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(6) THE APPLICATION OF CENSUS TRACT DATA
FOR ECONOMIC MODELING

(10) Hugh K./DeLong, III Captain, USAF
Robert M./Julsonnet Captain, USAF

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The DOD has responded to the NEPA EIS requirement in many ways. The socioeconomic impact of projected federal actions has been predicted through the CERL EIFS model, which is based on county level information from within a 30 mile radius of the installation with a proposed change. The purpose of the study was to investigate the possibility of basing the model on census tract information. Rules were established for assigning census tracts to zip code areas. The zip code areas were used because they most accurately and conveniently depicted where the base personnel live. Thus, areas actually affected by base mission changes were examined. The rules proved to be valid. Subsequently assignment and environmental impact assessments were run to determine if differences existed between results gained from census tract and county based data. The differences were difficult to detect because of the need to specify a multiplier for each area of assessment. All indications support intuition that the results are different for the two data basis and more practical for the user.

LSSR 10-78A

THE APPLICATION OF CENSUS TRACT DATA FOR ECONOMIC MODELING

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Facilities Management

By

Hugh K. DeLong, III
Captain, USAF

Robert M. Julsonnet
Captain, USAF

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This thesis, written by

Captain Hugh K. DeLong, III

and

Captain Robert M. Julsonnet

has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

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CHAPTER I

INTRODUCTION

Statement Of The Problem

Throughout history, man desired to predict the future. Many decisions would have been changed if man could have forecasted future events with greater certainty. Recently, man's ability to predict what effect present decisions will have on future actions has increased significantly with the use of computers. Models have been devised to forecast the outcomes of proposed decisions and to answer perplexing problems.

Our government is interested in refining its ability to predict the impact of Federal actions (18). The National Environmental Policy Act (NEPA), passed in 1969, requires submission of an Environmental Impact Statement (EIS) by all Federal agencies for all "major Federal actions significantly affecting the quality of the human environment /10:1/." The Courts have defined a major Federal action as "one that requires substantial planning, time, resources, or expenditures /21:21/." They have also stated that

> . . . a federal action "significantly affecting the quality of the human environment" is one that has an important or meaningful effect directly or indirectly, upon any of the many facets of man's environment /21:21/.

The NEPA requirements necessitate a review of the physical, biological, and cultural environments. Quantifications of impacts in the physical and biological environments are more specific and precise than quantifications of impacts in the cultural environment. For example, it is easier to measure the particulate emissions from a factory than it is to measure the full extent of the socioeconomic impact of a personnel change upon a local community. The socioeconomic aspect of these actions generally receives the most interest locally because of the perceived potential effects it has on the economic viability and stability of the area (18).

Government agencies are continually trying to increase their proficiency in predicting and quantifying all categories of future impact caused by federal actions. Computer models are being devised to more accurately measure socioeconomic changes upon the community. Within the Department of Defense (DOD), the Army has developed an Economic Impact Forecast System (EIFS) model. The present EIFS model is fast, efficient, and comprehensive, but less accurate than desired (19:10). The accuracy is reduced because of the subjective underlying assumptions about the geographic region of assessment (10). The region of impact is presently identified as any county located within a 30 mile radius of the DOD installation as identified on Figure 1. Even counties that have only a small portion

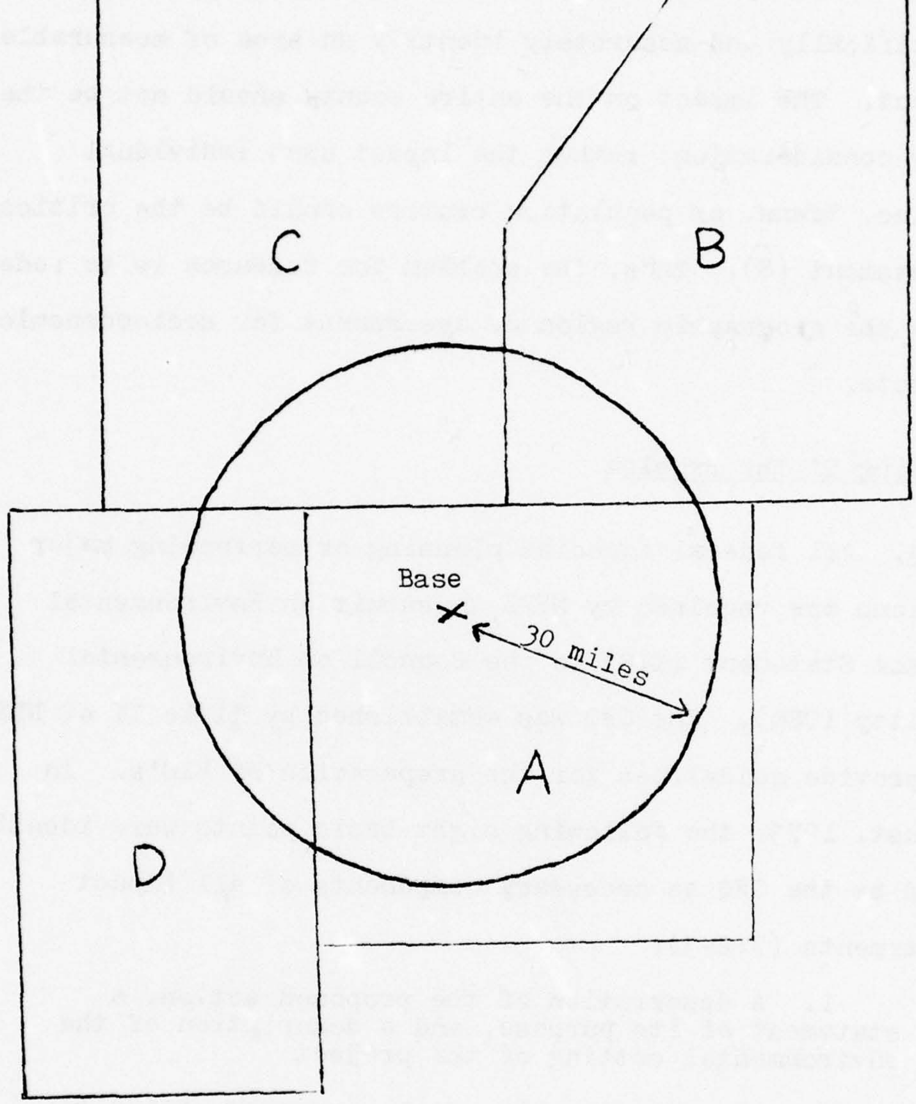


Figure 1.

Counties Within a 30 Mile Radius of Base of their area within the 30 mile radius are considered in their entirety. This area should be redefined to more specifically and accurately identify an area of measurable impact. The impact on the entire county should not be the only consideration; rather the impact upon individual cities, towns, or population centers should be the critical assessment (8). Thus, the problem for research is to redefine the geographic region of assessment for socioeconomic impacts.

Setting Of The Problem

NEPA. All federal agencies planning or performing major actions are required by NEPA to submit an Environmental Impact Statement (EIS) to the Council on Environmental Quality (CEQ). The CEQ was established by Title II of NEPA to provide guidelines for the preparation of EIS's. In August, 1973, the following eight basic points were identified by the CEQ as necessary components of all impact statements (7:2-3):

1. A description of the proposed action, a statement of its purpose, and a description of the environmental setting of the project

2. The relationship of the proposed action to land-use plans, policies, and controls for the affected area

3. The probable impact of the proposed action on the environment

4. Alternatives to the proposed action, including those not within the existing authority of the responsible agency

5. Any probable adverse environmental effects that cannot be avoided, and, separately, how avoidable parts will be mitigated

6. The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity

7. Any irreversible and irretrievable commitments of resources (including natural and cultural as well as labor and materials)

8. An indication of what other interests and considerations of Federal policy are thought to offset the adverse environmental effects identified.

Application of NEPA. The Air Force designated the Director of Civil Engineering as the Air Staff office of primary responsibility for all environmental protection actions (13:4). Major General Robert C. Thompson, Director of Engineering and Services, Headquarters USAF, stated the following in a policy letter:

> The identification and development of methods and procedures which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision-making along with economic and technical considerations [9:1].

Following the CEQ guidelines, the Armed Services of the Department of Defense wrote manuals and regulations to support the intent of NEPA. Air Force Regulation 19-1 provides Air Force personnel with directions for implementation of required NEPA actions (13:1). AFR 19-2, Environmental Assessments and Statements, requires that environmental consequences of any proposed action be assessed at the earliest practicable stage in the decision-making process (11:1). The Air Force Civil Engineering Center (AFCEC) at Tyndall Air Force Base, Florida, has an Environmental Planning Directorate to serve as the functional manager for Air Force-wide environmental impact assessments (1).

The interpretation of NEPA has been expanded to include not only major federal actions significantly affecting the quality of human environment, but also any controversial actions being taken by the Government. The DOD defined controversial issues as having "real, potential, or proposed adverse environmental consequences /2:6/." For this reason many "significant impacts have been associated only with social or economic consequences of some installation reduction of personnel /8/." Even in those areas where the draft EIS's showed little evidence of significant adverse physical environmental impacts associated with a major federal action, EIS's were required to show potential social and economic consequences of the personnel changes (8).

After several years of experience in writing EIS's, socioeconomic impact prediction surfaced as the most critical aspect of EIS preparation. As identified in a report by Dr. Lynch in April 1969 for the Department of the Air Force:

> The key to evaluating the impact of base closures on local communities is the recognition that cities with nearby bases have a demonstrably

> higher ratio of service or support-oriented employment . . . than other communities of comparable size without nearby military bases [4:304].

Dr. Lynch (4:305) emphasized the need to determine the employment changes in the support services in order to determine the impact of a military installation upon local communities (6:6).

Personnel writing EIS's had difficulty in predicting the socioeconomic impacts objectively and accurately. Cognizant of this shortcoming in the DOD impact assessment process, the Department of Defense tasked the Army Construction Engineering Research Laboratory (CERL) to resolve the inability to measure socioeconomic impacts in local communities (18).

<u>Developing a Model</u>. The Department of the Army (DA) responded to their tasking by devising a model in the following manner:

> A model to satisfy the need for economic analyses was first developed when CERL scientists began to prepare EIS's for DA activities. Sixty-four DA installations that were representative of different types of facilities (urban and rural, northern and southern, eastern and western, large and small, etc.) were selected. The model incorporated existing census data and well-established economic techniques, and was flexible and easy to use [20:7].

The Economic Impact Forecast System (EIFS) was created to address socioeconomic changes caused by military, specifically Department of the Army, programs (20:7). The system is designated to point out early in the decision-making process any severe problems or shortcomings in DOD proposals concerning what impact an action might have on the area. If the problems are severe, alternative plans could be considered. If no significant impact is shown, adequate Environmental Impact Assessment (EIA) documentation would be available (20:7).

When first deciding upon the required characteristics of the EIFS data base, the CERL scientists looked for a national data bank that was consistently formated, frequently revised, and easily acquired. Census information was a natural choice because it possesses all of these characteristics. EIFS receives socioeconomic data from the Bureau of The Census, the Bureau of Economic Analysis, and other government sources to forecast potential economic impact (19:15). EIFS "is intended to estimate the orders of magnitude of economic impact, not to provide exact values [19:15]." These orders of magnitude are identified by the categories insignificant, significant, or substantial (19:20) which indicate the economic stresses placed on the community as a result of the change. The initial data base for the EIFS model was subjectively broken down to the basic operating level of counties (or parishes, or municipos in Puerto Rico, or independent cities) (18). Most of the data base came directly from census data tapes organized at the county level, which the Bureau of the Census defines as the "primary political and administrative divisions of States [12:26]."

It is important to note that "the Census Bureau produced five kinds of maps for the 1970 census. They are the Metropolitan Map Series, county maps, place maps, county subdivision maps, and tract outline maps /12:12-13/." These maps are important because all census data was aggregated at each of these five levels. Since the maps are listed in decreasing order of size, the subjective decision to use county level data resulted in use of the second largest geographic size of data aggregation.

Basically, EIFS is an export base model that uses location quotient techniques to provide quantitative estimates of the economic impacts of a proposed major federal action (20:19). EIFS estimates the impact that changes in federal expenditures will have on "local businesses, households, and governments in the areas of employment, personal income, total business volume, housing revenues, housing and business investments, and government expenses /20:1/."

The "change" figures are given in relationship to the "baseline" figures. "The percentages of change in total business volume, personal income, and employment imply the relative magnitudes of change among the various alternatives /20:9/."

The EIFS model uses the indirect estimation techniques concerning export industries--industries that export products outside the region of assessment. "The central assumption of the indirect technique is that a fixed relationship exists between the export industires in a region and the other local businesses [20:147]." Therefore, an export industry can be isolated and a change in its employment shown to have an effect on the total local economy. It is important to note that this effect for each individual situation is computed, resulting in a single intermediate numerical variable that is called the multiplier. This multiplier is the quantification of the multiplicative affect of the export industry upon the industries in the region. "The size of the multiplier is directly related to the size of the region, the diversity of its industrial and commercial base, and the size of its population [20:15]."

By addressing the "Mission Change" functional area of the EIFS model, the user would simply have to input the following six arguments:

(1) Change in expenditures for local services and supplies;

(2) Change in civilian employment;

(3) Average income of affected civilians;

(4) Change in military employment;

(5) Average income of affected military personnel;

(6) Percent military personnel living on base (between 0 and 100) [20:25].

This information can be easily compiled for any base by referencing the TAB A-1 of the Annual Air Force Comprehensive Plan (15:1). The preparation of the TAB A-1 requires the Air Force installations to annually collect data concerning the economic interrelationship between the base and community in such areas as military/civilian payrolls, Federal aid, base construction, and local purchase expenditures, housing market statistics, employment statistics, and economic base of the community. The TAB A-1 also requires each Air Force base to annually predict its economic impact on the local community (14:6). Because there is not much information that needs to be tediously gathered by the users, the CERL model's simplicity makes it attractive (8).

The output from EIFS is then presented in three categories:

(1) baseline descriptive information,

(2) estimate of change, and

(3) analysis of past historical trends [20:7].

The historical trends can be used to see what actions of equal magnitude have occurred in the past and identify thresholds of "acceptable" economic change which are unique to the specific local economy. Thus, the analysis provides a measure of "significance" for the proposed action (20:8). The economic impacts are "highly aggregative and based on secondary data sources [19:15]" and are intended only to estimate the orders of magnitude of economic impact.

The advantages of this EIFS decision-making tool are its speed of access and cost-effective retrieval of information. These advantages far outweigh the disadvantages of prediction inaccuracies (20:10).

> The predictions made by EIFS represent an "extreme" case. The estimator is high when compared with actual field experiences. It tends to lend to overestimating the adverse effects of a reduction in force at an installation. This occurs because of the model's failure to consider intangible elements such as the human behavioral response to adverse economic conditions [20:10].

As evidenced in this quote, the EIFS model has one flaw: estimates of impact are "high when compared to actual field experiences [20:10]." In an effort to reduce errors generated by the model, previous researchers directed their attention towards a more definitive determination of the radial distance of the impact of DOD installations upon the surrounding community (3:1). The current model assumes that an installation's workforce has residences which, when taken in totality, form a normal distribution that centers itself on the base and radiates outward to a distance of 30 miles, beyond which no one (or no significant number of people) live. This region was illustrated in Figure 1. The model is set up to draw an imaginary 30 mile radius around the defense installation being examined and to include every county within or touched by the circle, as depicted in Figure 1, unless the analyst decides to delete a specific county. Mr. Ron Webster, at CERL, believes that this underlying assumption about the definition of the region of impact is a shortcoming in the model (18). The fallacy in this logic is that one county (such as A) may be very close to the installation and affected greatly by a socioeconomic change while another county (such as B) may be miles away and almost unaffected by any changes. Both counties are considered in their entirety in the evaluation of the economic impact. There is no individual city or locale assessment.

The radial distance also assumes that all people want to live in a location close to the place where they work. In actuality, transportation corridors may lengthen commuting distances to the place of work. Therefore the travel distance may extend beyond this computed radial distance of impact. People will also live where communities exist. These communities may not be next to the base. Additionally, because the base provides certain job opportunities to many individuals in the area, people may be willing to travel a greater distance to work in specific jobs. Also, the radial distance of impact may consider areas with a sparse population of government associated employees. These inappropriate determinations of the region of impact are blamed for the model's characteristic overestimation of impact by the model developers (18). The area of assessment is too large.

Assumptions Underlying The Current Data And Model

In addition to knowing the specifics about the data base and the model's inner workings, it is important to also review the conceptual framework upon which both are built. Figure 2 illustrates the visual model that EIFS is based upon (20:11). It shows the interrelationships among local government, households, and businesses. It points out the fact that "Interdependence is the rule of any economy [19:16]." The presence of a military installation in an area generally provides a large source of local revenue and employment for the community. Something that affects the military community affects every other sector. "EIFS can trace an activity's initial impact through the various sectors of the economy, recording the level of impact and estimating the secondary impacts at each stage [20:11]."

The current model has several other assumptions. It assumes accuracy in census data and veracity in the choice of economic modeling techniques. Additionally, they assume the use of a radial distance will result in a valid data base. Finally, they assume that only one composite look at the county is sufficient to determine all of the impacts of the actions (18).

Justification

The NEPA states, "it is the continuing responsibility of the Federal Government to use all practical means

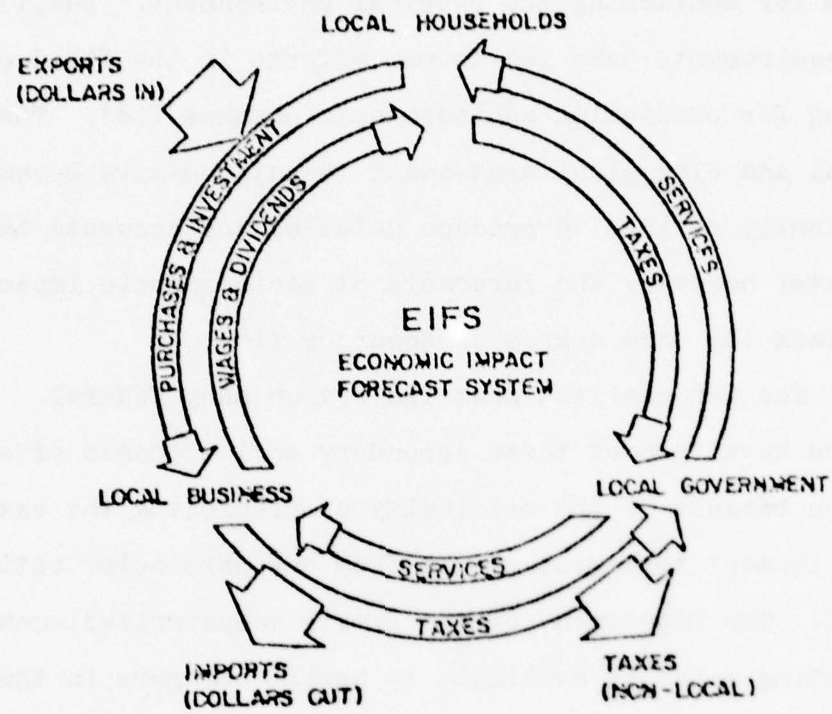


Figure 2.

Interrelationship in Local Economy (17:11).

. . . to improve and coordinate Federal plans, functions, programs, and resources . . . [10:17]." This federal mandate for improvement in assessment techniques has been the driving force for the development of impact measurement devices for monitoring the physical environment. Additional NEPA requirements have led to new efforts in the field of modeling for predicting socioeconomic changes (18). The physical and biological assessment techniques have become sufficiently refined to produce detailed and accurate impact forecasts; however, the forecasts of socioeconomic impacts still lack the same degree of accuracy (18).

The CEQ realized that the reason many federal agencies have ignored these secondary socioeconomic effects has been because of the difficulty of predicting the extent of development that will result from any particular action (21:24). The Department of the Army's computerized economic forecasting model is available to assist managers in their decision-making processes. The EIFS data bank allows for the cost-effective retrieval of information in a timely manner (20:10). The only apparent aspect of the model that needs improvement is the slight overestimation of adverse impacts due to the subjectively defined region of assessment (20:10). Subsequent to the Air Force acceptance and use of the Army EIFS model, the requirement for region refinement was independently addressed by the Air Force Civil Engineering Center (1). Because of this concern about the definition of the region of assessment by the developer and the major customers, it is imparative that research to refine the geographic region for socioeconomic assessment be undertaken. The thrust of this research is to advance efforts in support of the federal environmental mandate to improve assessment techniques through the refinement of the EIFS model definition for the region of assessment to use census tract areas instead of county areas.

The emphasis of this research is to find a way to relate the residences of the installation's personnel to a useable data source. The rational for finding this information is that knowing where people live provides a more accurate area depiction for analysts to use when they are making predictions of impact upon local governments and businesses (8).

The residences of the installation's personnel will be identified by their respective zip code areas. This zip code information will be obtained from the base personnel office and the TAB A-1. This research will involve a comparison of the zip code areas and census tracts. Census tracts are subdivisions of counties and are defined as follows:

> CENSUS TRACTS are small, relatively permanent areas into which large cities and adjacent areas have been divided for statistical purposes. Tracts are designed to be relatively homogeneous in population characteristics, economic status and living conditions, though these conditions may change over time. The average tract has about 4,000 inhabitants /12:24/.

The rational for using census tracts to identify the area for socioeconomic assessment is to increase the accuracy of the impact predictions. The model will be more specific and will not overestimate the impact of governmental actions. Currently, information that is important to a specific community is lost when looking at an entire county. The specific impact upon a small community is diluted by information generated by unaffected locations within the county. Also, the information that is received concerning the impact of an action is currently not tailored to answering questions of individual community members.

Specific rules will be stated for assigning census tracts to zip code areas. The numbers corresponding to these census tracts will then be used as inputs into the EIFS model. The analysis will be of specific census tracts identified by the zip codes of base personnel within the original 30 mile radius. This is illustrated in Figure 3. The only areas considered will be those with a large number of base employed personnel. These specific census tract areas will be aggregated to form a new region of assessment. This new data base will then be used to predict the impact of a mission change at Wright-Patterson Air Force Base. The results of that prediction will then be compared to the effect of the same mission change using the current data base. Any difference in predicted impact will then be discussed.

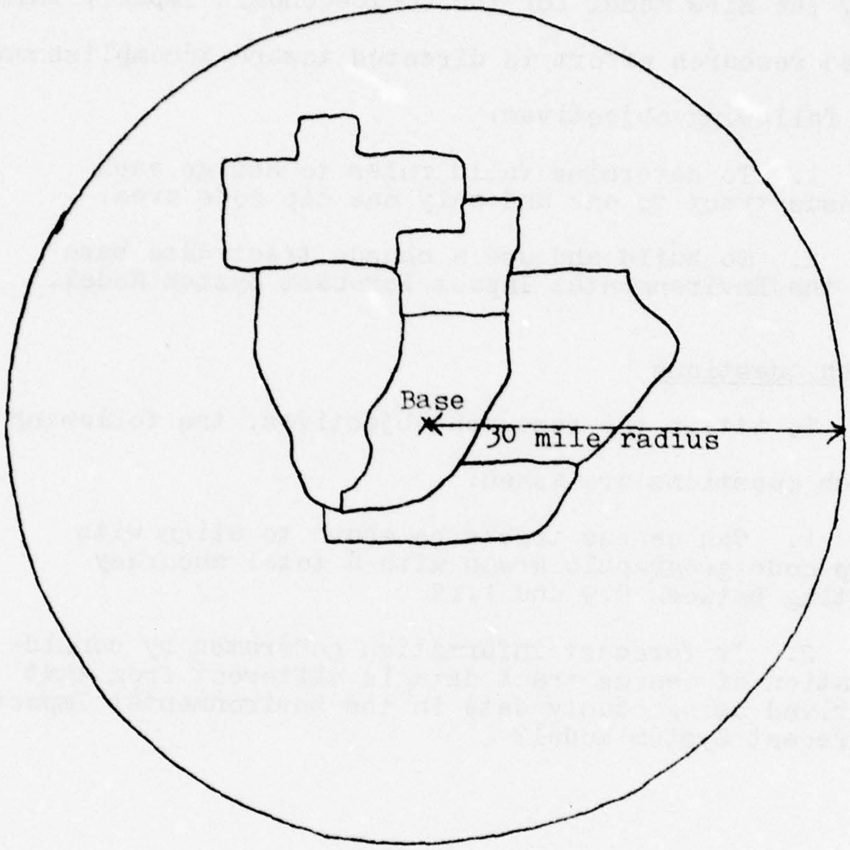


Figure 3

Zip Code/Census Tract Areas Within 30 Mile Radius of Base Having Highest Concentrations of Residences of Installation Personnel

Objectives

In an effort to better define the area of consideration by the EIFS model for the socioeconomic impact, this proposed research effort is directed toward accomplishment of the following objectives:

1. To determine valid rules to assign each census tract to one and only one zip code area.

2. To build and use a census tract data base on the Environmental Impact Forecast System Model.

Research Questions

To attain the research objectives, the following research questions are asked:

1. Can census tracts be shown to align with zip code geographic areas with a total accuracy rating between 0.9 and 1.1?

2. Is forecast information generated by consideration of census tract data is different from that derived using county data in the Environmental Impact Forecast System Model?

CHAPTER II

RESEARCH METHODOLOGY

Scope

The purpose of this research effort was to determine possible refinements concerning areas of assessment of the Army EIFS model. The current EIFS model computes the impact for entire counties. There is little information to be gained about the specific impact of a major federal action upon a specific town or community. The significant impact on a small town beside a closing base is obscured when the impact is computed for the entire county in which this town is located. Much data is lost when averaging the effect for the entire county (8).

This research concerned itself with individualizing the predictions of environmental impacts caused by major federal actions. The intent was not to challenge the veracity of the EIFS model but to rigorously determine valid rules for assigning census tracts to zip code areas in an effort to create a new data base. The research compared the zip code areas and census tracts in and around Dayton, Ohio. Specific areas analyzed were those serviced by the Dayton Branch Office of the United States Postal Service. All the census tracts were assigned to their respective single zip code areas using the same criteria. A perusal of several area maps indicated that the zip code areas may have been set up with the census tracts in mind. The zip code areas were also designed to minimize mail delivery costs (16:vii).

Because all census tracts and zip code areas were designed using the same basic sets of criteria, the information found in the Dayton area will be generalizable to the entire United States. The reason the Dayton area was chosen was because of the accessibility of the data.

Rules For Assigning Census Tracts To A Zip Code Area

The following rules were used to assign census tracts to zip code areas. An explanation of the rational for using each rule is presented.

Rule 1 stated that each census tract area can be assigned to only one zip code area. Consequently, all information about that census tract will be assigned to only one zip code area.

Rule 2 specified that if more than 50 percent of the census tract area is within the boundaries of a zip code area, the census tract will be assigned to that zip code area. In this way the census tract information was assigned to the area in which it had the greatest influence. For example if 70 percent of the census tract was within a zip code area, its census statistics would be assigned to that zip code area.

Rule 3 clarified that whenever a census tract is spread over three or more zip code areas, the census tract would be assigned to the zip code area having the largest portion of the census tract's area.

Graphic Data Collection And Analysis

Graphic map data was obtained from local maps of census tracts (CT) and zip codes (ZC). Next, these two types of boundaries were overlaid on a common map. These boundaries were then all drawn on the common map by one individual to minimize any transcribing errors. The common map also eliminated the possibility of error caused by different map scales.

A planometer was then used to measure the total area of each zip code region, the total area of each census tract, and the area of each census tract within each zip code. These planometer readings were all made and recorded by one individual at one place with other environmental variables such as lighting held constant to achieve minimum errors in data collection.

After all planometer readings were collected, they were tabularized in columns one, two, three, five, and six of the following chart which is an example of the columns that will be used in Table 2 in the analysis section of this thesis.

Col. 1 Zip Code Number	Col.2 Zip Code Area	Col. 3 Census Tract Number	Col. 4 Classification		Col. 5 Census Tract Area Within Zip Code	Col. 6 Total Census Tract Area	Col. 7 Percent of Census Tract Area Within Zip Code
			In	Out			

A chart was compiled for each zip code area near Dayton, Ohio, for which the required information could be obtained.

As a check on the accuracy of the planometer readings, the zip code area was compared to the summation of column five (CT area within ZC) for each zip code chart.

The differences in readings were used to judge the accuracy of the planometer readings. The next step was the computation of column seven (Percent within ZC) through a division of column five (CT area within ZC) by column six (CT area total) on a line-by-line basis for each zip code chart. The charts were then used to determine the assignment of each census tract to one zip code using the rules previously mentioned. The results of the assignment were then noted in column four (Classification) as either "in" or "out". To compute the accuracy rating of the assignment of census tracts to individual zip codes, the summation of all "out" census tracts total areas was subtracted from the summation of all "in" census tract areas within the zip code. This figure was then divided by the total area of the zip code to achieve an accuracy rating. The equation follows:

$$\text{Zip Code Accuracy Rating} = \frac{\text{Sum of total areas for census tracts assigned as "in"} - \text{Sum of total areas for census tracts assigned as "out"}}{\text{Total Zip Code Area}}$$

Ideally, an accuracy rating of one or unity would represent a condition wherein the collection of several census tracts would form a mutually exclusive and collectively exhaustive area identical to the zip code area under review. To ascertain the accuracy of the rules as applied to several zip codes, a simple averaging of individual zip code accuracy ratings was performed. The individual accuracy ratings were also averaged using an area-weighting technique and the results were used to determine if the size of the zip code area had any affect upon the accuracy of the census tract assignment rules. Both results of the Dayton Area zip code effort were then compared with the criteria contained in the first research question as the final step in the graphic data analysis phase.

Computer Data Collection And Use

The methodology for collecting the new EIFS data base involved finding where the base population lived and then building a new EIFS data base from that information. Both military and civilian personnel offices were queried about methods for obtaining the zip code numbers for the residences of base personnel. The tallies of military and civilian employees by zip code areas were then tabulated and summed. If the total base population for a particular zip code area was in excess of twenty (approximately .1 percent of Wright-Patterson Air Force Base's population), that zip code was judged to be significant and its associated census tracts were added to the new EIFS data base. Detailed information on "significant" census tracts was then obtained through the CERL Environmental Technical Information System. The EIFS model was adjusted to account for the newly defined region as a result of recommendations from EIFS creators, primarily Mr. Ron Webster.

Mr. Ron Webster emphasized that because the EIFS model has an export base, it is imparative that the area of concern (such as Wright-Patterson Air Force Base) be completely surrounded by census tracts to make the results valid (18). There can be no holes in the region of coverage around the base.

To actually "run" the new data base on the modified EIFS model, a set of entering arguments had to be established for the EIFS functional area of interest. These entering arguments were collected from several base offices, although they could have just as easily been taken from the TAB A-1 of the Wright-Patterson Air Force Base Annual Comprehensive Plan (15:1).

Underlying Assumptions

1. All secondary data used in this research was accurate.

2. The EIFS model is adaptable to census tract

(therefore zip code) area information.

3. Individual census tract forecasts more closely approximated the true impact in a specific locale than forecasts for the entire county containing that locale.

4. That the size of the sample was sufficiently representative that the results were generalizable to all zip codes located in the United States.

5. The use of the planometer produced sufficiently accurate data.

Limitations

1. All census tracts and zip code areas in the United States were not surveyed due to time constraints placed on the researchers.

2. The data level did not support parametrical testing.

Meeting The Research Objectives

The research objectives will be attained when the first research question has been supported by data findings. Specifically, the research objective will be met when census tracts can be shown to align with zip code areas within an adjusted accuracy range of 0.9 to 1.1. The second objective will be achieved when the new census tract data base has been run in the EIFS model and a difference noted between data computed on a census tract basis and a county basis.

CHAPTER III

DATA COLLECTION AND ANALYSIS

Although it was the opinion of the Dayton postmaster that the zip code areas had been established with census tracts as their basis (5), a literature review did not verify this fact. No publication that was read specifically stated that zip code area boundaries were set up based upon census tracts. The actual map depictions do allude to the premise that the spawning of zip code areas may have been from census tracts.

This research is done to show how closely zip code and census tract areas correlate to each other.

Collection Of Map Data

Several maps were used to find the exact boundaries of the zip code areas and census tracts. Maps from Census Bureau literature were used to identify the census tract boundaries (17:1-2). Through the literature search and through numerous telephone conversations with United States Postal Service employees in Washington, D.C., it was discovered that regional zip code maps were published by the United States Printing Office until 1972. All efforts to obtain one of those maps for Dayton, Ohio, were unsuccessful and a large wall map at the Main Post Office in Dayton, Ohio, was finally used in determining the zip code area boundaries. Because of its size and clarity, a Market Distribution Map from the Consumer Communication Service, 1916 Lucille Drive, Dayton, Ohio, was used to plot all the census tract and zip code boundaries.

The actual planometer measurements were taken with the use of one planometer following the data measurement methodology outlined in the previous chapter. Two readings were collected for each census tract identified in Table 1. The total area coverage was recorded as well as the area within a specific zip code area. Additionally, the area of each zip code was determined. All three readings were then placed in Table 2.

Analysis Of Map Data

The first step of map data analysis was verification of the accuracy and consistency of the planometer readings. The results of the one-to-one comparison of zip code area size to the summation of column five readings are shown in Table 3. All pairs of readings were within a range of plus or minus two percent of each other, and the planometer readings were therefore judged to be accurate. From these readings, computations were next made to determine what percentage of the census tract was within the zip code boundaries. A histogram of these results is shown in Graph 1. The results were skewed left. More census tract

TABLE 1

LIST OF 22 DAYTON AREA ZIP CODES USED IN CENSUS TRACT ASSIGNMENT RESEARCH

45402
45403
45404
45405
45406
45407
45408
45409
45410
45415
45416
45417
45419
45420
45424
45428
45429
45430
45432
45433
45439
45449

TABLE 2

BASIC DATA CHART

Zip Code Number	Zip Code Area	Census Tract Number	Classification		Census Tract Area Within Zip Code	Total Census Tract Area	Percent of Census Tract Area Within Zip Code
			In	Out			
45402	7.95	35	x		1.64	1.92	85.4
		36	x		.77	.77	100.0
		37	x		1.14	1.14	100.0
		38	x		1.96	1.96	100.0
		39		x	.13	4.28	3.0
		40	x		.65	.65	100.0
		45	x		.30	.41	73.2
		45	x		1.48	2.34	63.2
			TOTAL		8.07		
45403	11.77	44		x	.32	1.43	22.4
		45		x	.11	.41	26.8
		46		x	.86	2.34	36.8
		47	x		1.35	1.35	100.0
		48		x	.41	1.38	29.7
		49		x	.06	.74	8.1
		57		x	.20	1.05	19.0
		58	x		1.75	2.15	81.4
		59	x		1.73	1.73	100.0

TABLE 2 (Continued)

Zip Code Number	Zip Code Area	Census Tract Number	Classification In	Classification Out	Census Tract Area Within Zip Code	Total Census Tract Area	Percent of Census Tract Area Within Zip Code
		60	x		1.91	1.91	100.0
		61	x		1.60	1.60	100.0
		62	x		1.59	1.94	82.0
			TOTAL		11.89		
45404	25.42	62		x	.21	1.94	10.8
		63	x		2.12	2.12	100.0
		64	x		3.14	3.14	100.0
		65	x		5.73	5.73	100.0
		901	x		5.62	9.07	62.0
		902	x		3.98	3.98	100.0
		903		x	4.30	20.48	21.0
			TOTAL		25.10		
45405	19.20	1	x		1.25	1.25	100.0
		2	x		.92	.92	100.0
		3	x		.81	.81	100.0
		4	x		1.19	1.60	74.4
		5		x	.60	1.39	43.2
		7		x	.19	2.01	9.5
		8	x		1.71	1.71	100.0
		9	x		1.82	1.82	100.0
		10		x	.41	2.31	17.7

TABLE 2 (Continued)

Zip Code Number	Zip Code Area	Census Tract Number	Classification In	Classification Out	Census Tract Area Within Zip Code	Total Census Tract Area	Percent of Census Tract Area Within Zip Code
		801		x	3.05	10.01	30.5
		803	x		3.03	3.63	83.5
		804	x		2.85	2.85	100.0
		806	x		1.68	3.05	55.1
			TOTAL		19.51		
45406	21.21	4		x	.41	1.60	25.6
		5	x		.65	1.39	46.8
		6	x		2.21	2.21	100.0
		7	x		1.82	2.01	90.5
		10	x		1.90	2.31	82.3
		11	x		1.12	1.12	100.0
		12	x		1.88	1.88	100.0
		13	x		1.70	1.70	100.0
		14	x		3.92	4.63	84.7
		15	x		1.88	2.54	74.0
		703		x	.03	15.51	0.2
		706		x	.98	7.37	13.3
		801		x	2.22	10.01	22.2
		803		x	.60	3.63	16.5
			TOTAL		21.32		
45407	9.37	5		x	.14	1.39	10.1

TABLE 2 (Continued)

Zip Code Number	Zip Code Area	Census Tract Number	Classification In	Classification Out	Census Tract Area Within Zip Code	Total Census Tract Area	Percent of Census Tract Area Within Zip Code
		15		x	.66	2.54	26.0
		16	x		1.07	1.07	100.0
		17	x		.96	.96	100.0
		18	x		.37	.37	100.0
		19		x	.15	.69	21.7
		20	x		.72	1.20	60.0
		21	x		1.28	1.99	64.3
		29		x	.63	1.50	42.0
		30	x		.91	.91	100.0
		31	x		1.23	1.23	100.0
		32	x		.96	1.89	50.8
		33		x	.14	2.69	5.2
		34		x	.32	2.78	11.5
			TOTAL		9.54		
45408	12.96	26	x		2.50	2.97	84.2
		27		x	1.26	10.93	11.5
		28	x		3.16	3.16	100.0
		29		x	.14	1.50	9.3
		32		x	.93	1.89	49.2
		33	x		2.34	2.69	87.0
		34	x		2.46	2.78	11.5
			TOTAL		12.79		

TABLE 2 (Continued)

Zip Code Number	Zip Code Area	Census Tract Number	Classification In	Classification Out	Census Tract Area Within Zip Code	Total Census Tract Area	Percent of Census Tract Area Within Zip Code
45409	15.65	35		x	.28	1.92	14.6
		39	x		4.15	4.28	97.0
		42		x	1.29	3.01	42.9
		101		x	.38	3.69	10.3
		102		x	1.30	4.69	27.7
		201	x		4.35	5.71	76.2
		202	x		1.64	3.56	46.1
		301		x	2.21	15.43	14.3
			TOTAL		15.60		
45410	10.97	41	x		.88	.88	100.0
		42	x		1.72	3.01	57.1
		43	x		1.09	1.09	100.0
		44	x		1.11	1.43	77.6
		48	x		.97	1.38	70.3
		49	x		.68	.74	91.9
		50	x		1.03	1.51	68.2
		51	x		2.84	3.48	81.6
		57	x		.85	1.05	81.0
			TOTAL		11.17		
45415	22.91	701		x	1.98	11.20	17.7
		801	x		4.03	10.01	40.3

TABLE 2 (Continued)

Zip Code Number	Zip Code Area	Census Tract Number	Classification In	Classification Out	Census Tract Area Within Zip Code	Total Census Tract Area	Percent of Census Tract Area Within Zip Code
		802	x		5.54	5.54	100.0
		1201	x		10.76	17.74	60.7
		1251		x	.61	14.37	4.2
			TOTAL		22.92		
45416	6.18	14		x	.23	4.63	5.0
		707	x		5.28	5.72	92.3
		801		x	.71	10.01	7.1
			TOTAL		6.22		
45417	9.49	19	x		.54	.69	78.3
		20		x	.48	1.20	40.0
		21		x	.71	1.99	35.7
		22	x		2.09	2.09	100.0
		23	x		1.75	2.23	78.5
		25	x		1.81	1.81	100.0
		26		x	.47	2.97	15.8
		29	x		.73	1.50	48.7
		703		x	.83	15.51	5.4
			TOTAL		9.41		
45419	15.31	54	x		1.78	3.49	51.0
		101	x		3.31	3.69	89.7
		102	x		3.39	4.69	72.3

TABLE 2 (Continued)

Zip Code Number	Zip Code Area	Census Tract Number	Classification In	Classification Out	Census Tract Area Within Zip Code	Total Census Tract Area	Percent of Census Tract Area Within Zip Code
		201		x	1.36	5.71	23.8
		203	x		2.34	4.49	52.1
		208		x	.21	3.48	6.0
		209	x		1.71	1.71	100.0
		210		x	1.01	2.82	35.8
		215		x	.35	4.07	8.6
			TOTAL		15.46		
45420	24.26	50		x	.48	1.51	31.8
		51		x	.64	3.48	18.4
		52	x		1.10	1.10	100.0
		53	x		1.43	1.43	100.0
		54		x	1.71	3.49	49.0
		55	x		3.46	3.46	100.0
		56		x	.19	1.85	10.3
		210	x		1.81	2.82	64.2
		211	x		2.31	2.31	100.0
		212	x		1.85	3.37	54.9
		213	x		6.53	8.32	78.5
		214	x		2.85	3.78	75.4
		215	x		.37	4.07	9.1
			TOTAL		24.73		

TABLE 2 (Continued)

Zip Code Number	Zip Code Area	Census Tract Number	Classification In	Classification Out	Census Tract Area Within Zip Code	Total Census Tract Area	Percent of Census Tract Area Within Zip Code
45424	97.77	901		x	3.45	9.07	38.0
		903	x		16.18	20.48	79.0
		1001	x		20.95	23.89	87.7
		1002	x		7.50	7.50	100.0
		1003	x		6.38	6.38	100.0
		1004	x		31.05	31.05	100.0
		2001	x		11.20	27.50	40.7
		2902		x	2.85	9.80	30.6
			TOTAL		99.56		
45429	35.26	202		x	.80	3.56	22.5
		203		x	2.15	4.49	47.9
		204	x		7.24	7.24	100.0
		205	x		1.25	1.25	100.0
		206	x		7.35	7.35	100.0
		207	x		1.69	1.69	100.0
		208	x		3.27	3.48	94.0
		212		x	1.52	3.37	45.1
		214		x	.93	3.78	24.6
		215	x		3.35	4.07	82.3
		216		x	1.14	6.04	18.9
		401		x	4.12	18.16	22.7

TABLE 2 (Continued)

Zip Code Number	Zip Code Area	Census Tract Number	Classification In	Classification Out	Census Tract Area Within Zip Code	Total Census Tract Area	Percent of Census Tract Area Within Zip Code
		402		x	.95	7.80	12.2
			TOTAL		35.76		
45430	21.93	213		x	.23	8.32	2.8
		2103	x		8.56	11.69	73.2
		2104	x		11.05	18.32	60.3
		2105		x	.81	33.05	2.5
		2106		x	.85	58.41	1.5
			TOTAL		21.50		
45432	27.69	56	x		1.66	1.85	89.7
		213		x	1.56	8.32	18.8
		910	x		4.28	4.28	100.0
		2102	x		12.96	19.29	67.2
		2103		x	2.28	11.69	19.5
		21.06		x	5.37	58.41	9.2
			TOTAL		28.11		
45433	44.39	904	x		7.18	7.18	100.0
		2001		x	2.68	27.50	9.7
		2002	x		35.34	35.59	99.3
			TOTAL		45.20		
45439	22.72	33		x	.21	2.69	7.8
		202		x	1.26	3.56	35.4

TABLE 2 (Continued)

Zip Code Number	Zip Code Area	Census Tract Number	Classification In	Classification Out	Census Tract Area Within Zip Code	Total Census Tract Area	Percent of Census Tract Area Within Zip Code
		301	x		13.22	15.43	85.7
		302	x		3.41	5.88	58.0
		502	x		4.97	4.97	100.0
			TOTAL		23.07		
45449	25.28	501	x		9.14	15.24	60.0
		503	x		16.65	18.86	88.3
			TOTAL		25.79		

areas tended to be totally within a specific zip code area. Each census tract was then classified as "in" or "out" of the zip code area based upon the rules specified in the preceding chapter.

Finally, calculations were made to examine how closely the census tract areas identified as within the zip code area would match the actual area within the zip code boundary. The equation mentioned in the methodology chapter was employed in these calculations, and the results are listed in the Table 2. The equation was analyzed for each zip code area. These results determined the accuracy of assigning census tracts to zip code areas with the rules as formulated. These accuracy ratings were graphed and

TABLE 3

VERIFICATION OF PLANOMETER READINGS

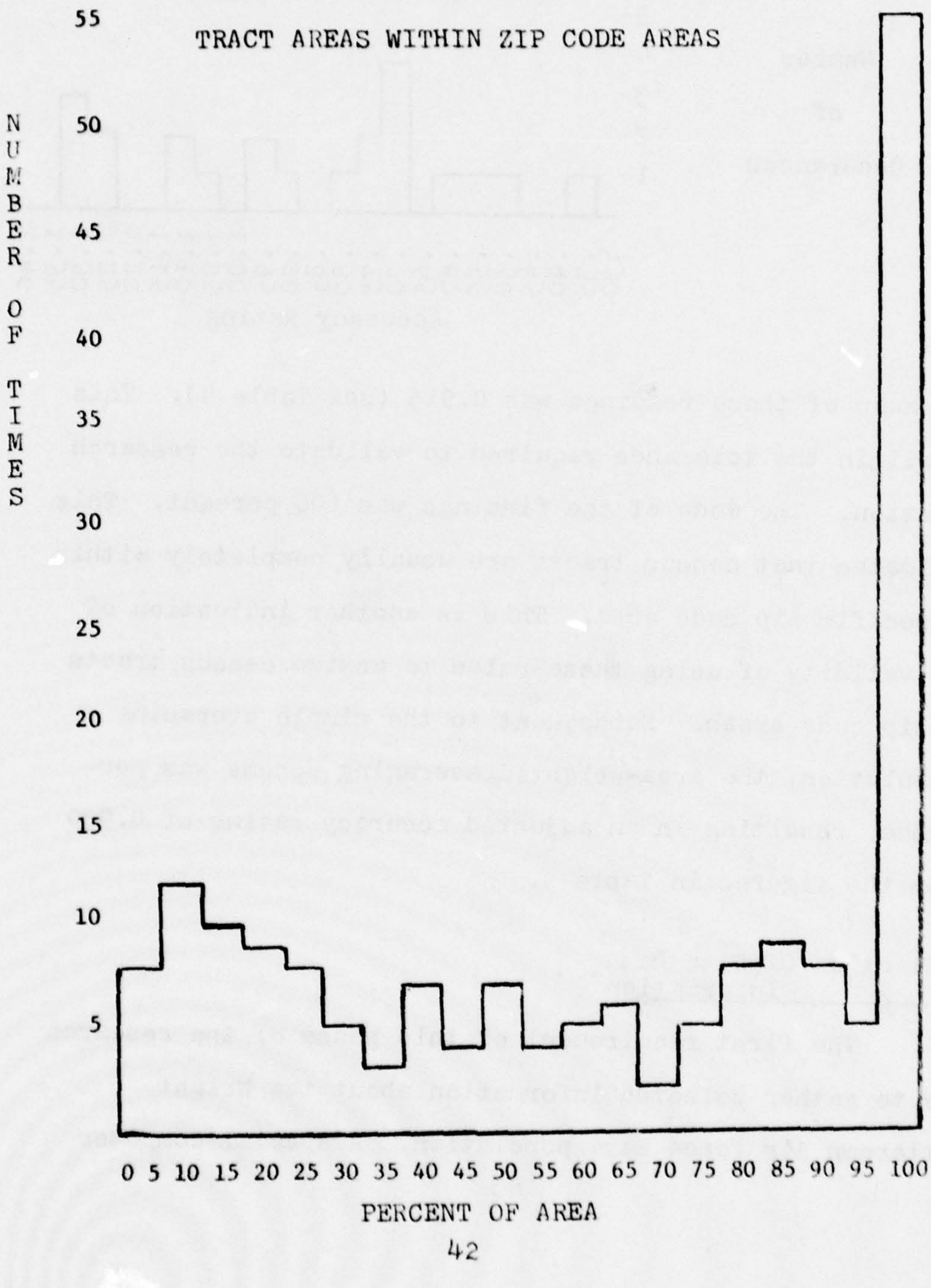
Zip Code Number	Zip Code Area	Sums Of Column 5, Table	Per Cent Difference
45402	7.95	8.07	- 1.5
45403	11.77	11.89	- 1.0
45404	25.42	25.10	+ 1.3
45405	19.20	19.51	- 1.6
45406	21.21	21.32	- .5
45407	9.37	9.54	- 1.8
45408	12.96	12.79	+ .9
45409	15.29	15.60	- 2.0 *
45410	10.97	11.17	- 1.8
45415	22.91	22.92	- .4
45416	6.18	6.22	- .7
45417	9.49	9.41	+ .9
45419	15.31	15.46	- 1.0
45420	24.26	24.73	- 1.9
45424	97.77	99.56	- 1.8
45428	2.87	2.87	0.0
45429	35.26	35.76	- 1.4
45430	21.93	21.50	+ 2.0 *
45432	27.69	28.11	- 1.5
45433	44.39	45.20	- 1.8
45439	22.72	23.07	- 1.5
45449	25.28	25.79	- 2.0 *

* High and Low Readings

GRAPH 1

HISTOGRAM OF PERCENTAGES OF CENSUS

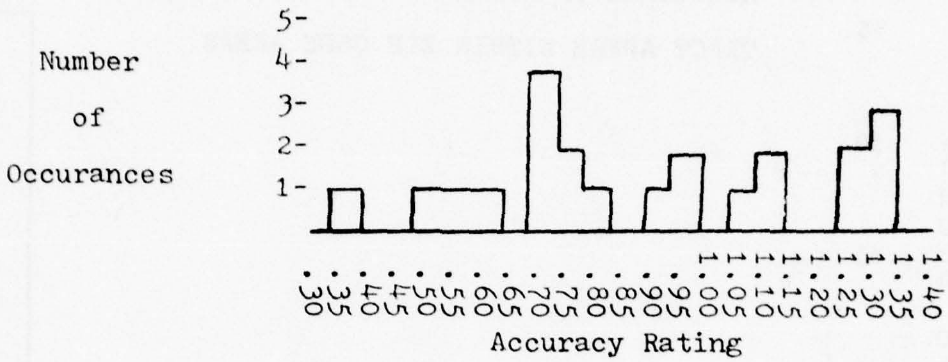
TRACT AREAS WITHIN ZIP CODE AREAS



averaged for all zip code areas examined (see Graph 2).

GRAPH 2

HISTOGRAM OF ACCURACY RATINGS



The mean of these readings was 0.915 (see Table 4). This is within the tolerance required to validate the research question. The mode of the findings was 100 percent. This indicates that census tracts are usually completely within a specific zip code area. This is another indication of the validity of using these rules to assign census tracts to zip code areas. Subsequent to the simple averaging calculation, the area-weighted averaging scheme was performed, resulting in an adjusted accuracy rating of 0.930 from the figures in Table 5.

Collection Of Data Base Information

The first requirement of this phase of the research was to gather selected information about the Wright-Patterson Air Force Base population. A special computer

TABLE 4

ACCURACY RATING LIST

Zip Code Number	Accuracy Rating
45402	1.14
45403	.74
45404	.77
45405	.70
45406	.73
45407	.80
45408	.72
45409	.53
45410	1.33
45415	1.34
45416	.77
45417	.61
45419	.99
45420	.96
45424	1.13
45428	1.27
45429	.38
45430	1.28
45432	.59
45433	.90
45439	1.09
45449	1.35
Total	20.12
Average	.915

TABLE 5

AREA-WEIGHTED ACCURACY RATING LIST

Zip Code Number	Zip Code Area	Accuracy Rating	Adjusted Figure
45402	7.95	1.14	9.06
45403	11.71	.74	8.67
45404	25.42	.77	19.57
45405	19.20	.70	13.44
45406	21.21	.73	15.48
45407	9.37	.80	7.50
45408	12.96	.72	9.33
45409	15.65	.53	8.29
45410	10.97	1.33	14.59
45415	22.91	1.34	30.70
45416	6.81	.77	5.24
45417	9.49	.61	5.79
45419	15.31	.99	15.16
45420	24.26	.96	23.29
45424	97.77	1.13	110.48
45428	2.87	1.27	3.65
45429	35.26	.38	13.40
45430	21.93	1.28	28.07
45432	27.69	.59	16.38
45433	44.39	.90	39.95
45439	22.72	1.09	24.77
45449	25.28	1.35	34.13
TOTALS	491.13	——	456.94
Weighted Accuracy Rating (456.94/491.13) = .930			

inquiry of the Automated Personnel Data System was requested through the base consolidated personnel office. The residential mailing addresses of military personnel loaded on the military personnel computer system were surveyed and tallies for each zip code area were printed on two computer runs and those results were entered in Table 6, columns one and two. All efforts to obtain facts about the distribution of base civil servant residences were unsuccessful. Therefore, the distribution of off-base civilian residences were assumed to be proportional to the military residences. The ratio of off-base military residences within each zip code to total off-base military residences was computed and listed in column three. This ratio was then multiplied by the total number of base civil servants to obtain an estimate of the number of civilians living in particular zip code areas. This estimate was then listed in column four of Table 6. Columns two and four were then summed in column five to obtain the number of base personnel residing within that zip code area. The criteria was established that if more than 20 base personnel resided within a zip code area, then that zip code was judged to be significant (see column six of Table 6), and it was added to the new data base.

After the complete data base of significant zip codes was compiled, the list of zip codes was transferred into a list of census tracts using the techniques derived

TABLE 6

THE NUMBER OF BASE PERSONNEL RESIDENCES IN ZIP CODE AREAS

Zip Code Number	Tally of Military	Military Ratio	Estimate of Civilian	Total Base Personnel	Significance (Yes or No)	
45322	1686	.251	4246	5932	Yes	
45323	64	.010	169	233	Yes	
45424	1175	.175	2962	4137	Yes	
45325	0	.000	0	0		No
45342	2	.000	0	2		No
45344	81	.012	203	284	Yes	
45377	9	.001	17	26	Yes	
45402	3	.000	0	3		No
45403	31	.005	85	116	Yes	
45404	29	.004	68	97	Yes	
45405	25	.004	68	93	Yes	
45406	34	.005	85	119	Yes	
45407	5	.001	17	22	Yes	
45408	1	.000	0	1		No
45409	7	.001	17	24	Yes	
45410	13	.002	34	47	Yes	
45414	22	.003	51	73	Yes	
45415	22	.003	51	73	Yes	
45416	6	.001	17	23	Yes	
45417	1	.000	0	1		No
45419	14	.002	34	48	Yes	
45420	27	.004	68	95	Yes	
45424	1056	.159	2691	3747	Yes	
45426	14	.002	34	48	Yes	

TABLE 6 (Continued)

Zip Code Number	Tally of Military	Military Ratio	Estimate of Civilian	Total Base Personnel	Significance (Yes or No)	
45427	1	.000	0	1		No
45428	8	.001	17	25	Yes	
45429	29	.004	68	97	Yes	
45430	52	.008	135	187	Yes	
45431	1686	.251	4246	5932	Yes	
45432	186	.028	474	660	Yes	
45439	1	.000	0	1		No
45449	7	.001	17	24	Yes	
45459	44	.007	118	162	Yes	
45485	228	.043	728	1016	Yes	
45501	0	.000	0	0		No
45502	44	.007	118	162	Yes	
45503	7	.001	17	24	Yes	
45504	11	.002	34	45	Yes	
45505	7	.001	17	24	Yes	
45506	6	.001	17	23	Yes	
Total	6,704	1.000	16,923	23,627		

in the graphic data collection and analysis phase of research. From the census tracts listed, a short list of local counties was evolved. These county names were then entered into profiles one, five, and ten of CERL's Environmental Technical Information System (ETIS). The outputs of profiles one, five, and ten were listing of census tract statistics subsequently aggregated at the county level, which are displayed in Tables 7, 8 and 9. The average income of employed persons by industry in

TABLE 7

ETIS PROFILE ONE RESULTS

Region Name (Counties)	Population	Size (Sq. Miles)	M Value (From ET)
Greene	125,057	415	1.6537
Clark	156,946	402	2.6084
Montgomery	606,148	459	2.3128
Montgomery and Greene	731,205	874	2.3010
Montgomery, Greene, and Clark	888,151	1,276	2.4157
Wright-Patterson Air Force Base Region	1,520,967	5,711	2.7810

Table 10 was obtained from CERL to manually run the EIFS model. The actual EIFS model equations were identified and listed in Table 11. Although treated as variables, several equation variables were actually constants and these were shown in Table 12. The remaining internal working variables of the model are cite-specific and these were gleaned from the ETIS profiles. Because several internal working variables of the EIFS model are county level figures, those internal working variables for the new data base were recomputed using methods of proportioning recommended

TABLE 8

ETIS PROFILE FIVE RESULTS

SIC Code	Number Of Workers In Region	Percent of Total Workers	Excess Number Of Workers By Code In Region	Value Added Per Excess Workers	Excess Number x Value Added
1	882	.0026	—	14,792.00	—
2	1,324	.0039	—	10,099.50	—
3	12,546	.0370	—	10,346.60	—
4	447	.0013	—	4,027.60	—
5	3,805	.0112	—	14,496.30	—
6	6,181	.0182	433	14,496.30	6,276,897.90
7	32,832	.0968	2,325	14,929.70	34,711,552.50
8	24,103	.0711	1,114	13,060.60	14,549,508.40
9	13,039	.0385	139	15,361.20	2,135,206.80
10	18,897	.0557	547	13,479.10	7,373,067.70
11	1,171	.0035	—	16,613.30	—
12	175	.0005	—	14,168.40	—
13	10,390	.0306	156	4,321.70	674,185.20
14	1,514	.0045	—	27,989.20	—
15	6,037	.0178	—	10,246.10	—
16	113	.0003	—	9,811.00	—
17	4,077	.0120	—	9,000.00	—
18	3,265	.0096	—	9,653.20	—
19	3,767	.0111	—	13,488.60	—
20	2,533	.0075	—	19,551.10	—
21	9,026	.0266	—	10,008.50	—
22	8,033	.0237	—	9,479.90	—
23	11,922	.0352	62	2,295.00	142,290.00
24	13,960	.0412	195	3,551.30	692,503.50

TABLE 8 (Continued)

SIC Code	Number Of Workers In Region	Percent of Total Workers	Excess Number Of Workers By Code In Region	Value Added Per Excess Workers	Excess Number x Value Added
25	7,402	.0218	—	12,691.30	—
26	9,585	.0283	—	7,912.50	—
27	4,976	.0147	—	8,120.10	—
28	8,634	.0255	—	31,462.00	—
29	7,255	.0214	43	8,141.10	350,067.30
30	2,716	.0080	—	8,141.10	—
31	208	.0006	—	1,859.40	—
32	6,753	.0199	—	6,743.50	—
33	2,277	.0067	—	5,588.20	—
34	10,099	.0298	21	8,468.80	177,844.80
35	5,314	.0157	—	8,468.80	—
36	1,205	.0036	—	5,060.70	—
37	251	.0007	—	5,060.70	—
38	195	.0006	—	5,060.70	—
39	4,746	.0140	—	4,619.60	—
40	1,843	.0054	—	16,302.10	—
41	75,615	.2229	12,704	8,257.90	104,908,361.60
TOTAL	339,113	1.0000	17,739	—	171,991,485.70

TABLE 9

ETIS PROFILE TEN RESULTS

Census Tract	1976 Population	1976 Households	Household Income	Per Capita Income
29.02	10,846	3,117	10,493	2,929
30	8,122	2,437	10,283	2,997
2001	6,482	2,123	20,084	6,492
2002	3,421	258	20,674	13,871
2003	5,686	1,809	13,580	4,260
2004	2,237	891	14,694	5,777
2005	6,202	1,740	10,308	2,852
2006	4,707	1,304	18,380	5,024
2007	4,775	1,605	17,085	5,667
2008	903	245	25,014	6,684
2009	3,454	993	21,310	6,045
2101	1,983	539	12,525	3,361
2102	6,174	1,856	13,315	3,950
2103	3,567	950	23,960	6,301
2104	5,355	1,461	18,851	5,077
2105	1,684	471	12,351	3,409
2106	10,362	2,793	14,646	3,898
56	4,134	1,153	16,698	4,498
57	1,458	551	9,208	3,364
58	4,113	1,540	11,813	4,274
59	3,171	1,313	10,643	4,259
903	5,377	1,918	9,612	3,311
904	6,179	1,582	8,753	2,165
905	3,106	1,004	11,012	3,442
906	3,113	1,151	22,860	8,170
907	2,519	756	16,141	6,679

TABLE 9 (Continued)

Census Tract	1976 Population	1976 Households	Household Income	Per Capita Income
908	1,809	530	13,689	3,871
909	5,995	1,489	18,962	4,551
910	5,040	1,778	15,769	5,375
1001	2,062	709	10,315	3,428
1002	11,894	3,287	18,018	4,810
1003	10,793	2,998	17,048	4,576

by Mr. Ronald Webster of the Construction Engineering Research Laboratory (18). The results of these operations are displayed in Table 13.

The final requirement prior to running EIFS with the new data base was to collect the entering arguments for the functional area of interest. The mission change option was selected for study because that functional area is the one most often used in a period of shrinking military force. The mission change option required six entering arguments. These arguments are listed in Table 14 to show 1) entering argument, 2) variable symbol, 3) quantity used in EIFS, and 4) sources of information.

That mission change scenario was then used as the entering argument for three different types of EIFS runs. Initially, the CERL ran a computerized run of the scenario against the pre-defined Wright-Patterson Air Force Base region of assessment. The results of the first run are

TABLE 10

VALUE ADDED OF EMPLOYED PERSONS BY INDUSTRY

Number	Name of Industry	Value Added Per Employee	Average Percent
1	Agriculture, Forestry, Fisheries	$14,792.00	3.71
2	Mining	10,099.50	.82
3	Construction	10,346.60	5.97
4	Furniture, Lumber and Wood Products	4,027.60	1.28
5	Primary Metal Industries	14,496.30	1.74
6	Fabricated Metal Industries	14,496.30	1.75
7	Machinery, except electrical	14,929.70	2.60
8	Elect. Machinery, Equipment, Supplies	13,060.60	2.49
9	Motor Vehicles, Transportation Equipment	15,361.20	2.79
10	Other Durable Goods	13,479.10	2.68
11	Food and Kindred Products	16,613.30	1.82
12	Textile Mill, Other Products	14,168.40	2.85
13	Print, Publish, Allied Industries	4,321.70	1.56
14	Chemical, Allied Products	27,989.20	1.29
15	Other Non-Durable Goods	10,246.10	3.06
16	Railroads, Railway Express Service	9,811.00	0.83

TABLE 10 (Continued)

Number	Name of Industry	Value Added Per Employee	Average Percent
17	Trucking Service, Warehousing	9,000.00	1.41
18	Other Transportation	9,653.20	1.45
19	Communications	13,488.60	1.40
20	Utilities, Sanitary Service	19,551.10	1.68
21	Wholesale Trade	10,008.50	4.09
22	Food, Bakery, Dairy Stores	9,479.90	2.50
23	Eating, Drinking Places	2,295.00	3.00
24	General Merchandise Retailing	3,551.30	2.73
25	Vehicle Retailing, Service Stations	12,691.30	2.22
26	Other Retail Trade	7,912.50	5.54
27	Banking, Credit Agencies	8,120.10	1.69
28	Insurance, Real Estate, Finance	31,462.00	3.32
29	Business Services	8,141.10	1.56
30	Repair Services	8,141.10	1.57
31	Private Households	1,859.40	1.47
32	Other Personal Services	6,743.50	3.15
33	Entertain, Recreation Services	5,588.20	0.82
34	Hospitals	8,468.80	2.78
35	Medical, Other Health Services	8,468.80	2.78
36	Government	5,060.70	5.65

TABLE 10 (Continued)

Number	Name of Industry	Value Added Per Employee	Average Percent
37	Private	5,060.70	1.95
38	Education, Kendred Services	5,060.70	.44
39	Welfare, Religious, Non-Profit	4,619.60	1.52
40	Legal, Engineering, Professional Services	16,302.10	2.55
41	Public Administration	8,257.90	5.49

listed on Table 15 under "computer results." The second run was a manual calculation of the CERL run used to verify the accuracy of the EIFS computer model and the results were also listed on Table 15 under "calculator results." The internal working variables for the second run were obtained from an ETIS, profile five computer product for the pre-defined region, which were listed in Table 13. The third and final type of EIFS run was another manual EIFS calculation. This run used the newly defined region of assessment to calculate the amount of the value added per employee to be used for further EIFS calculations. The formula for value added (V_a) used was:

$$\text{Region } V_a = \frac{\text{Sum of (Excess employees x } V_a \text{ for Industry Type)}}{\text{Sum of Excess Employees}}$$

The result of the V_a calculations from Table 8 are listed in Table 13. Because of the significant computational

TABLE 11

EQUATIONS OF EIFS MODEL MISSION

CHANGE FUNCTIONAL AREA (17:30)

$$V_o = \Delta E_{ss} + \Delta E_c \cdot I_c + \Delta E_m \cdot I_m \cdot P_{OB} \cdot P_{SLO} + \Delta E_m \cdot I_m \cdot (1-P_{OB}) \cdot (P_{SL} + h)$$

$$\Delta T = V_o \cdot M$$

$$IT = \Delta T - V_o$$

$$\sigma = \Delta Em \cdot (1 - P_{OB})(P_{SL} + h) \cdot I_m + \Delta E_c \cdot I_c$$

$$\Delta I = \sigma + (\Delta T - \sigma) \cdot \nu$$

$$\Delta E_H = \Delta I \times h$$

$$\Delta E_O = \Delta I \times o$$

$$\Delta E = \Delta T/Va$$

$$\Delta P = (\Delta T \cdot TV)/(T \cdot a)$$

$$\Delta I_H = E_H \cdot r \cdot i_H$$

$$\Delta I_{NH} = E_O \cdot i_{NH}$$

$$\Delta TR = (\Delta P \cdot p) + (\Delta T \cdot s \cdot pr)$$

$$S = E_M(1 - P_{OB}) \cdot C\ pa$$

$$\Delta A = S \cdot C_c \cdot (P_F + p_s)$$

$$\Delta C_s = S \cdot C_c \cdot (1 - P_F - p_s)$$

$$\Delta C_O = (\Delta T/T) \cdot B$$

$$\Delta C = \Delta C_s + \Delta C_O$$

TABLE 12

EIFS MODEL CONSTANTS

Constant Symbol	Constant Amount	Constant Name
P_{SLO}	.335	Percent Spent Locally By On-Base Personnel
P_{SL}	.335	Percent Spent Locally
h	.16	Average Propensity To Consume For Housing
o	.63	Average Propensity To Consume (Non-housing)
r	7.75	Constant Relating Rental Income To Value
i_H	.06	Propensity To Invest In Housing
i_{NH}	.12	Propensity To Invest In Non-housing
C	1.5	Children Per Family

TABLE 13

EIFS INTERNAL WORKING VARIABLES

Variable Symbol	Quantity Used In EFIS	Variable Name
M	1.5, 2.0, 2.5, 3.0 (Sensitivity Analysis)	Export Employment Multiplier
v	.817	Constant Relating Change In Business Volume To Change In Total Personal Income
V_a	$9,696	Value Added Per Employee
TV	$3,361,377,000	Total Assessed Value of Real Property
T	$10,091,391,000	Total Business Volume
a	30.66	Assessed to Market Value Ratio
E_H	$494,679,980	Housing Expenditures
E_O	$989,359,960	Other Expenditures
p	7.63	Property Tax Rate
s	4%	State Sales Tax Rate
pr	50.%	Percent of Sales Tax Retained Locally
pa	69.82	Percent Attending School
S	599,707	Number of School Children
C_C	$1,038.	Cost of Education Per Child
P_F	7.3%	Percent of Education Financed By Federal

TABLE 13 (Continued)

Variable Symbol	Quantity Used In EIFS	Variable Name
P_S	22.6%	Percent of Education Financed By State
B	$320,700,000.	Operating Budget for Non-education

burden of computing the newly defined regions export employment multiplier (M), a sensitivity analysis of four values of M was conducted. Because the size of the multiplier is directly related to the "size of the region, the diversity of its industrial and commercial base, and the size of its population /20:15/," several local Ohio regions were reviewed in order to predict the approximate range of the new region's export employment multiplier. From the findings listed in Table 7 from six local regions of various sizes and populations, the four M values chosen for sensitivity analysis were 1.5, 2.0, 2.5, and 3.0. The results of these analyses are in Table 16.

Computer Data Base Analysis

The first analysis of the modified data base considered verification of computerized listing of residences by zip code. The sum of column two of Table 6 (6704) was compared to the difference between the total base military personnel strength and the number of military personnel

TABLE 14

EIFS ENTERING ARGUMENTS

Entering Argument	Variable Symbol	Quantity Used In EIFS	Sources of Information
Change In Expenditures For Local Services And Supplies	E_{ss}	-\$523,391,000	Base Budget Office (2750 ABW/ACB)
Change In Civilian Employment	ΔE_C	-16,923	Base Finance Civilian Personnel Office (2750 ABW/ACFTA)
Average Income Of Affected Civilians	I_C	\$19,995	Base Budget And Finance (2750ABW/ACB) (2750 ABW/ ACFTA)
Change In Military Employment	ΔE_M	-8,105	Base Military Personnel Office (2750 ABW/DPMD)
Average Income Of Affected Military Personnel	I_M	\$19,292	Base Budget And Military Personnel Office (2750 ABW/ACB) (2750 ABW/DPMD)
Percent Military Personnel Living On Base	P_{OB}	25.75%	Base Military Personnel Office (2750 ABW/DPMD)

TABLE 15

COMPARISON OF COMPUTER AND CALCULATOR RESULTS

Variable Label	Variable Name	Computer Results Of Current Data Base	Calculator Results Of Current Data Base
V_O	Direct Dollar Of Expenditures Due To Activity	-$935,044,000.	-$932,723,306.
ΔT	Change In Total Business Volume	-$2,600,346,000.	-$2,593,903,514.
IT	Induced Business Volume	-$1,665,301,000.	-$1,661,180,208.
α	Direct Removal Of Personal Income	BLANK	-$395,844,159.
ΔI	Change In Local Personal Income	-$2,197,644,000.	-$2,191,658,652.
ΔE_H	Change In Housing Expenditures	-$395,575,000.	-$350,665,384.
ΔE_O	Change In Other Expenditures	-$1,384,515,000.	-$1,380,744,951.
ΔE	Change In Local Employment	-241,720	-256,670
ΔP	Change In Local Property Values	-$2,825,065,000.	-$2,818,044,569.
ΔI_H	Change In Housing Investment	-$183,942,000.	-$230,026,191.

TABLE 15 (Continued)

Variable Label	Variable Name	Computer Results Of Current Data Base	Calculator Results Of Current Data Base
ΔI_{NH}	Change In Non-Housing Investment	-$166,141,000.	-$118,723,195.
ΔTR	Change In Tax-Related Revenues	-$267,421,000.	-$266,894,871.
S	Number Of School Children	-24,025	-6,303
ΔA	Change In State And Federal Aid To Schools	-$7,456,000.	-$1,956,088.
ΔC_S	Change In Costs To Local Schools	-$17,481,000.	-$4,586,011.
ΔC_O	Change In Local Governmental Costs	-$82,638,000.	-$82,433,121.
ΔC	Net Change In Costs To Local Government	-$100,120,000.	-$87,019,141.

TABLE 16

SENSITIVITY ANALYSIS OF FOUR M VALUES

Variable Label	Results Using M = 1.5	Results Using M = 2.0	Results Using M = 2.5	Results Using M = 3.0
V_O	932,723,306.0	932,723,306.0	932,723,306.0	932,723,306.0
ΔT	1,399,084,959.0	1,865,446,612.0	2,331,808,265.0	2,798,169,918.0
IT	466,361,653.0	932,723,306.0	1,399,084,959.0	1,865,446,612.0
α	395,844,158.6	395,844,158.6	395,844,158.6	395,844,158.6
ΔI	1,215,491,893.0	1,596,509,363.0	1,977,526,834.0	2,358,544,304.0
ΔE_H	194,478,702.9	255,441,498.1	316,404,293.4	377,367,088.6
ΔE_O	765,759,892.5	1,005,800,879.0	1,245,841,905.0	1,485,882,912.0
ΔE	144,295.1	192,393.4	240,491.8	288,590.1
ΔP	1,519,980,890.0	2,026,641,186.0	2,533,301,482.0	3,039,961,779.0
ΔI_H	230,026,190.7	230,026,190.7	230,026,190.7	230,026,190.7
ΔI_{NH}	118,723,195.2	118,723,195.2	118,723,195.2	118,723,195.2
ΔTR	143,956,241.1	191,941,654.7	239,927,068.4	287,912,482.1
S	6,302.6	6,302.6	6,302.6	6,302.6
ΔA	1,956,087.5	1,956,087.5	1,956,087.5	1,956,087.5
ΔC_S	4,586,011.3	4,586,011.3	4,586,011.3	4,586,011.3
ΔC_O	44,462,309.2	59,283,078.9	74,103,848.6	88,924,618.3
ΔC	49,048,329.3	63,869,099.0	78,689,868.7	93,510,638.4

living on base (8105 - 2087 = 6018). When the sum of column two of Table 6 was adjusted to compensate for those military personnel serviced by but not assigned to the Wright-Patterson Air Force Base Consolidated Base Personnel Office, it closely approximated 6018. Therefore, the computerized listing of residences by zip codes was judged valid and accurate.

The methodology for assignment of civilian personnel residences to zip code areas was assumed to be correct and the accuracy of the actual assignments was verified when the total of column four of Table 6 equalled the base civil servant population level of 16,923.

The three profiles required for the counties containing the new region census tracts were all obtained through the mail from CERL following telephone requests for the information. Profile one printouts were used to obtain county-based local region names, populations, areas, and M values as listed in Table 7. This information was used to determine an approximate range of M values for the sensitivity analysis of the new region with regard to export employment multiplier. The profile five printout for the counties of the new region was also used as a data point for Table 7. However, the main use of the profile five printout was as the data base for subsequent region value added calculations as shown in Table 8. Profile ten, the last ETIS product used, was used to accumulate information about the census tracts of the newly defined region. Selected parts of profile ten are shown in Table 9.

During a telephone interview with Mr. Webster, national information concerning value added of employed persons by industry was obtained and subsequently listed in Table 10. That information was used as the basis for computation of the new region's value added per employee.

The computer results of the running of the current Wright-Patterson Air Force Base region of assessment against the total base closure scenario displayed in Table 14 are shown in column three of Table 15. Using the EIFS equations of Table 11 with the constants of Table 12 and the cite-specific internal working variables listed in Table 13, manual calculation results were also listed in Table 15. The manual EIFS calculations were performed as a check of the EIFS model and the result of the check was the identification of several discrepancies. The first and most obvious discrepancy was the rounding technique employed within the EIFS model. Although this subject is not addressed in the user manual, it appears that the model has internal and printout rounding to the nearest thousand. The second discrepancy involves the constant value for h. Although documented as being equal to .16 in the user's manual, the value of h used for our computer product closely approximated .18. The final discrepancy involved the equation for S. Although listed in the user's manual as $S = E_M (1 - P_{OB}) \cdot C \cdot pa$, our computer product quantity of S can only be obtained when using $S = (E_M (1 - P_{OB}) \cdot C \cdot pa) + (E_c \cdot C \cdot pa)$.

For these three reasons, any comparison of manual EIFS computations for the new region were made against the manual calculations for the current region.

The final group of data collected for this research effort was the result of running the EIFS model manually using the cite-specific internal working variables, the new region's value added per employee and the four M values selected. This data is listed in Table 16 and it will be discussed in the next chapter.

It is important to note that the census tract region of assessment completely encompassed Wright-Patterson Air Force Base to validate the use of the export model. As explained in the personal letter from Ron Webster in the Appendix, it is essential to avoid having any holes in the area of assessment when using the export model.

The figures computed in the sensitivity analysis closely correlate to the figures for the computer's 30 mile radius assessment. This would support the belief that the smaller area of assessment is actually more severely affected on the base closure than the EIFS would lead analysts to believe. The percent affect of unemployment and business volume will be greater for the smaller region if in fact the people and dollar values come out the same for the census tract and county area assessments.

The EIFS socioeconomic impact still greatly overestimates the probable results of a base closure at Wright-Patterson Air Force Base. Mr. Ron Webster, at CERL, explained the large estimation of change in local employment as being based on the entering argument of change in expenditures for local services and supplies, $523,391,000. This large dollar value is used to estimate how many people would lose their job if paid $20,000 a year, for example. The model still appears to overestimate the loss in local employment by a factor of approximately 2.5. The authors agree with the EIFS user's manual assertion about the overestimating nature of the EIFS model (20:10). In the scenario used in this research, a loss of 25,000 jobs and $523 million in local expenditures resulted in a forecasted loss of 240,000 jobs. However, the model does appear to have validity for comparisons between different mission changes at several installations. The relative magnitude of expected changes are not affected by the overestimation of impacts.

The present EIFS equations and sequence of computations are being changed to reduce the amount of overestimation (18). The income and employment distributions will be computed first. The computer results will still, however, overestimate the probable impact on the area slightly (18). The computation of the multiplier is regarded by many engineering and civilian corporations as far superior to multipliers used in other models (18). The more exact information used in computing the multiplier is from the fourth level Standard Industrial Category (SIC) (18).

No calculations were made on single zip code areas because of the increased cost in scanning the computer tapes to glean the required information necessary to compute a multiplier for the census tract areas and the other additional data for computation in the EIFS equations. Mr. Webster said the costs are much higher to extract the limited census tract information from the data source tapes than the cost for acquiring readily available county level information. He also stated that there is not enough readily available census tract information for modeling (18).

So although the idea of using census tract information in specific zip code regions is practical, its use is very costly. The use of the EIFS export model also requires the area of assessment to fill all the characteristics of an essential self-sustaining community with diverse industry and export products.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

Because the mean of the accuracy ratings (0.91) has fallen within the criteria range (0.9 to 1.1) for the first research question, the first objective of the research has been satisfied. The logical rules that have been written for assigning census tracts to zip code areas are valid and supportable.

The sensitivity analysis using the census tract information for those areas identified as "significant" because of the base population living in the area appears to support the second objective of difference in results for census tract and county comparisons. Although the figures computed from the EIFS equations for mission changes were almost identical, the difference in area size of assessment indicates a larger percentage impact on the census tract area. No calculations were made on specific zip code areas because of the cost associated with obtaining the necessary census tract information from computer tapes. Intuitively the second research question is answered in the affirmative, but cost considerations preclude its immediate verification.

As a result of this research effort, the EIFS model has been shown to be amenable to census tract data in addition to the current county data. It is important to note that a DOD installation's impact upon a single zip code area could not be predicted using the current EIFS model. This restriction exists due to the requirements for regional definition when using export-based location quotient economic modeling techniques (18).

Through this research, the impact of the export employment multiplier upon the EIFS model output was found to be significant. Although the actual size of the multiplier appears to be linearly correlated to region size and population (see Table 7), the diversity of the commercial and industrial base is another cite-specific variable which requires detailed calculations for computation. The result of such calculations can significantly affect the linear relationships of size and population to the multiplier size. Although the EIFS model produces several direct calculations of the entering arguments, the vast majority of output variables are driven by the value of the multiplier.

The information compiled for specific census tracts when doing environmental impact analyses can be much more readily used by small communities to gain an accurate appraisal of the impact of a proposed government action. The information will not be diluted with extraneous facts generated by relatively unaffected areas. The inaccuracies of the estimates of the impacts will be reduced if not entirely eliminated.

Recommendations

The CERL and CEC should use census tracts in economic modeling. The added information derived from census tract data for smaller areas of assessment will be worth the extra effort. Those doing impact studies will be better able to answer questions posed by members of towns and local communities.

The CERL should also retain their capability to provide impact analysis information on a county basis. Because census tract statistics contain the same information as county statistics, the EIFS model would only need to be expanded to obtain the capability of giving socio-economic forecasts for specific communities by identifying the zip code and the census tracts of concern.

APPENDIX

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 2750TH AIR BASE WING (AFLC)
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

REPLY TO ATTN OF: ACFTA (Mr. Gilmore, 74887) 19 May 1978

SUBJECT: Information on Annual Civilian Payroll Costs

TO: AFIT/LSG (Mr. Robert Julsonnet)

Information supplied in this letter is to be used "For Official Business Only." The gross pay amounts listed are for one (1) pay period. In order to arrive at an annual gross salary, multiply the figures by 26 pay periods.

Payroll Cycle	Pay Period Gross Pay	Employees On Payroll
ASD	$ 7,472,560	8,903
AFLC	5,541,894	8,020
TOTAL	$13,014,454	16,923

FOR THE COMMANDER

T R Moody

T. R. MOODY, Major, USAF
Office of the Comptroller

PERSONAL LETTER FROM RON WEBSTER

For purposes of the study underway at AFIT regarding the EIFS model, some adjustment or weighting of certain variables will be necessary. These weightings will provide some concept of the differences sought regarding multi-tract regional definition; as apposed to the county aggregation currently used by EIFS. Although the resultant estimates will be less than exact, the estimates may indicate trends which will suffice for the study.

The first variable requiring study is the multiplier, M. The four digit SIC distribution is used as a basis for the multiplier. Before a new multiplier can be produced, the distribution of employment must change. This is going to represent quite a challenge in reducing to the multi-tract region. Land use classifications or other knowledge of the region could be used to proportion the county level data down to a tract level at a division or 2-digit level. The same percentage allocation could be distributed to the other subcategories of each employment sector. At that point, the standard location quotient derivation could be used to calculate the multiplier.

The problem of regional depiction needs some clarification. The location quotient export base technique is only valid when applied to a region which contains all aspects of a typical economy; households, business, and government. Employee distribution, used as a single criteria can be misleading. If only the residences of the employees are used, it is likely that "bedroom" or residential communities will be included while many business and other economic activity will be excluded. Therefore, the concept of an "economic region" is violated and the location quotient export base approach is inappropriate. This problem is a significant one when counties are used. It can be considerably worse if tracts are used as the basic unit.

The following variables can remain unchanged: v, h, o, TV, T, a, r, i_H, i_{NH}, p, s, pr, pa, C_C, p_F, and p_S. For all practical purposes little can be done here. The changes to be expected would probably be insufficient to warrent the problems associated with such an attempt.

The Va figure will require recalculation.

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