STEAM) database. The effect of individual level station attributes was predicted using regression with new contract production as a function of recruiting station population statistics drawn from the STEAM database. A secondary purpose of this thesis was to determine if the interaction of the target recruiting population, the number of recruiters assigned to a market, and the presence of other armed forces recruiting stations in the same location had an effect on recruiting production. Both models showed that recruiter presence was the most important factor in attaining new contracts. Also, Navy contracts were positively related to other armed services recruiting production. This suggests complementarity. The county unemployment rate was positively related to Navy recruiting production, as were all race/ethnicity coefficients.

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I. INTRODUCTION

A. GENERAL

With the advent of the All-Volunteer Force (AVF) in 1973, the Department of Defense has relied greatly upon active duty members assigned to recruiter positions to ensure enlistment goals are achieved. The Commander, Navy Recruiting Command (CNRC) establishes an annual goal for the entire recruiting force. CNRC is tasked with ensuring that Navy recruitment goals are attained in order to maintain the supply of personnel needed to support the required force size. Usually, the recruiting goals are met or exceeded; however, there have been times when the goals have been missed.

The two most important types of goals are new contract accessions into the Delayed Entry Program (DEP) and the "shippers." The "shippers" include the number of enlistees that have been in the DEP and are now actually going to Recruit Training plus direct entry enlistees going immediately to recruit training. Since the number of "shippers" is strongly dependent on the number of new contracts, this thesis will concentrate on the attainment of the enlisted new contract goals. Officer accessions will not be addressed.

The Navy Recruiting Command is divided into four Navy Recruiting Areas (NRAs), which are then divided into a total of 31 Navy Recruiting Districts (NRDs). The annual new contract goal for CNRC is divided into monthly goals that are then assigned to each NRA. The NRAs then assign goals to the NRDs within their territory. The goals are ultimately assigned to a Navy Recruiting Station (NRS) based on the size of the eligible male population for each station.

Demographic information is used to identify the target recruiting market. The

eligible male population includes the number of 17-21 and 22-29 year olds, the number of male high school seniors, and the number of male community college students in the area. An NRS may have multiple recruiters assigned based on the size of the eligible population in the area of the station. It is at the station level that recruiting goals are ultimately met or missed by the individual recruiters.

The vast majority of Navy enlisted personnel enter at the E-1 to E-3 levels. In a hierarchical system such as this, the success of the recruiter is critical to maintaining the basis of the overall structure of the All-Volunteer Force. If the proper number of youths does not enlist, the shape of the force will eventually become skewed toward a higher ranking and older force.

Recruiting officials maintain that it is essential that recruiters be uniformed representatives of their respective services and that they accurately and positively portray military life. Recruiters advertise military life through direct contact with applicants, presentations at schools, and canvassing typical places of teenage employment. Officials also state that face-to-face contact between a recruiter and an applicant is necessary to actually finalize a contract. [GAO Report, 1994]

The emphasis of this study will be to analyze the attributes of the local population of eligible civilians using the Navy Recruiting Command's Standardized Territory Evaluation, Analysis and Management (STEAM) database. STEAM data is collected at the zip code level and tracks past new contract production. The database also includes information on the recruiting station that encompasses each zip code. The STEAM database includes, but is not limited to, demographic data including population statistics of male 17-21 and 22-29 year olds, subgroups of the male 17-21 year old population by

ethnicity, and number of males that scored above 50 on the Armed Forces Vocational Aptitude Battery (ASVAB) test. These individuals are classified as Category I-IIIA and are referred to as the Upper Mental Group (UMG). The current and previous fiscal years' new contract production of UMGs for the Navy and all services are also included in the database. Prior to STEAM's implementation in 1993, the Navy compiled these statistics through very labor intensive, manual operations. Since STEAM has been implemented, CNRC believes that the NRS information has become much more accurate. [Under Secretary for Defense Personnel and Readiness (OUSD(P&R)),1996]

B. BACKGROUND AND LITERATURE REVIEW

Several studies have been conducted that have analyzed recruiting station location in order to choose sites that optimize recruiter production. Bohn, Schmitz and Van Meter (1996) analyzed the issues of station location and recruiter allocation on Navy recruiting production and the relationship between Navy recruiting and the presence of Army recruiters. Questions concerning station location and manning can be investigated at the local market level.

The authors developed a model that forecast production at the zip code level and then aligned recruiting stations and recruiter assignments to optimize new contract production. The analyses are performed on data from 26,785 zip codes in the forty-eight contiguous states. The number of contracts for the Army and Navy came from the Military Entrance Processing Command files for fiscal years 1993 and 1994. Two years of data were used to decrease the effect of abnormally high or low production in a single year. The Navy produced 57,310 male A-cell contracts during the period, while the Army produced 74,463 contracts. The structure of the Navy stations considered

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consisted of 3,164 recruiters located in 1,018 recruiting stations, while the Army had 4,191 recruiters in 1,487 stations. There were 12,026 zip codes covered by stations that were collocated. [Bonn, Schmitz, and Van Meter, 1996]

The Poisson model allows for discrete integer values of the dependent variable (new contracts) to be greater than or equal to zero. Since the number of new contracts is a discrete, integer number and many zip codes produce no new contracts, the authors used a Poisson regression to estimate their models. [Bonn, Schmitz, and Van Meter, 1996]

The explanatory variables in this model included the population of 17-21 year old males, physical area in square miles, the number of recruiters assigned to each recruiting station, the zip codes canvassed by each recruiting station, and the distance between the recruiting station and the zip code centroid. [Bonn, Schmitz, and Van Meter, 1996]

A recruiter effort share was estimated for each zip code by dividing the youth population of each zip code by the total youth population of all the zip codes in the station's market. The estimate was multiplied by the recruiters assigned to determine the "recruiter share." The distance between the geographic centroid of the zip code and the recruiting station, assumed to be the distance traveled by applicants, was computed by using the latitude and longitude of both the geographic centroid of the zip code area and of the recruiting station. [Bonn, Schmitz, and Van Meter, 1996]

Three major results were obtained. First, the presence of other service recruiters in a market favorably contributed to production. Second, the potential exists to increase production by realigning recruiters. Finally, geographic presence is a valuable commodity and arbitrarily reducing the number of stations will reduce productivity.

The results from the models are listed in Tables 1.1 and 1.2. Table 1.1 displays results for the Navy enlistment models and Table 1.2 displays results for the Army models. Their results showed that the number of recruiters assigned to a station (R_n and R_a) is the most important factor in predicting the number of own-service recruits in a zip code. An increased recruiter presence in a zip code produced more contracts. They also found that distance between the recruiting station and the zip code (D_n and D_a) had a negative effect on production for both services. Doubling the distance of a zip code from a recruiting station reduced contracts by 31 percent for the Navy and 24 percent for the Army. Negative coefficients for the Army and the Navy for the JOINT variable indicated a penalty to those stations that are collocated. The variable 'P' is the 17-21 year old male population and 'A' is the area in square miles of the zip code. The results show that as area increases, holding population constant, the number of contracts increase. This means that less dense areas produce more contracts. [Bonn, Schmitz, and Van Meter, 1996]

Variable	Model 1	Model 2
	Coefficient(t-stat)	Coefficient(t-stat)
P	0.2511(28.243)	0.0380(3.564)
A	0.1589(38.301)	0.1484(30.917)
R_n	0.4748(55.019)	0.2982(29.869)
D_n	(-0.3115) (-43.985)	(-0.2717)(-31.233)
R_a		0.4122(33.591)
D_a		(-0.0593)(-6.639)
JOINT		(-0.0346)(-3.852)
Constant	2.0965(10.807)	10.4688(28.857)

Table 1.1 Navy Production Models

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Variable	Model 1	Model 2
	Coefficient(t-stat)	Coefficient(t-stat)
P	0.05617(6.355)	0.0057(0.611)
A	0.1406(36.725)	0.1634(38.754)
R_n		0.1086(12.500)
D_n		(-0.1223)(-16.105)
R_a	0.7341(79.757)	0.6549(60.929)
D_a	(-0.2359)(-34.780)	(-0.1705)(-21.776)
JOINT		(-0.0154)(-1.923)
Constant	9.0866(33.382)	14.0863(37.045)

Table 1.2 Army Production Models

Lawphongpanich, Rosenthal and Schwartz (1992) developed a Navy location-allocation model and applied the model to Naval Recruiting Stations located in New York and New Jersey Districts. The regression model assumed the number of A-cell, or UMG, contracts was a function of the following variables: the number of 17-21 year old males in the zip code, the distance to the recruiting station from the zip code centroid, the population density of the zip code and the number of recruiters assigned to each open station. The model forecasts the number of stations that should remain open and the number of recruiters to be allocated to each station. [Lawphongpanich, Rosenthal and Schwartz (1992)]

The authors estimated a log-linear contract production model using 1991 data from 28,247 zip codes. They found that the following decisions must be made in order to maximize A-cell production. First, it is decided whether a station should stay open, then whether a zip code belongs to a given recruiting station and how recruiters should be allocated. Finally, recruiter shares must be assigned to each zip code. [Lawphongpanich, Rosenthal and Schwartz (1992)]

The authors divided the problem into two subproblems: station location and recruiter allocation. The results for the New York and New Jersey districts were similar.

In 1991 New York had 38 recruiting stations and 111 recruiters. Figure 1.1 depicts the results from the two-stage process with the number of stations varying from 10 to 38 per NRD and the number of recruiters from 10 to 120. The number of A-cell contracts increased with the number of stations and recruiters assigned per NRD. However, the number of contracts increased at a decreasing rate indicating diminishing returns to recruiters. [Lawphongpanich, Rosenthal and Schwartz (1992)]

Another report prepared for the Office of the Under Secretary for Defense Personnel and Readiness (OUSD (P&R)) (1996) addressed recruiting station and recruiter assignment methodology. The OUSD study addressed responsibilities, procedures, databases, methodologies, and rationale used to determine recruiter numbers, recruiter territory assignments and locations for recruiting offices. Recruiting policy statements, the sources of recruiting market data, and database tracking systems were studied for all services. Also, the cost of facility maintenance for fiscal year 1995 was included.
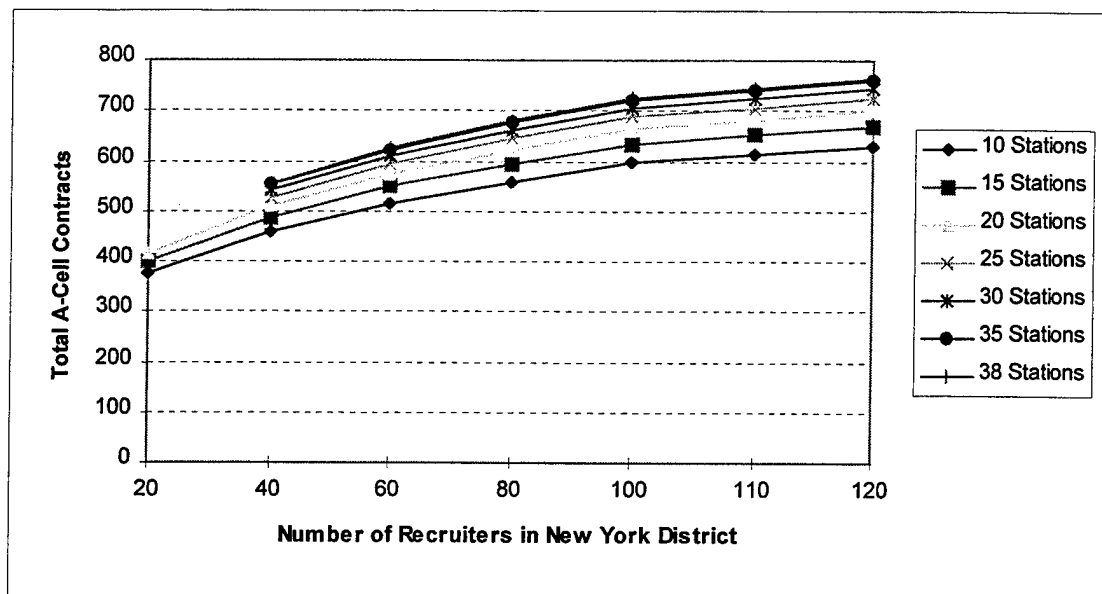

Figure 1.1 Number of Expected A-Cell Contracts in New York District, FY-91

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The major goal of this study was to determine the feasibility of joint recruiting locations. Templates of questions were developed to analyze similarities and the possibility of joint locations of armed forces recruiting stations. The ultimate goal was to cut costs in DOD recruiting efforts. They found that joint location of recruiting stations could save money. The study did not clarify the benefits and liabilities to contract production. [OUSD (P&R), 1996]

Warner (1990) conducted a study on data from 1981-1987 that examined the trends in military recruiting during the 1980's and estimated the contributions various policy tools such as pay, recruiters, advertising and educational benefits had on military recruiting. The study also examined relationships among the services' recruiting programs. Spillover effects between service recruiting programs were examined and were generally positive with an enlistment supply model that included the effects of civilian unemployment and the number of recruiters assigned to an NRS. The presence of other services' recruiting stations in the same location as the Navy recruiting station was surmised as important in determining recruiting success. [Warner, 1990]

Warner stated that goals are the primary factor in shaping the actual number of enlistment contracts. Goals reflect the demand for new entrants and recruiter assignments are highly coordinated with the goals. Recruiters would not be assigned without a goal. Varying the number of recruiters assigned and varying advertising expenditures were the most immediate policy tools used. A ten percent increase in the Army or Navy recruiting force is estimated to increase high quality, or UMG, enlistments by about four percent. Increased advertising increased awareness in the target population. [Warner, 1990]

Warner also addressed the issue of interservice competition and complementarity. For example, when one service expands its recruiting effort, other services can either reap the benefits of the increased awareness, or can lose prospective enlistees to the other service. In the latter case, an increase in the recruiter strength of one service may generate extra competition for the available youth supply. Alternatively, since recruiters contact more potential recruits than they actually enlist, the increased information about military service could be seen as a spillover effect that complements other service recruiting. [Warner, 1990]

Warner's model was estimated using a fixed-effects model. Each variable was measured as the deviation in a given quarter from the average value of the variable in a given NRD over the 28-quarter sample period. The fixed effects estimator was useful for two reasons. First, it removed the influence of unobservable factors that vary across the NRDs but not across time. Second, it removes the influence of district size. Recruiters and goals are assigned largely on the basis of recruitment-eligible population and thus are highly positively correlated across services. The fixed effects estimator converts the data into a series of time series. The variations over time in recruiting resources in different geographic areas are much less correlated than the resource levels for the services at one point in time. Warner believed that this methodology provided a more plausible test of interservice competition versus cooperation.

Warner's research also revealed that enlistments are highly responsive to the civilian unemployment rate. He estimated that for every ten percent change in the civilian unemployment rate, high-quality enlistments changed by four to five percent. The decline in the civilian unemployment rate from 9.5 percent in 1983 to 5.5 percent in

1988, a 43 percent reduction, is estimated to have reduced high quality enlistments by 17 to 24 percent. [Warner, 1990]

Warner found the basic economic forces of relative pay and civilian unemployment are important determinants of high-quality military enlistments. Also important are the services' recruiter strengths, recruiting goals, educational benefits and- for the Army- advertising. Recruiters were found to be the most cost effective means of varying high-quality enlistments.

Goldberg conducted a study that examined the cost-effectiveness of four types of policies: recruiters, advertising, military pay and GI Bill benefits. The study, conducted at the NRD level for the period of 1975-1980, produced a model that forecast enlistments in the 1980's. The impact of reductions in the GI Bill benefits that occurred in 1977, the decline of military pay (relative to civilian earnings), the movement of recruiting resources, as well as the fluctuations in the economy, and the increased size of the youth population were seen as possible causal factors that were used in the model. [Goldberg, 1982]

An enlistee who signs a contract this year may enter the "delayed entry pool" (DEP) and enter active duty up to twelve months later. Although the DEP dampens the effects of changes in supply, the new contracts will be affected. Thus, new contracts are a better measurement of enlistment supply. Goldberg's model used regression analysis to estimate the effects of supply factors on the number of contracts signed by non-prior service, male, high school graduates. [Goldberg, 1982]

Goldberg stated that goals are highly correlated with recruiters assigned. Recruiting Commanders do not add a recruiter to the recruiting force without also

assigning a goal. To determine recruiter elasticity, he held goals per recruiter constant. The recruiter elasticities he estimated were similar to previous studies. Omitting goals per recruiter does not cause serious bias of the recruiter elasticity. Recruiters are more intensively assigned to urban areas. An urban variable was added to determine if urban youths are more likely to enlist than those who live in suburban areas are.

Goldberg also found a strong correlation between youth unemployment and the requirement for recruiters. As the unemployment rate increases, expected civilian earnings decline. Subsequently, increases in unemployment rate will increase supply to the armed forces. If youth unemployment falls, additional recruiting resources may be required. Goldberg found that the effect of unemployment is statistically significant across all services except the Army. He also found that the use of total unemployment rate might not have yielded results as accurate as use of the youth unemployment rate would have. [Goldberg, 1982]

The above studies provide a small sample of the many studies that have estimated enlistment supply models over the 25 years of the volunteer armed forces. The studies that use district level data are useful for estimating the effect of policy weapons, such as recruiter and advertising expenditures, they are less useful for analyzing issues of station location and recruiter assignment within recruiting districts. The two studies using zip code level data reflect the type of data and modeling approach necessary to answer these market-level questions. This thesis attempts to shed light on these issues by using zip code level data on Navy recruiting.

C. PROBLEM STATEMENT AND APPROACH

This thesis examines Navy Recruiting Stations and their respective production of new contracts using zip code level data from the STEAM database. The research will attempt to determine whether the location of an NRS has an impact on the new contract production from the zip code. The effect of individual station attributes will be predicted using regression with new contract production as a function of zip code level recruiting station attributes drawn from the STEAM database. A secondary purpose of this thesis will be to determine if the interaction of the target recruiting population, the number of recruiters assigned in a market, the presence of other armed forces recruiting stations in the same location, and the local unemployment rate affect recruiting production.

D. THESIS ORGANIZATION

Chapter II gives an overview of the data used to conduct this thesis. Chapter III details the methodology of the analysis. Chapter IV contains the analysis in full detail while Chapter V summarizes the results and provides conclusions and recommendations for further study.

II. DATA

The main database, referred to as the Standardized Territory Analysis, and Management (STEAM) database, was obtained from Commander, Navy Recruiting Command (Code 220). The data used covered fiscal year 1996. Each of the 31 NRD's has its own 3-digit identification number. The first of the three digits corresponds to one of the four Area Commands (1, 3, 5, or 8) under which the NRD resides. The following two digits denote the individual NRD.

The full data set contained 53 variables. The unit of observation was the zip code and the variables of interest were zip code population statistics. The variables that were used included population variables by age group and ethnicity (Black, White, Hispanic, and Asian/Pacific Islander). Also considered were college attendance and military new contract production for the previous fiscal year. Zip codes, county codes (FIPS) and recruiting station identification codes were used to sort and merge the data sets. These variables are listed and explained in Table 2.1. Within the database, each 5-digit zip code was a separate observation.

CNRC separately furnished the number of recruiters assigned to each station for fiscal year 1996. Additionally, county codes with respective county level unemployment rates for 1996 were obtained from the United States Census Bureau homepage. [www.census.gov,1996]

NAME	DESCRIPTION
IDCODE	Station identification code. The first three digits are the same as the Navy Recruiting District number, and the final three digits are unique to the station to which the record belongs.
ZIP	Five-digit zip code. This is the primary field for identifying a unique record.
MALE-1721	All males between the ages of 17 and 21, inclusive, who do not attend high school or college, who are not in the military or institutionalized, and who reside in this zip code.
MALE-2229	All males between the ages of 22 and 29, inclusive, who are not institutionalized, or enlisted or commissioned in the military services, who reside in this zip code.
BLACK MALE	Total number of black males who are not institutionalized, who are not already members of the military, and who are not attending college, between the ages of 17 and 21, residing in that zip code.
HISPANIC MALE	Total number of Hispanic males who are not institutionalized, who are not already members of the military, and who are not attending college, between the ages of 17 and 21, residing in that zip code.
API MALE	Total number of Asian/Pacific Island males who are not institutionalized, who are not already members of the military, and who are not attending college, between the ages of 17 and 21, residing in that zip code.
COLLEGE	The number of males age 17 to 21 who are enrolled in college and residing in that zip code.
ALL SERVICES	The number of non prior-service contracts written by all services in Fiscal Year 1995 who are UMGs residing in that zip code. This data is from the Military Entrance Processing Command (MEPCOM).
ASVABTEST	Total number of seniors tested with the Institutional ASVAB in that zip code during school years 91-92, 92-93, and 93-94.
NAVY CONTRACTS	The number of non prior-service contracts written by Navy recruiters in Fiscal Year 1995 who are UMGs residing in that zip code. This data is from MEPCOM.
FIPS	The five-digit code associated with the county wherein the zip code resides.

Table 2.1 STEAM Database Field Structure and Descriptions for FY-1996

Each of the 31 district data sets were merged into one file and the population

variables were extracted for the analysis. This condensed data set was used as the basis

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for the subsequent merging of three other data sets.

The data from the STEAM files was merged with a file that contained unemployment rate for 1996 for all counties in the United States. These rates were assigned to all zip codes that corresponded to the respective county code. Therefore, all zip codes in a specific county were assigned the same unemployment rate. This file also contained codes to indicate if the zip code was considered a metropolitan area by the United States Census Bureau. See Figure 2.1. This data set was then merged with the file that contained the Navy Recruiting Stations assigned to the zip codes using the common variables of the Recruiting Station Identification (RSID) number and the zip codes, along with a data set that contained the number of recruiters assigned to the respective recruiting stations. See Figure 2.2. Each zip code was credited with the number of recruiters assigned to the respective station. If a station had three recruiters assigned to it, all zip codes covered by that station were assumed to have three recruiters assigned. A recruiter share variable was subsequently created. The method for this calculation is explained in Chapter III. A slight inconsistency was noted during this process. The RSID's in the STEAM data set contain six digits; however, the RSID's in the second data set contained a two digit extension. This extension indicated whether the station was a full-time or part-time station. Since the vast majority were full-time stations, to accommodate the merge the extensions were truncated to match the six digit codes used in the STEAM database.

As mentioned previously, the Recruiting Station Identification Codes had to be modified to permit a merge. EXCEL 6.0 was used to truncate the values and reenter them into the Naval Postgraduate School mainframe computer for merging.

```
┌─────────────────────────┐          ┌─────────────────────────┐
│    STEAM DATABASE       │          │     UNEMPLOYMENT        │
│ (Zip codes, population  │          │       DATABASE          │
│  by zip, new contract   │          │    (County, County      │
│      production)        │          │ unemployment rates and  │
│                         │          │   metropolitan codes)   │
└───────────────────┐     │          │     ┌───────────────────┘
                    └─────┘          └─────┘
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                    ┌─────────▼───────────────────┐
                    │   STEAM AND UNEMPLOYMENT     │
                    │         MERGED FILE          │
                    │ (Zip codes and STEAM         │
                    │   population variables)      │
                    │                              │
                    │                              │
                    └──────────────────────────────┘
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Figure 2.1

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┌──────────────────┐   ┌──────────────────────┐   ┌──────────────────┐
│   STEAM AND      │   │ RECRUITING STATION   │   │   RECRUITING     │
│  UNEMPLOYMENT    │   │   and ZIP CODE FILE  │   │   STATION and    │
│  MERGED FILE     │   │ (Stations and        │   │   RECRUITER      │
│                  │   │  respective zip      │   │  ASSIGNMENTS     │
│                  │   │     codes)           │   │                  │
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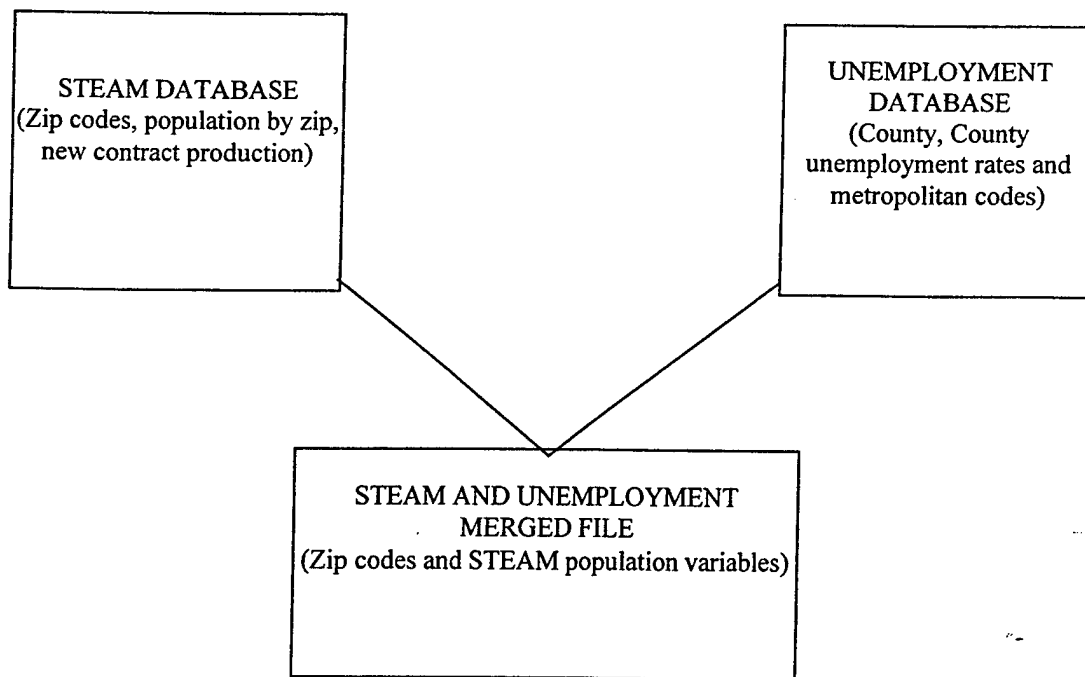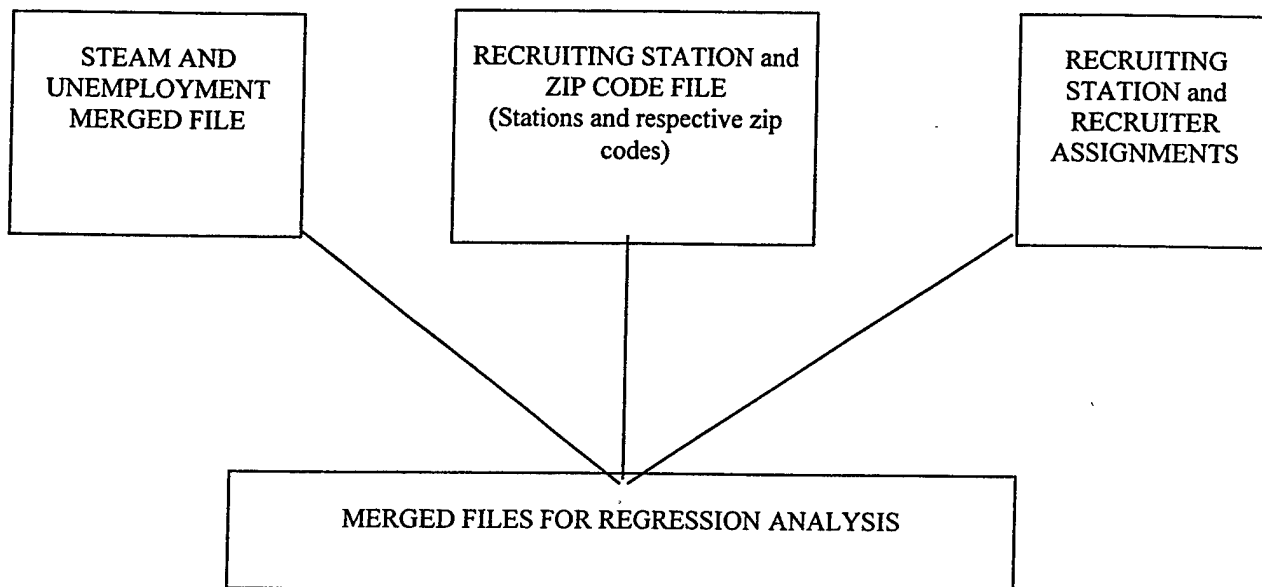
Figure 2.2

Approximately 30 percent of all observations had missing values and were not used in the analysis. Of the 39,379 observations in the zip code file, only 26,176 observations (zip codes) were used in the computations. The missing zip codes were spread relatively evenly across all Areas and NRD's. Therefore, the remaining zip codes used were representative of the entire United States.

III. METHODOLOGY

The data file contained information regarding all new contracts written for the Navy in fiscal year 1996. NAVY CONTRACTS, contracts written by the Navy in the previous fiscal year, was the dependent variable in all of the analysis.

A. THE VARIABLES

Population variables from the STEAM data set were used as predictor variables for the dependent variable, NAVY CONTRACTS. The population variables used, described in Table 2.1, included COLLEGE, BLACK MALE, HISPANIC MALE, ASIAN PACIFIC ISLANDER MALE, ASVABTEST, MALE-1721, MALE-2229, and ALL SERVICES.

The recruiter share variables, SHARE1721 and SHARE2229, were calculated by multiplying the number of recruiters assigned to a specific recruiting station (RECRUITER) by the ratio of the eligible male population for a given zip code (MALE-1721 and MALE-2229) to the total eligible male population for all zip codes covered by that recruiting station (TOT1721 and TOT2229). Therefore,

$$SHARE1721 = (MALE - 1721 / TOTAL1721) * RECRUITER$$

Equation (3.1)

where   MALE-1721 = population of 17-21 year old eligible males in a specific zip code

             TOTAL1721 = population of 17-21 year old eligible males in the area covered by a specific recruiting station

             RECRUITER = number of recruiters assigned to that station

             SHARE1721 = portion of recruiters assigned that are dedicated to the specific zip code for this model

The recruiter shares for 22 to 29 year old males were calculated using the same method. If the number of recruiters assigned to a station was missing, then SHARE1721 and SHARE2229 for that station were assigned missing values. If the eligible population, MALE-1721 or MALE-2229, for a specific zip code was zero, then the recruiter shares for that zip code and age group were assigned the value zero. Recruiters are not normally assigned to an area with zero population of eligible recruits.

The variable OTHER SERVICE, which represents the number of new contracts written by the Army, Air Force and Marines, was calculated by subtracting NAVY CONTRACTS from ALL SERVICES, the variable which indicates new contracts written by all four of the armed services. Dichotomous (dummy) variables were created for each of the 31 recruiting districts to determine if the regional location of the recruiting district had an effect on new contracts produced. To determine the population that did not claim one of the previously listed ethnic backgrounds, the WHITE MALE[1] variable was calculated by subtracting the three ethnic variables, BLACK MALE, HISPANIC MALE, and API MALE, from MALE-1721.

Calendar year 1996 county level unemployment rates for all 50 states were obtained from the United States Census Bureau homepage. [www.census.gov] Additionally, listed on the United States Census Bureau homepage were areas regarded as metropolitan. If a county was listed as part of a metropolitan area, the variable METRO was assigned the value one for all zip codes in that county; otherwise, METRO was assigned the value zero for all zip codes in that county.

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[1] This variable contains all male Caucasians and any other ethnic group not considered Black, Hispanic or Asian Pacific Islander. However, no data was available to clarify this assumption.

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B. THE MODELS

One problem encountered while specifying the production models was that many of the population variables are highly collinear. Correlation coefficients were calculated to determine the degree of collinearity between the independent variables. For example, SHARE1721 was calculated using the 17-21 year old male population. All of the race/ethnicity variables (BLACK MALE, HISPANIC MALE, etc.) are subgroups of the 17-21 year old male population. Collinearity was expected between these variables. The primary objective was to measure the strength or degree of linear association between two variables that would be included in the model. The results from the correlation analysis are discussed later in Table 4.1 in Chapter IV below.

1. Preliminary Data Analysis

Simple statistics for the predictor variables from the data set were calculated and are listed in Table 3.1. The maximum number of observations used in the models is constrained to 30,438 due to many missing observations for SHARE1721 and SHARE2229. All other variables have more observations and thus, these two variables set the limit of the number of observations used because of missing values. The values for unemployment rate have been converted to percentages. For example, an unemployment rate of 0.05 was converted to 5.0 percent.

Variable	N	Mean (Standard Deviation)	Minimum	Maximum
NAVY CONTRACTS	30635	1.74	0	77
		3.39		
WHITE MALE	32710	110	0	4653
		191.5		
BLACK MALE	32710	25.9	0	2960
		115.4		
HISPANIC MALE	32710	23.9	0	2764
		115.3		
API MALE	32710	6.8	0	1467
		34.4		
METRO	41732	0.5147	0	1
		0.4998		
UNEMPLOY RATE	41689	6.4	1.1	34.6
		2.7		
RECRUITER	37346	3.7	0	9
		1.8		
MALE-1721	32710	166.7	0	5444
		290.7		
MALE-2229	32710	374.4	0	9032
		690.6		
SHARE1721	30348	0.1088	0	3.17
		0.1958		
SHARE2229	30348	0.1088	0	3
		0.1943		
ASVABTEST	37589	7.9	0	1331
		20.6		
OTHER SERVICE	30635	4.3	0	128
		7.4		
COLLEGE	32710	91.5	0	5413
		219.8		

Table 3.1 Simple Statistics for Predictor Variables

2. Model I

Log-linear and log-log regressions were not considered appropriate due to the fact

that zero was a possible value for new contract production and the logarithm of zero is undefined. Therefore, a linear specification was used for all of the contract production models. Model I incorporated the population variables, the recruiter share variable MALE-1721, the county-level unemployment rate and the recruiting district dummy variables as predictors in a linear regression of Navy new contract production for a specific zip code. This model attempted to show the relationship of the 17-21 year old male population, along with race ethnicity and unemployment rates as predictors. The METRO dummy variable also was included to determine if the population from metropolitan areas had an effect on Navy new contract production. NRD dummy variables were included to determine if the region of the country had an effect on Navy new contract production. Model I is represented by the following equation

$$N_i = \beta * X_i + \mu + \varepsilon$$

Equation (3.2)

where N_i is the number of Navy contracts written and X_i is a vector of explanatory variables including WHITE MALE, BLACK MALE, HISPANIC MALE, API MALE UNEMPLOY RATE, METRO AND SHARE1721. A vector of the NRD dummy variables is represented by u.

3. Model II

The second model combined the predictor variables from the Model I with the variables COLLEGE, ASVABTEST, OTHER SERVICE, and SHARE2229. The intent of this model was to capture the effects of the 22-29 year old male population, as well as the effects of those in a four -year college. The ASVABTEST variable was included to determine if those who scored high on the ASVAB test were more likely to enlist. The

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inclusion of the OTHER SERVICE variable was an attempt to see if joint recruiting stations or other armed forces recruiting stations within the same zip code had an effect on Navy new contract production. Model II was then compared to the Model I to analyze the effects of the additional variables on Navy new contract production. Model II is represented by the following equation

$$N_i = X_i * \beta + Z_i * \gamma + \mu + \varepsilon$$

Equation (3.3)

where X_I and N_i represent the same variables inluded in Model I and Z_i represents the variables COLLEGE, ASVABTEST, SHARE2229 and OTHER SERVICE.

It is expected that these models will show the effects of population changes on the production of Navy contracts. The ethnicity variables have been included to determine the possible effects of ethnicity on Navy contract production. It is expected that the unemployment rate will have a positive effect on production. Whether the area is a metropolitan area may also affect production. It also expected that the recruiter share variables have a positive effect on production. The recruiter share variable based on 17-21 year olds (SHARE1721) is included in Model I, while Model II includes SHARE1721, as well as, the share variable for 22-29 year olds (SHARE2229). A negative effect is expected from the COLLEGE variable. The effect of other service recruiting will be captured by OTHER SERVICE. This variable is attempting to determine whether the relationship between the Navy and the other services recruiting is complementary or competitive.

IV. DATA ANALYSIS

This section discusses the correlation of the independent variables. It also estimates and discusses the results from estimating Equations 3.2 and 3.3.

A. CORRELATION BETWEEN INDEPENDENT VARIABLES

As previously stated, one problem encountered while specifying the production models was that many of the population variables are highly collinear. Correlation coefficients were calculated to determine the degree of collinearity between the independent variables. A complete table of the correlation coefficients is listed in Table 4.1.[1]

As listed in Table 4.1, the race or ethnic population variables, WHITE MALE, BLACK MALE, HISPANIC MALE, and API MALE, were found to be positively correlated and significant to the .01 level. Further, HISPANIC MALE and API MALE were positively correlated with UNEMPLOY RATE and significant to the .01 level. WHITE MALE was negatively correlated with UNEMPLOY RATE to the .01 level, while the correlation between BLACK MALE and UNEMPLOY RATE was not significant. Additionally, SHARE1721 and SHARE2229, were negatively correlated with UNEMPLOY RATE and significant to the .01 level. New contracts written by the Army, Air Force and Marines, OTHER SERVICE, were positively correlated with the

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[1] Correlation between independent variables is measured between -1 indicating a perfect negative correlation and +1 indicating a perfect positive correlation. A positive correlation coefficient indicates the variables move together. Both variables either increase or both variables decrease together. As the correlation coefficient becomes negative, the variables tend to go in opposite directions. Zero indicates that the two values are not correlated.

Table 4.1 Pearson Correlation Coefficients for the Independent Variables

Variables	BLACK MALE	WHITE MALE	HISPANIC MALE	API MALE	RATE	METRO	SHARE 1721	SHARE 2229	ASVAB TEST	OTHER SERVICE	COLLEGE	RECRUITER
BLACK MALE	1	0.12686	0.1531	0.08089	0.00205	0.14622	0.45066	0.37186	0.30775	0.38734	0.29248	0.08864
	0.0	0.0001	0.0001	0.0001	0.7132	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
WHITE MALE	0.12686	1	0.10705	0.20773	-0.1104	0.25507	0.69317	0.59626	0.32122	0.56795	0.65432	0.04936
	0.0001	0.0	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
HISPANIC MALE	0.1531	0.10705	1	0.28999	0.09916	0.1755	0.46693	0.44223	0.23958	0.38577	0.33457	0.0783
	0.0001	0.0001	0.0	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
API MALE	0.08089	0.20773	0.28999	1	0.09916	0.14628	0.34291	0.30007	0.14472	0.23066	0.42062	0.04329
	0.0001	0.0001	0.0001	0.0	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
RATE	0.00205	-0.1104	0.09916	0.03540	1	-0.184	-0.01904	-0.0245	0.0551	0.00469	-0.06685	0.03726
	0.7132	0.0001	0.0001	0.0	0.0	0.0001	0.001	0.0001	0.0001	0.4163	0.0001	0.0001
METRO	0.14622	0.25507	0.1755	0.14628	-0.184	1	0.29828	0.30962	0.09651	0.2693	0.28471	0.25539
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
SHARE1721	0.45066	0.69317	0.46693	0.34291	-0.01904	0.29828	1	0.89822	0.46267	0.74191	0.6745	0.20708
	0.0001	0.0001	0.0001	0.0001	0.001	0.0001	0.0	0.0001	0.0001	0.0001	0.0001	0.0001
SHARE2229	0.37186	0.59626	0.44223	0.30007	-0.0245	0.30962	0.89822	1	0.45711	0.76849	0.6719	0.20871
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0	0.0001	0.0001	0.0001	0.0001
ASVAB TEST	0.30775	0.32122	0.23958	0.14472	0.0551	0.09651	0.46267	0.45711	1	0.51097	0.27082	0.09724
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0	0.0001	0.0001	0.0001
OTHER SERVICE	0.38734	0.56795	0.38577	0.23066	0.00469	0.2693	0.74191	0.76849	0.51097	1	0.54122	0.12027
	0.0001	0.0001	0.0001	0.0001	0.4163	0.0001	0.0001	0.0001	0.0001	0.0	0.0001	0.0001
COLLEGE	0.29248	0.65432	0.33457	0.42062	-0.0669	0.28471	0.6745	0.6719	0.27082	0.54122	1	0.0907
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0	0.0001
RECRUITER	0.08864	0.04936	0.0783	0.04329	0.03726	0.25539	0.20708	0.20871	0.09724	0.12027	0.0907	1
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0

race or ethnicity variables, but its correlation with unemployment was not significant. UNEMPLOY RATE was negatively correlated with metropolitan areas.

The population share of 17-21 year old males, SHARE1721, and 22-29 year old males, SHARE2229, were very strongly correlated with recruiter assignments. This result was not surprising since RECRUITER is used to calculate both of the recruiter share variables. SHARE1721 and SHARE2229 were also strongly positively correlated to both OTHER SERVICE and to COLLEGE. SHARE1721 and SHARE2229 were both slightly negatively correlated with the UNEMPLOY RATE. OTHER SERVICE was only slightly positively correlated with unemployment. Because SHARE1721 AND SHARE2229 were highly correlated with one another, only SHARE1721 was used in Model I. SHARE 2229 was used in Model II to attempt to capture the effects of both. The OTHER SERVICE variable was highly correlated with all of the population variables. Therefore it was only used in Model II.

B. RESULTS OF ESTIMATING MODEL I

For Model I eight independent variables were used to explain the dependent variable, NAVY CONTRACTS. The model used 26,176 of 39,379 observations (zip codes) from the data set. The other 13,203 observations (zip codes) had missing values for some variables and were omitted.

The estimate used the ordinary least squares (OLS)[2] technique. Dummy variables were included for all 31 recruiting districts. The linear model produced an R^2 value 0.55, which indicates the amount of variation in the dependent variable, NAVY CONTRACTS, explained by the independent variables. As shown in Table 4.2, all of the

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[2] Used SAS 6.09 procedure 'PROC GLM'.

predictor variables were found to be significant at the 0.01 significance level. The coefficients of the race or ethnicity variables are interpreted as follows. Holding all other variables constant, an increase in the 17-21 year old Black male population by 1000 should result in a 4.028 increase in Navy new contracts annually in a zip code. Similarly, an increase in the 17-21 year old Hispanic male population by 1000 should result in an 3.614 increase of Navy new contracts, and an increase in the 17-21 year old Asian/Pacific Islander male population by 1000 should result in a 4.229 increase in Navy new contracts. An increase in the 17-21 year old white male population by 1000 should result in a 1.695 increase in Navy new contracts. The interactive variable, SHARE1721, had the greatest influence on Navy new contract production. An increase in the ratio of 17-21 year old male population, MALE1721, to the total 17 to 21 year old population, TOTAL1721, in a specific zip code or an increase in the number of recruiters assigned will improve Navy new contract production by a factor of 8.643 times the change in the SHARE1721 ratio. Unemployment rate for the county in which the zip code resides was also statistically significant. The estimated coefficient for UNEMPLOY RATE indicates a 1.7 percent increase in Navy new contract production as unemployment increases by one percent, holding all other variables constant.

All of these coefficients were positive and thus have a positive impact on Navy new contract production. The population and most importantly, the interaction of recruiter assignments with the population, has indicated a strong positive effect on recruiting success.

As shown in Table 4.2, METRO was found to be significant in the linear regression. The coefficient for METRO was .32720, which indicates a small positive

effect on Navy new contract production in those areas considered metropolitan areas by the Census Bureau.

Parameter	Estimate	Standard Error	T-stat
Intercept	0.29561*	0.08993	3.29
WHITE MALE	0.00169*	0.00012	13.7
BLACK MALE	0.00402*	0.00015	26.8
HISPANIC MALE	0.00361*	0.00015	24.2
API MALE	0.00422*	0.00043	9.7
METRO	0.3272*	0.035	9.3
UNEMPLOY RATE	0.01702*	0.00626	2.72
SHARE1721	8.64365*	0.14561	59.4
R^2	0.5566		
N	26175		
F-stat	965.14		

Table 4.2 Model I Results

* = indicates variable is significant at one percent level.

C. RESULTS OF ESTIMATING MODEL II

For Model II, twelve independent variables were used in the regression. Ordinary least squares was again used to estimate the regression. The R^2 value indicates that the amount of variation in NAVY CONTRACTS explained by the twelve independent variables increased to 0.68. As shown in Table 4.3, all of the predictor variables were significant at the 0.01 level, with the exception of UNEMPLOY RATE. COLLEGE is not significant to the 0.01 level. However, using the "2-t Rule of Significance"[3] COLLEGE is statistically significant the 0.05 level. Therefore, an increase in the population of 17-21 year old college students will have a negative effect on production at the 5 percent level of significance. The coefficients of the ethnicity variables are

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[3] "2-t" Rule of Significance. If the number of degrees of freedom is 20 or more and if the level of significance is set at 0.05, then the null hypothesis can be rejected if the t value exceeds 2 in absolute value.

interpreted as follows. An increase in the 17-21 year old Black male population by 1000 should result in a 2.94 increase in Navy new contracts. An increase in the 17-21 year old Hispanic male population by 1000 should result in a 2.09 increase in Navy new contracts. An increase in the 17-21 year old Asian/Pacific Islander male population by 1000 should increase Navy new contracts by 5.24. Whereas, an increase in the 17-21 year old white male population by 1000 should result in an increase of 0.7 of one Navy contract. The additional Model II reduced the size of the ethnic population variables as compared to Model I.

Parameter	Estimate	Standard Error	T-stat
Intercept	-0.07489	0.07598	-1.03
WHITE MALE	0.0007*	0.0012	5.68
BLACK MALE	0.00294*	0.00013	21.71
HISPANIC MALE	0.00209*	0.00013	16.2
API MALE	0.00524*	0.00039	13.47
METRO	0.7958*	0.02967	2.68
UNEMPLOY RATE	0.00378	0.00626	0.71
SHARE1721	0.61666*	0.14561	3.3
SHARE2229	3.795*	0.16183	23.45
COLLEGE	0.00021**	0.00009	-2.24
ASVABTEST	0.00874*	0.00072	12.06
OTHER SERVICE	0.21444*	0.00276	77.7
R^2	0.6853		
N	26175		
F-stat	1498.04		

Table 4.3 Model II Results
*=significant at one percent
**=significant at five percent

WHITE MALE showed the greatest difference. It was approximately one half of the estimate for Model I. The interactive variable, SHARE1721, had a much smaller influence on Navy new contract production, compared to Model I, with a coefficient of 0.6166. An increase in the ratio of the 17 to 21 year old male population, MALE-1721,

to the total 17 to 21 year old population, TOTAL1721, in a specific zip code or an increase in the number of recruiters assigned will improve Navy new contract production by a factor of 0.6166 times the change in the SHARE1721 ratio. The second interactive variable, SHARE2229, had the largest influence on Navy new contract production in Model II. An increase in the population ratio or the number of recruiters assigned will improve Navy new contract production by 3.7949 times the change in the SHARE2229 ratio.

The coefficient for Model II in this study was 0.6166. Lawphongpanich, Rosenthal and Schwartz (1992) used zip code level data from 1991 to calculate the best coefficients for their model. Using a log-linear regression, the best value of the coefficient for the recruiter share variable was 0.64179. The magnitude of the coefficient was twice that of the next largest coefficient. The results from Model II seemed to mirror the results of the model estimated by Lawphongpanich, Rosenthal and Schwartz and validate the significance of the recruiter share on production for the New York/New Jersey District. Model II results indicate that the same is true for the country as well. [Lawphongpanich, Rosenthal and Schwartz (1992)]

The variable ASVABTEST, indicating the members of the population that scored in the upper mental group category on the ASVAB test, was significant with a parameter estimate of 0.087. Therefore, approximately nine new Navy contracts would result from every additional 100 upper mental group scores on the ASVAB test.

The parameter estimate for OTHER SERVICE shows that five additional new contracts written by the Army, Air Force and Marines should result in one additional contract for the Navy. There are two possible reasons for this result: (1) complementarity

in production for all of the armed forces or (2) the same population variables related to successful Navy production may also affect the production of the other services. METRO was significant but had a much smaller effect on Navy new contract production in the Model II than in the Model I.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The results of both models have shown a positive coefficient for the recruiter share variables. The magnitude of the coefficient of SHARE1721 was two orders of magnitude greater than all the other coefficients in Model I. The magnitude was more than 20 times the next largest coefficient, METRO. However, the variables are measured differently and direct comparisons could be misleading. The SHARE2229 variable was added to Model II and was the largest coefficient. This indicated that recruiter presence is the most important factor for attaining new contracts in these models.

The OTHER SERVICE variable, used in Model II was significant and also had a positive coefficient. Contracts written by the Navy are positively related to those written by the other armed services in the same zip code. This suggests that the recruiters' efforts are complementary.

All race/ethnicity coefficients were positive and statistically significant to the 0.01 level. Population statistics for a recruiting station's area of responsibility are an important factor in determining the production of that station. The unemployment rate in the county of a specific zip code was significant. However, this unemployment rate was for the entire labor force and could be misleading. It is indicative of the economic status of that area, which tends to affect everyone, not just 17-29 year old males.

B. RECOMMENDATIONS

The STEAM database contained numerous variables that could be considered useful in modeling new contract production. However, many of these variables contained

missing observations and thus added no value to the supply models. Other variables were administrative in nature and could not be used in the model. It is recommended that a single production database be developed that that includes the recruiters assigned and county unemployment rates included, to study production analysis. Also, the STEAM database contained population statistics for 17-29 year old males. With more females entering the Navy, it is recommended to include similar population statistics for females in the database in order to maintain data to estimate similar supply models for women.

These supply models could be enhanced by adding a variable that indicates the distance between the zip code and the station. This would measure how far the applicants or recruiters must travel to make contact. (e.g., 0-10 miles, 11-25 miles, >25 miles) A variable similar to the METRO variable in these models could be created to provide a more precise definition of the type of area in which the applicant lives. Three possible classifications could be Metropolitan, Suburban, or Rural.

Another issue for future study is the effect on production of stations that are collocated with other armed forces recruiting stations. Data should be included in the database to permit comparisons of the production of collocated stations with those that are single-service only. Recruiting station identification codes, RSIDs, should be the same throughout all data sets used for new contract production analysis. The two-digit extension that denoted full-time, part-time, or closed stations was the most informative.

The unemployment rate that is used should be that of the target recruiting population (17-29 years of age). A more focused unemployment rate could give a better indication of the effect of youth unemployment on new contract production.

A possible extension is to use a Poisson regression in future recruiting supply

models because of the existence of discrete nonnegative integer values for population statistics and new contract production. Local advertising expenditures could be added to estimate the effect it has on Navy production.

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