DEVELOPMENT OF A COMMUNITY
SIMULATION MODEL FOR
CLASSROOM TEACHING

By

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Submitted to the faculty of the
Graduate College of the
Oklahoma State University
In partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
December, 2000

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CLASSROOM TEACHING

Thesis Approved:

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ACKNOWLEDGEMENT

In the name of Allah.

I wish to thank my major advisor, Dr. Michael Woods for his invaluable advice, patience, financial support, and understanding for preparing this study. Without his assistance this endeavor would not be endurable.

My sincere gratitude is extended to my thesis committee members: Dr. Gerald Doeksen, Dr. Larry Sanders, Dr. Notie Lanford, Dr. Janet Kimbrell, and Dr. David Henneberry. Their thorough and enthusiastic critique and healthy exchange of ideas and knowledge with me were very important for this final thesis to take place.

Special gratitude is expressed to my wife, Nasrin and our daughters, Neda, and Nika for their understanding, encouragement and many sacrifices. Their love and care during my graduate career were big assets for completion of this study. I especially thank and am proud of Neda for her cooperation and time consuming help.

I also extend my appreciation to my mother for her spiritual support and devotion during my study. Thanks go to my brother Saeed and sisters Monir and Naier for their encouragement. I wish my father were alive to see this day. I dedicate this endeavor to him. His memorizing have been a great source of strength at difficult times

Finally, I am grateful to Gracie Teague for her trouble shooting skills and formatting the draft. Her willingness to help was precious and unforgettable. I would also like to thank Norma Eddington for her helpful secretarial assistance during the preparation of my dissertation.

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CHAPTER I

INTRODUCTION

Background

Over the last three decades, academicians have developed and used the Experiential Learning method as a more effective technique to overcome shortcomings of the traditional teaching methods such as lectures, case studies and laboratory exercises. A study by Decker (1994) concluded that 75 percent of professors in the United States are using experiential learning techniques in their undergraduate courses. The importance of experiential learning can be realized by reviewing the history of experiential education from the early days of human history to the present. Experiential education flourished in the early days of human history where societies depended upon close-knit families and clans for sharing survival techniques – i.e., the skills of hunting, food gathering, defense against wild animals and human enemies, and surviving of weather extremes and disease. In these early human groupings, learning was clearly experiential and accomplished through practice.

Experiential education was often neglected by schools and colleges in the early years of the industrial revolution, but has flourished in more recent professional and academic programs. Since the 1960s a tremendous expansion has occurred in experiential programs. Colleges and universities in the U.S. have established cooperative education programs and increased utilization of experiential learning methods.

These programs were added because they helped students acquire practical competence in their chosen fields.

General Problem

The shortcomings in teaching economics are outlined by Trapp et. al. (1995). They include:

1. students learn economics purely theoretically,
2. students do not become familiar with real world issues;
3. economic courses do not emphasize social, political or moral issues,
4. the traditional methods do not encourage students to synthesize content and develop critical thinking skills,
5. students are unable to integrate economic concepts.

With increased economic globalization and technological advancement, traditional teaching methods are unable to meet the goal of effectively educating students and preparing them for the existing complex world. In traditional teaching such as lecture, instead of introducing the students to the real world of experience, the teacher abstracts from it, reducing the vital and complex nature of reality into static, predictable and compartmentalized units. The student is seen as a receptacle or a depository and the teacher is seen as a depositor.

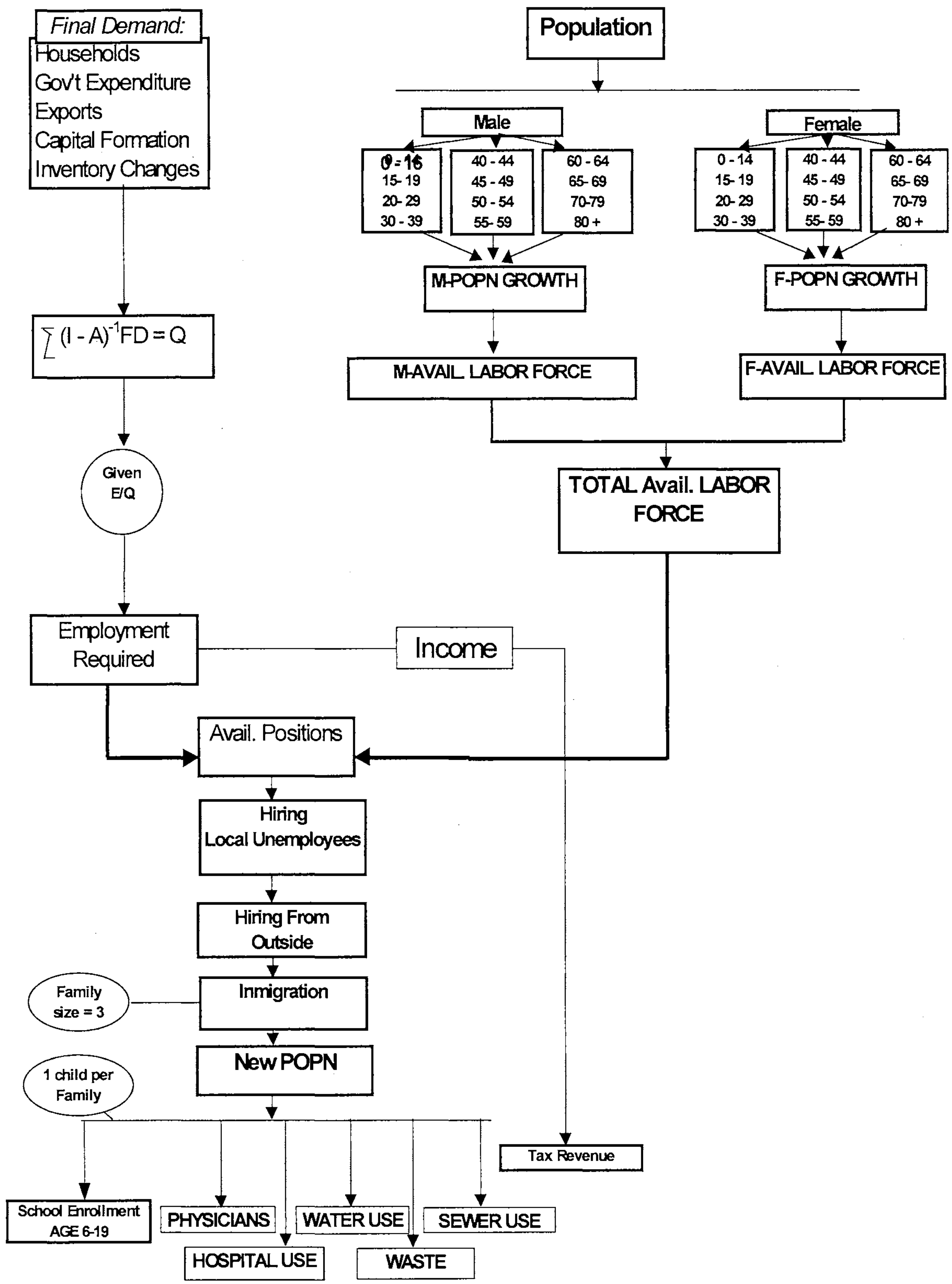
There should be emphasis on interaction with the real world, for experimentation. True knowledge can result only from such experientially based learning permitting the learner to make one's own way through the unknown.

Overall Objective of Study

The general objective of this study is to develop a Community Simulation Model (CSM) as a teaching tool to be used in the classroom environment. An additional objective is to make the simulation model applicable for decision-makers in rural communities. The use of the model in classroom not only will address the problems of traditional education mentioned earlier, but also provide students of community economics an opportunity for deeper understanding of the course materials and prepare them for complex decision-makings. Figure 1 illustrates a general picture of the model.

Experiential learning means "learning by doing." The hands-on experience improves comprehension and retention of the subject matter by the learners for a longer period of time. Students are themselves demanding education, which combine theory and practical experiences. Education for the future calls for a new synthesis of highly specialized knowledge into large scale integrated systems, which, with the aid of computers, helps the students obtain a functional understanding of how theories relate to the real world. Therefore, experiential education could become indispensable to the educational systems of the future.

Figure 1
Diagram of OSU Community Simulation Model



Specific Objectives

To achieve the broad objective, the following specific objectives are to be accomplished:

1. Construct a CSModel to be used with a micro-computer allowing interactive-student scenarios;
2. Design the CSModel to be used in classrooms during several short (50 minutes) class sessions to simulate a local economy as a game or exercise;
3. Ensure the CSModel is adaptable and transferable for use by other institutions and states.
4. Apply the CSModel to scenarios that could be applicable to educational programs in an extension setting working with rural community leaders.

Using OSU-CSModel in a classroom to play a simulation game creates situations for students to participate, think, compete, role-play, and interact with each other to better understand the economic and demographic concepts. The OSU-CSModel analyzes the impacts on a community resulting from some changes in the economic base, with its attendant changes in economic and demographic variables. Also, students will have the opportunity to learn about the community-wide linkages to local firms and interaction of firms among themselves. The CSM allows students to have the opportunity to "experience" the dynamics of a community economy when change occurs. This will enhance the students' understanding of potential impacts resulting from changes in the local economic base. Also, the model will be a useful tool for community leaders to learn the impacts of their tentative decisions prior to making their final decision.

The Organization of the Study

Literature review of experiential learning including impact models and community simulation models are presented in Chapter II. The procedures for accomplishing the stated objectives are presented in Chapter III. The Community Simulation Model is discussed in detail in Chapter IV. Application of the Community Simulation Model for Harper County, Oklahoma including game playing in the classroom using CSM is presented in Chapter V. The results – evaluation of students' learning from the model are presented in Chapter VI. The summary, evaluation, limitations and need for further research of the model are discussed in Chapter VII.

CHAPTER II

LITERATURE REVIEW

The objective of this chapter is to review previous works on experiential learning and impact models. The purpose of this review is to grasp a fuller understanding of what experiential learning is and its preference over other teaching methods and deeper understanding of impact models. There is substantial literature about the effectiveness of experiential learning, use of impact models for pedagogical purposes, and utilization by the practitioners. A literature review reveals the questions of substance and consistency, and provides guides for further investigation. This review will help to identify the principles needed in order to teach economics effectively and build the simulation model.

Experiential Learning

"Green Revolution /Exaction" workshop developed by Chapman and Dowler (1986) is a role playing simulation exercise conducted more than twenty times by the faculty in the Department of Agricultural Economics at Oklahoma State University. The workshop has been used in the classroom and extension programs for producers and the Oklahoma Agriculture Leadership Program. It has also been used in other universities and by USAID to train professionals (Bernardo and Sanders, 1993). This exercise involves 25-40 participants (students), 2-4 game managers, and 5-8 hours to complete. It simulates a farm village with each team consisting of 2-4 players acting as a farm unit. There is 6-12 of these farms with a random distribution of resources. There is also a banker, a buyer, a seller, and a game manager who also acts as an agent for the rest of the world, an urban sector, and an export market with currency differentials. The urban sector includes industry, labor, and government all role-played by participants. The Game provides participants with opportunities to experience the complexity of international marketing.

The benefits of the “Green Revolution /Exaction” workshop can be outlined as follows:

1. It is more effective than traditional teaching techniques (lecture, labs, etc.) in learning economic concepts;
2. The exercise is found to be not only productive, but also enjoyable; and
3. Students gain a better understanding of macroeconomic behavior, such as sectoral linkages and policy impacts.

A similar exercise, the “Packer-Feeder Game” developed by Koontz et.al. (1995) in the Department of Agricultural Economics at Oklahoma State University (OSU) is offered at OSU. The Developers are interested in the effects of market institutions on the economic performance of fed cattle markets. Students role play as feed lot marketing managers and meatpacker order buyers. The game simulates cash transactions between eight feed lots and four meat- packing plants, and future transactions of these twelve teams and four speculators. Each team has two students who act as role players. Financial records were kept for each team and competition was developed for the best profit record. The team who makes the highest profit after a certain number of transaction wins. The game moderator periodically provides additional information (e.g. the proximity of an impending drought) in order to observe its effects on the market. The observed benefits of the game can be outlined as follows:

1. The game generated a high level of involvement, and resulted in a large amount of learning about economic and business concepts;
2. Decisions by participant teams determined the direction of the market prices;
3. Students realized that their collective action determined the market environment. They understood that to forecast the market environment they must understand the economic structure of the market and assess their competitors' behavior;
4. Since all transactions were conducted face to face, interpersonal communications and negotiation skills were strengthened;
5. Students realized that to compete in the game they must understand break-even calculations, supply and demand structure, and be able to anticipate market changes;
6. Students had a better understanding of how fundamental supply and demand affected market price determination; and
7. The game encouraged students to "think."

The study by Gosenpud and Washbush (1994) concerns the purpose of one educational experience frequently used on the college level, the computerized total enterprise simulation. The authors believe that there is little research that tells us exactly what students are learning while they play these simulations and the pedagogical value of games are very open to investigation. On the other hand, there is research on <u>learning from courses</u> using simulations. Wolfe (1990) summarized an extensive body of literature comparing course sections that did and did not include simulations with regard to the delivery of total course material. This review suggested that sections with games do at least as well as those without them in imparting factual and conceptual knowledge. As reported by Keys and Wolfe (1990), studies by Kaufman (1976) and Wolfe and Guth (1975) found superior results for game-based versus case groups in course grades, performance on concepts examinations, and goal setting exercises.

While studies have captured what is learned from a course that includes a simulation, they did not identify what is learned from the simulation itself. There are some studies that reveal hints about the learning taking place as a result of playing a simulation. Whitely and Faria (1989) found that simulation players scored better on the quantitative items of the final exam than non-players, but for non-quantitative items, players did no better. This suggests that simulation players gain quantitative expertise. Teach and Govahi (1988) surveyed 62 alumni to assess how well teaching methods helped them learn predefined skills. The respondents perceived that simulations were best in helping them set and evaluate objectives, solve problems systematically, make decisions, forecast, adapt to new tasks, and manage time. From a personal view Goosen (1993) discussed learning from playing a simulation. He learned that losing money brought great disappointment that the fruits of analysis did not come immediately, but that thoughtful, hard work often brought rewards later on.

There are studies in exploring what learning occur, as a result of playing a simulation by asking simulation instructors what they thought players should be learning. There is not a great deal of research on that issue, but at least one previous study has dealt indirectly with it. Anderson and Lawton (1992) surveyed 146 professors who use simulations in their classes. They presented respondents with a variety of ways to grade simulation learning and performance and asked them which ones they used (implicit in their answers is what they expect students to learn). Results showed that 93% of those using a simulation graded on competitive performance. Over 50% graded on the quality of written plans, analytic papers, and oral performance reviews. Approximately fifteen percent graded on forecast ability, peer evaluation, and rote knowledge of game rules and procedures. These results suggest that most instructors believe that students should learn to perform well in the simulation and plan and analyze their own performance, and that some instructors believe that students should be learning to forecast, constructively cooperate, and memorize game rules and procedures. The approach of this study was more direct. The purpose of this study was to survey simulation users to determine what they thought players should be learning, and the approach was to simply ask them that question. This study is part of a larger set of projects concerning participant learning in the simulation. Is it the same or different from what is intended by teachers, trainers and designers? Is learning identifiable and measurable? Does more learning take place with superior performance?

The researchers designed a two-part survey of perceptions of intended learning effects of simulations. Part 1 of the survey form presented respondents with nine learning-elements Likert scales. Each scale used the semantic differential "None" and "Considerable" at its extremes. Respondents marked each scale to indicate the degree to which whole enterprise simulations should promote a specific kind of learning. The learning elements were:

1. Marketing mix management;
2. Production and inventory management;
3. Cash management;
4. Raising and investing capital;

5. Financial statements and cost analysis;
6. Strategic decision making;
7. Strategic management theory;
8. Group process effectiveness; and
9. Communication skills

These nine events were used because they were mentioned by a group of simulation users as the most important elements learned in a simulation in a session at the 1992 Association of Business Simulation and Experiential Learning (ABSEL) conference.

Part 2 of the survey was open-ended and appeared on a separate page. It contained only the request to describe representative topics, items, and questions that would be part of an exam the respondent might create to evaluate what students have learned from a simulation hypothetically used.

Surveys were distributed to 574 professionals from three sources:
One hundred and twenty-seven surveys were distributed with packets to registrants at the 1993 ABSEL conference in Savannah; 91 were sent to individuals on the mailing list for THE BUSINESS POLICY GAME; 356 were sent to people on the mailing list of MICROMATIC.

These data reflect a wide spectrum of thought about the assessment of learning from the simulation. Even the Likert-scale data can be interpreted as reflecting a wide variety of opinions. Scores for six of the nine learning element items averaged about seven or more on the nine-point scale. Apparently the majority of simulation users expect students to learn well six general sets of skills. This is a considerable range.

The lack of detail in the responses to the open-ended question is also noteworthy. Only twelve people gave actual test items, and only thirteen stated learning goals to be evaluated with an examination. The greatest number of responses involved exercises tapping general game understanding. The most thorough answers were philosophical, discussing the relative merits of various approaches to evaluations, for example. The vast majority of respondents provided little detail about assessing what students should be learning from the simulation. Most of these respondents did not indicate that they prioritize learning goals or use simulation to help students learn predefined pedagogical objectives. Instead, they apparently use the exercise and let students learn whatever comes to them.

Whether one should define learning goals and teach towards them is open to argument, but there are those who believe that student outcomes ought to be thought through by the instructor (Gagne, 1968; Gartner, 1993). It appears from this sample, though, that many simulation instructors do not teach toward predefined learning goals. Gagne, 1968 and Gartner, 1993 are not unconditionally in favor of setting specific goals and teaching only towards them. They value what is naturally and spontaneously learned from experiential situations, and they see complex and difficult problems in defining and testing learning emerging from participating in computerized simulation games. These authors agree with those in the sample who see dangers in giving tests, believe that an exam will cause the learner to focus too narrowly, contend that the simulation in and of itself is full, complex and has long term benefits, believe that given the richness of the experience, exams may be inappropriately narrow as evaluations of the learning. However, there are several dangers in <u>not</u> defining learning goals and <u>not</u> assessing their accomplishment. These leave the instructor out of the learning equation. By just giving the experience and not influencing what the students get out of it, the instructor may show little concern for student outcome. In addition, several of previous studies suggested that (1) simulation competitive performance is not a good indication of what is learned; (2) successful performers do not learn more than less successful ones. Thus, the teachers do not know, from performance results alone, whether students are learning or not. Given this, and given the (not universally held) value that grade should reflect learning, the instructor should understand ahead of time what is likely to be learned in a simulation, think through which types of learning are the most valuable, and assess on these bases. Whether teachers should prioritize, teach towards predefined learning goals are questions not answered in this study. What the data of this study indicate is that teachers are not doing these things.

Malik and Howard (1996) attempted to review the literature from 1985 to 1995 in an effort to identify where the research on business simulation currently stands. Based upon this review, it is possible to make some general statements about where the field needs to head in the future. Their examination of the literature from 1985 to 1995 focused on articles related to business simulations that fell into the following categories:

1. Reviews on different aspects of business simulations;
2. Research on both the external and internal validity of business simulations;
3. Research examining the effectiveness of simulations as a learning tool; and
4. The examination of the individual factors and group processes involved in playing the simulation.

In order to establish the role of business simulations as a learning tool, researchers must do a more rigorous job of examining how simulations increase learning. The relationship of different dimensions of learning to simulation play must be examined. If the field does not do this, the current trend of a decrease in the classroom use of simulations will continue. Given the predictions of the experts in Wolfe's study (1993), more research is also needed to examine the use of simulations at graduate and corporate training levels.

Another area that needs more attention is the external validity of simulations. One way that simulation experience may have a more generalizable effect would be to increase the time that the simulation is played. Longitudinal designs like the one used by Wolfe and Roberts (1986) should be replicated with different total enterprise simulation (TES) and timeframes. Another method to address external validity might be to model algorithms that exist in actual industries and then examine the similarity of these with those that structure TES. Finally, there has been some progress in examining group dynamics and simulation process issues. However, there is considerable room for additional research. There are a number of factors in group-research that could be adapted to simulation research further. For example, does diversity within a group increase or decrease performance? Are there gender differences in group-performance? How does leadership style relate to simulation performance? Malik and Howard (1996) believe that As Association for Business Simulation and Experiential Learning (ABSEL) looks to the future of business simulations and their effective use in the classroom, there is a number of issues still to be decided. Research has progressed this past decade, but simulation writers and researchers are behind.

Papathanasis (1990) describes how to construct a computerized debate to simulate economics controversies, using public domain and software programs. Computer-Assisted Instruction (CAI) and simulation programs may be easily designed to handle controversial issues where more than one point of view must be conveyed. Rethinking of conventional wisdom is suggested. Is “free trade” really free? Similarly, current economics do not point out the difficulties of measuring economic phenomena (Bergman, 1987), and overemphasize efficiency consideration. The cultural environment is not always incorporated into the analysis. Economics courses often do not touch on social, political, or moral issues. Critical thinking cannot be promoted with current methods because, we need more comparative studies. These shortcomings in economics education can be removed by utilizing controversies. The article used the controversy surrounding profits as an example. The traditional approach in economics education is to assign readings, some of which support and others refute the notion that business firms must include other things, besides profits, in their objective functions. Although this method presents several viewpoints, it presents them in a sequential and non- contrasting way. The simulation of readings related to profits, on the other hand, demonstrates how students can overcome the limitations of the printed page, and study the contrasting views simultaneously. The windowing techniques facilitate the construction of a controversy simulation. By presenting questions, responses, and conflicting viewpoints as separate overlapping and removable screens, a window-based CAI program may simulate an electrical discussion. The module presented in the article was created with WINDO©, a shareware program which, combined with TURBOPASCAL© language, provides a user-friendly environment with ease of programming and cost efficiency.

The model of CAI, which utilizes controversies to teach economics, encourages students to synthesize content and develop critical thinking skills. It also increases the teacher's effectiveness in the classroom. A controversial CAI may allow instructors to devote more time in developing the basic ideas of a subject because the students study the controversial and theoretical nuances with the help of the computer. Controversies, finally, may shift emphasis from the current view that we should increase students' ability to make reasoned judgments to the more meaningful issue of how to convey the notion that value judgments affect critical evaluations.

Morano and Difabio (1986) structured a competitive simulation around a company called Universal Greetings, Inc., that manufactures and sells greeting cards. It is a two-and-half-hour management simulation with subgroup and class debriefing discussion that follow. The concepts or skills tested in the simulation are: use of the management functions of planning, organizing, implementing, and monitoring; decision making and communicating; group effectiveness; and, leadership. Each participant subgroup assumes the role of a separate Universal Greeting Company that is in competition with the other subgroups. Each company must produce specific types of greeting cards in specific quantities in accordance with specific quality requirements in order to make profit. The winning company is the one that earns the highest profit. Groups need to purchase paper early in the first period in order to produce simple greeting cards. Then a shock such as a paper strike is introduce to the groups. Groups can negotiate with each other to buy paper if they need it. At the end of first period, card sales revenues are published. In the second period, the production of more complex, specialty greeting cards is required, which demand more efficient organization by group members.

Also, the paper strike is over and groups can purchase papers. The excess paper inventory has no value at the end of the simulation. When the simulation ends, groups are briefly given the results and the winner is recognized.

This simulation has great impact because it aligns the learner's experience with focused management concepts; the learning is experienced as well as understood, and therefore a learner is motivated. It promotes excitement and emotion and teaches important management concepts and principles by having students walk through a real life situation.

Impact Models

There are many impact-models, which are developed to anticipate the changes within a community, or a region before or after an economic change has occurred in a community. A good model should be flexible and should be able to fit any local situation. Different communities develop different impact models to fit their own local situation. Utilization of impact analysis for an educational purpose is also very useful.

Schaffer (1977) believes that "impact analysis" is the most frequently suggested use of regional input-output models. In his paper, he outlines approaches to impact analysis used in two studies with which the author has been involved: the Georgia input-output study, and a study of the impact of the Montreal Expos. The typical regional input-output model is based on a transactions-table that can be described in terms of two equation systems. The first identifies the disposition of regionally produced industry outputs. The second equation system defines industry purchases. In input-output analysis, impact analysis occurs through a change in final demand. Changes in final demand are primarily changes in demands by other areas, investors, or governments for the goods produced in the region. The author put these in the context of the two models: Georgia and impact of the Montreal Expos. In the Georgia input-output system, a set of procedures is developed for simulating the introduction of a new plant or industry into the economy. These procedures take advantage of the data system on which the Georgia table is based, and apply the various multipliers expected changes. To see the effect of introducing a new plant in an industry that already exists in Georgia, a *new-plant simulator* was developed. This procedure is actually a revision of the aggregation procedure which simply specify that the Georgia input-output table be aggregated from the worksheet level to the presentation level, to include one more detailed industry.

To see the effect of a plant in an entirely new industry, a more complex procedure must be followed. A set of new coefficients must be developed and inserted into the table. In the Georgia system, these coefficients are developed from the detailed national table. The rows and columns for the sixty-seven noncompetitive industries were retained in price-adjusted form. The columns provided the technical coefficients for new industries. "We used the average regional trade coefficient for each of its supplying industries to reduce these technical coefficients to regional terms. For the row representing the new industry, we used purchases from our worksheets, with an estimate of trade based on the supply-demand pool technique." If this new industry produces more than is demanded locally, then all local needs were supplied (that is, the author sets the trade coefficients all equal to 1 for this row), and export the rest. If the new industry produces less, the author supplies local needs in proportion to availability and imports the remainder. This paper has identified the common means through which input-output models may be used for economic impact analysis. To illustrate these means, the authors have discussed procedures used with the Georgia model for simulating development, and they have briefly outlined the way in which the economic impact of an activity such as baseball may be trace through an input-output model. In concluding this paper, a few critical comments would be appropriate. In presenting impact analyses, economists have emphasized almost exclusively the positive, benefit-producing aspects of projects under review. But a number of other important points are neglected. One of these points is effect over time. Generally, the models are static, and data for future years is difficult to come by, especially when values stand a chance of going down as well as up. Another neglected point is alternative costs. None of the traditional impact models are set up to show the sacrificial aspects of expenditures. With unconstrained systems the models show flows, and even a large construction expenditure can be converted from a loss of alternatives to flows of outputs, employment, and incomes. A third sidestep concerns linkages and economic growth. By concentrating on current flows as a measure of inter-industry linkage, the authors neglect the agglomerative aspects of new industries and intra-structures. These agglomerative links are probably the more important keys to economic growth, and should be emphasized in impact research. And finally, the authors find it easy to permit the indirect effects which they identify for a project to become secondary benefits in project appraisals. Since many projects with which the authors become involved are nationally financed, the increased income which, we identify in input-output analyses are really redistribution of benefits which could accrue to other regions. But despite these few critical remarks, Schaffer (1977) believes that regional input-output analysis remains the best tool for tracing impacts through an economic system.

Woods et. al.(1983) described four impact-models. The Industrial Impact Model (IIM) analyzes the fiscal impacts of a new industry during the first full year of operation. The Texas Assessment Model (TAMS) was designed for large-scale energy projects and it is useful when wide area regional impacts are needed. The Community Impact Model (CIM) designed for community service analysis, and The Boom 1 Model describes the impacts of large energy plants on small communities. As a dynamic model it follows the path of initial boom to bust periods after construction of a plant.

Data used for Industrial Impact Model are for the most recent year from secondary sources, primarily fiscal. It has been developed for use in Texas. Impacts are analyzed for four sectors: private, municipal government, county government, and local school district. Input data needed and form of output are covered in depth. The private sector accounts for direct, indirect and induced wages and salaries. The municipal sector counts income from property tax revenues resulting from the industry and any new residents. Also sales tax revenues and municipal service revenues are included. Costs to the municipal government include increases in cost of utility provision, municipal service cost, and cost of services consumed by in-commuters. The local school district counts as income property taxes levied against the new industry and any new homes, state and federal transfers for new students associated with the industry and any indirect revenues from the increased economic activity. Accounted costs include instructional expenses for new students. For TAMS, large databases of historical demographic and economic data are used. TAMS was developed to provide projections of economic, demographic, fiscal and service impacts of energy projects (Murdock, et al., 1979).

Goode (1986) described extensively two methods of estimating the magnitude of economic change: Input-output and export base models. The procedures to calculate the multipliers and application and assumptions of each model are outlined in depth.

Input-output multiplier assumptions are: fixed input coefficients (production technology does not change), net vs. gross income changes (increased payments to labor represent new income to area residents), and unchanging economic structure (the level of output of various sectors increase but there will be no business established as a result of the increased activity).

The export base model characterizes all of the production (or employment) in a regional economy as being for export or for local consumption. Goode (1986) mentioned two criteria for deciding between use of the two models. One depends upon the specificity required for the multipliers. For example, if the community knows that a particular type of firm is going to locate in their community, then perhaps the input-output model is more appropriate because multiplier estimates can be developed that are specific to that type of industry. On the other hand, if the type of the new firm is unspecified, then perhaps the export base multiplier provides an adequate estimate of the economic impact. The second criterion for deciding between the models is the amount of financial resources available for the study. If a community is going to make public investment decisions based on the estimated impacts, then very precise estimators are needed. In these cases, the input-output models should be used.

In conclusion, there is no formula for determining which of these models to use in a specific case. Understanding of the models, experience, and knowledge of the practitioners lead to better decisions regarding the choice of models.

Allen et. al. (1990) developed the Business Impact Model (BIM) to be used by local economic developers to evaluate the economic impact of businesses locating or expanding in the State of Oklahoma. It is an input-output based worksheet with logical step-by –step procedures for estimating the impact of a business or industrial facility on employment, income, and tax revenues within the state, county, municipality, and school district.

The BIM worksheet is completed using employment and income multipliers and other necessary information provided by local officials through the data needs questionnaire. Income and employment multipliers (direct, indirect, and induced) are developed within an aggregation scheme consisting of 84 industry sectors by geographic site using a non-survey based input-output methodology, IMPLAN model. Indirect and induced sales and income taxes are estimated by applying a "tax per dollar of wage income" factor to indirect and induced income. Impacts are quickly estimated by injecting the appropriate data into separate parts of the worksheet and sequentially working through each step. All estimates assume one full year of operations.

Both experiential learning and impact models are constructed using economic assumptions. Experiential learning are mostly educational oriented and impact models are mostly policy oriented. However, the economic theories underlying the construction of impact models can be similar to that of an experiential learning for a similar situation. Impact models can be used for pedagogical purposes by making some modifications in their programming and incorporate role-playing into them.

Relevance of Literature to the OSU-CSModel

The above literature review of experiential learning and impact models contributes useful principles to this study in terms of the construction of the OSU-CSModel and achieving its objectives.

The literature on experiential learning emphasizes the idea that experiential learning as a teaching method is more effective than the other methods such as lecture, labs, case study, etc. This is evidenced in the "Green revolution/Exaction" and "Packer Feeder Game." In addition, the literature discussed the benefits of using experiential learning such as students' involvement, strengthening interpersonal communications, better understanding of economic interactions, and observing the relationship of a theory to a real world economic issue. These characteristics of experiential learning are utilized to build the OUS-CSModel.

The literature on various impact models indicates that utilization of experiential learning will result in observing the impacts of a change on a community. In addition, the understanding of impact models described in this chapter contributes to the construction of the OSU-CSModel. For instance, the Business Impact Model (BIM) developed by Allen et. al. (1990) describes how to evaluate the economic impact of businesses locating or expanding in the State of Oklahoma. As mentioned earlier, BIM is an input-output based worksheet which estimates the impact of a business or industrial facility on employment, income, and tax revenues within the state, county, municipality, and school district. The OSU-CSModel performs a similar impact analysis for a community in addition to an impact of changes in other sectors of an economy such as household expenditures, government expenses, and exports. Another useful impact model is the

Georgia model described by Schaffer (1977). In the Georgia input-output system a set of procedures is developed for simulating the introduction of a new plant or industry into the economy, then the economic impacts of the new plant are analyzed. Both the Georgia model and the BIM model are constructed based on input-output tables. Since OSU-CSModel uses input-output coefficients as a pivot for projections and impact analysis, the usefulness of the Georgia model and the BIM model become apparent. Basically, the comprehension of different impact models and their usefulness for specific cases aided in building the OSU-CSModel.

CHAPTER III

PROCEDURE FOR ACCOMPLISHING OBJECTIVES AND THEORIES OF EXPERIENTAL LEARNING AND ECONOMIC DEVELOPMENT

Introduction

The purpose of this chapter is to discuss the theories of experiential learning and economic development and procedures used in this study. The procedures include data analysis and computer model development. The model application/evaluation will be discussed in chapters V.

Theories of Experiential Learning

Learning has been of interest to philosophers, psychologists, educators, and politicians for centuries. The systematic investigation of this phenomenon has resulted in many explanations of how people learn. This section reviews some of these theories. Since there are dozens of learning theories, for simplicity, they are grouped into four different orientations to learning, any of which might include numerous learning theories. The behaviorist, cognitivist, humanist, and social learning orientations were chosen by Sharan and Rosemary (1991) for their diversity and for their insights into learning in adulthood. Table 1 summarizes these four orientations. Since each is based on different assumptions about the nature of learning, the strategies one might use to enhance learning

Table 1.
Four Orientations to Learning

Aspect	*Behaviorist*	*Cognitivist*	*Humanist*	*Social Learning*
Learning theories	Thorndike, Pavlov, Watson, Guthrie, Hall, Tolman, Skinne r	Koffka, Kohler, Lewin, Piaget, Ausubel, Bruner, Gagne	Maslow, Rogers	Bandura, Rotter
View of the Learning process	Change in behavior	Internal mental process (including insight, information processing, memory, perception)	A personal act to fulfill potential	Interaction with and observation of others in a social context
Locus of learning	Stimuli in external environment	Internal cognitive structuring	Affective and cognitive needs	Interaction of person, behavior and environment
Purpose of education	Produce behavioral change in desired direction	Develop capacity and skills to learn better	Become self- actualized, autonomous	Model new roles and behavior
Teacher's role	Arrange environment to elicit desires	Structures content of learning activity	Facilitate development of whole person	Models and guides new roles and behavior
Manifestation in adult learning	* Behavioral objectives * Competency-based education * Skill development and training	* Cognitive Development * Intelligence, learning, and memory as function of age * Learning how to learn	* Andragogy * Self-directed learning	* Socialization * Social roles * Mentoring * Locus of control

Source: Sharan and Rosemary . "Learning in Adulthood" 1991, p138.

will depend on one's orientation. Instructors and program developers can use this review of major learning theories to identify their own theory of learning and discover the strategies for facilitating learning that are most congruent with their theory.

Behaviorists define learning as a change in behavior. The focus of their research is overt behavior, which is a measurable response to stimuli in the environment. The role of the teacher is to arrange the contingencies of reinforcement in the learning environment so that the desired behavior will occur. Findings from behavioral learning theories can be seen in training and vocational adult education.

In contrast to behaviorists, researchers working from a cognitivist perspective focus not on external behavior but on internal mental processes. Cognitivists are interested in how the mind makes sense out of stimuli in the environment – how information is processed, stored, and retrieved. This orientation is especially evident in the study of adult learning from a developmental perspective. The major concerns are how aging affects an adult's ability to process and retrieve information and how it affects an adult's internal mental structures.

Also in contrast to behaviorism is the humanistic orientation to learning. Here the emphasis is on human nature, human potential, human emotions and affect. Theorists in this tradition believe that learning involves more than cognitive processes and overt behavior. It is a function of motivation and involves choice and responsibility. Much of adult learning theory, especially the concept of self-directed learning, are grounded in humanistic assumptions.

The fourth and final orientation is social learning. This perspective differs from the other three in its focus on the social setting in which learning occurs. From this perspective learning occurs through the observation of people in one's immediate environment and behavior. Variations in behavior under the same circumstances can be explained by idiosyncratic personality traits and their unique interaction with environment stimuli. Social leaning theories contribute to adult learning by highlighting the importance of social context and explicating the processes of modeling and mentoring.

Experiential learning is as a sequence of events with one or more identified learning objectives, requiring active involvement by participants at one or more points in the sequence. That is, lessons are presented, illustrated, highlighted, and supported through the involvement of the participants. The central tenet of experiential learning is that one learns best by doing. Experiential learning has evolved from being an exploratory, experimental technique in the 1950s and 1960s in growth centers such as the National Training Laboratories and the Esalen Institute, to being common practice currently wherever learning is pursued. Its principles and techniques are derived form modern theories of effective learning, as documented by Cantor, 1946, 1953 and Knowles, 1970. In 1953, for example, Nathaniel Cantor, the *The Teaching – Learning Process* (1953, pp. 286-312), outlines the following nine propositions for modern learning:

1. The pupil learns only what he is interested in learning;
2. It is important that the pupil share in the development and management of the curriculum;

3. Learning is integral; genuine learning is not an additive experience but a remaking of experience;
4. Learning depends on wanting to learn;
5. An individual learns best when he is free to create his own responses in a situation;
6. Learning depends on not knowing the answers;
7. Every pupil learns in his own way;
8. Learning is largely an emotional experience; and
9. To learn is to change.

Cantor's nine points about effective learning also can be applied to the general qualities of experiential learning, wherein the emphasis is placed on engaging the individual in the experience of learning. In contrast, one can examine the traditional instructional technique of the lecture, known to be used as early as the fifth century B.C., and established as the common method in university teaching in medieval times when manuscripts were rare and costly. The lecture approach to learning is based on an entirely different set of assumptions; Cantor described orthodox teaching, of which the lecture is symbolic, as follows (1953, pp. 59-72):

1. It is assumed that the teacher's responsibility is to set out what is to be learned and that the student's job is to learn it;
2. It is assumed that knowledge taken on authority is education in itself;
3. It is assumed that education can be obtained through disconnected subjects;
4. It is assumed that the subject matter is the same to the learner as to the teacher;

5. It is assumed that education prepares the student for later life rather than that is a living experience;
6. It is assumed that the teacher is responsible for the pupil's acquiring of knowledge;
7. It is assumed that pupils must be coerced into working on some tasks;
8. It is assumed that knowledge is more important than learning; and
9. It is assumed that education is primarily an intellectual process.

In short, participation is limited to listening, reading, writing, and possibly speaking. Little or no effort is made to integrate thought and action by linking concepts to behavior. In contrast to experiential learning, an intellectual learning experience fails to address the pupil as a total person.

The Characteristics of Experiential Learning

Experiential learning is operative when participants are fully involved, when the lessons are clearly relevant to the participants, when individuals develop a sense of responsibility for their own learning, and when the learning environment is flexible, responsive to the participants' immediate needs.

Involvement results from engaging in an activity. To learn how to drive a car, people do not register for a course consisting solely of lectures and assigned readings on driving. They do read about, listen to, and think about the basic rules of driving, but the integration of this material only begins to occur through riding in a car and then actually "taking the wheel." Similarly, when traveling on a commercial airline, people are comforted to know that the pilot has logged hundreds of hours on flight simulation training equipment and has years of flying experience as well as the appropriate book learning.

Involvement affects attitude change and growth as well as skill development. The armed services use experience-based training to prepare people for the discomfort, depersonalization, and emotional stress encountered in combat. The Outward Bound wilderness programs use direct involvement for building self-confidence, coping skills, and independence. Individuals have a need for some degree of mastery over their environment, and can satisfy that need to a greater degree when directly involved in their learning (Erikson, 1950). Active learning can be motivating and self-reinforcing.

The *relevance* of a particular topic is readily demonstrated through the use of experiential techniques, since information is linked to behavior and practical applications can be considered. Insights are also gained from the interpersonal exchange involved in addressing a topic since relationships are a central component in everyone's life. Participants consistently report an appreciation of the personal significance of this component of their learning.

Experiential learning promotes participant *responsibility* in a number of ways. Participants have to choose the amount of energy to invest and how to respond in the activities. Their responses in the learning situation can then be related directly to their choices. If they desire different outcomes, they must behave differently to achieve them. The responsibility for managing this change is solely in their hands. Second, most experiential activities provide opportunities for participant involvement in determining the goals of the learning experience. Consequently, participants become committed and gain a real sense of responsibility for the success of the learning experience.

Experiential learning is *flexible* in its uses, which can be discussed under three major headings: settings, participants, and types of learning experiences including their purposes and objectives. The settings for experiential learning include: educational institutions from preschools to graduate programs in universities, government agencies, business and industry, health and community service agencies, churches, and other groups are currently using experiential techniques to some degree.

Within these settings, it follows that experiential approaches can be used with participants of widely differing needs. For people with very little life experience, the techniques can concentrate on expanding their experience base; for university students, the techniques can concentrate on linking intellectually relevant experiences and personal development with theory and empirical research. For experienced and older individuals from many groups, the techniques can concentrate on brining order, comprehension, and new skills to their life experiences.

There are five methods that are central to experiential learning: simulations, exercises, group interaction, role-playing, and body movement. This study utilizes all of these methods in the whole process of developing the OSU-CSModel for a local community, creating a role-playing simulation game usable in a classroom to teach the economic and demographic concepts. Since the simulation is the heart of the study, the characteristics of simulation methods will be discussed here. The other methods will be discussed in chapter VI.

Simulations (and games) are models or representations of some facet of the human experience. Sets of rules, guidelines, and materials are used to provide a structure that in turn illustrates, reflects, approximates, or duplicates some other process, event, or condition. Perhaps more than any other method, simulations are uniquely flexible in their application to a large number of topics yet also rich in their potential for tapping many underlying change processes. Four broad classifications of activities are possible: games, simulations, nonsimulation games, and simulation/games.

Games are competitive activities with sets of rules and specified goals; outcomes are determined by skill or chance of a combination of the two. Although general principles may be abstracted form playing them, they are intended to stand for themselves and do not represent any other facet of reality. Poker, chess, and baseball are examples. *Simulation* are attempts to reproduce, in simplified form, some aspect of reality so that others, by being immersed in a prescribed format, can experience a facsimile of that reality. Either roles or resources might be defined, but goals or specific participant actions are not. Participants are free to behave in any way they think appropriate within the parameters of the simulation. Examples of this type of activity are the NASA Lost on the Moon Task and SIMSOC (Simulated Society). *Nonsimulation games* are games based on knowledge within a given subject area; winning is contingent on mastery of the content. These activities are desirable for several reasons.

> The gaming situation itself, and the social interaction with peers in an atmosphere that suggest fun rather than classwork, appear to be sufficiently appealing to induce students to devote willingly increased time and energy to learning the requisite skills...In this type of game, knowledge of results is usually immediate, and repeated plays reinforce learning. (Seindner, 1976, pp. 225-226)

Simulation/games combine aspects of games and simulations. There are specified participant goals within a set of rules, but, in this case, the format and rules are designed to reflect some aspect of reality.

The general theories of learning mentioned above are helpful to further understand the benefits of a specific-learning method such as the experiential learning aspect of the OSU-CSModel, which is constructed in a way to contain these learning theories. Using OSU-CSModel in a classroom to play a simulation game creates situations for students to participate, think, compete, role-play, and interact with each other to better understand the economic and demographic concepts.

Community Development Theories

Demand-oriented development theories suggest that local development results from an external demand for locally produced goods and services. If a community has a comparative cost advantage in the market, then the community will attract the capital and labor necessary to produce the good or services.

Over the long run, competitive market forces create an optimal spatial distribution of economic activity by selecting those production sites most cost-efficient for the market served. Local unemployment, low income, and slow growth represent short run symptoms of decline or shift in demand for the community's output. The market responds to this decline in demand by shifting capital and labor to alternative production (more productive uses) within the community or in other communities. The presence of lower-cost factors of production, particularly unemployed labor, attracts other lines of production to the community. Persistent symptoms of distress (unemployment, low income, lack of growth) indicate that national economic development might be improved if an absolute (i.e., out-migration of resources) occurred in the community. (Shaffer 1989)

Demand-oriented community economic development theories study the forces that affect the demand for the goods and services the community produces and the way in which that demand is translated into community income or employment. The most explicit demand-oriented community economic development theory is the export base theory (Shaffer, 1989).

Export base theory or economic base theory argues that a community can be divided into two sectors. The first is the export or base sector, that proportion of the economy, which trades with other areas. The export sector brings dollars into the community because someone outside the community purchases goods and services produced in the community. The second sector (the nonexport, nonbasic, or residentiary sector) sells its product within the boundaries of the community and exists to support the export sector. The critical force in the community's economic development is external demand, not its ability to supply capital and labor or to use technology. The timing and pace of the community's economic development depends upon the success of its export sector, the characteristics of that sector, and the disposition of income received from exports. The assumptions of export base theory mentioned by Shaffer (1989) are as follows:

1. Income and employment changes in a community are totally dependent upon changes in the level of exports, with no other stimulus for local change;
2. The marginal propensity to consume locally (the amount of local income spent for local products) is stable over time and over a relatively wide range of income change (multipliers);

3. The amount of local income generated by each dollars of local spending does not change and thus the local labor content does not vary over time for locally consumed goods and services;
4. There are no changes in relative prices of capital or labor as their use increases or decreases (no shift from labor to capital, or vice versa, in response to change in export demand);
5. The additional labor and capital required to expand production is available immediately and without any increase in wage or profits, since the community has a perfectly elastic supply of capital and labor to meet increases in demand;
6. The economic structure of the community at any one time will predict its future economic structure;
7. The homogeneous export sector implies that earnings from jobs, backward linkages, etc., in separate sub-sectors of the export sector are roughly equivalent; and
8. None of the local consumption of the goods and services sold for export comes from importing those goods and services (i.e., no cross-hauling).

As mentioned earlier, the export base theory is an explicit demand-oriented community economic development. However, there are distinctions between the OSU-CSModel and simple export base theory. For example, the assumption "income and employment changes in a community are totally dependent upon changes in the level of exports" is not assumed in the OSU-CSModel. In the OSU-CSModel, domestic and foreign export is one of the five components of final demand. The model is designed to illustrate the effects of any change (increase or decrease) in final demands on economic and demographic variables. The process of effects can be traced in Figure 1. As an example, a change in exports will affect the total of final demand, which in turn will affect the output, employment, and income of the community. Accordingly, income and employment changes not only depend on the level of exports but they also depend on other factors such as changes in the level of investment, household expenditures, and government expenditures. Consequently, the OSU-CSModel utilizes the basic theory of demand-oriented community economic development.

Data Analysis

Secondary data from various sources are collected and utilized to construct equations, which are used in the model. If the data for the community were not available, state or national data were used. The equations for the OSU-CSModel are identified and specified. These equations are constructed from available data. Initially, data for Harper County, Oklahoma will be collected for model development. In addition, data for Osage County, Oklahoma will be collected and will be used as a second test of the model. The model has four major databases: Economic, Capital, Demographic, and Government Account. It contains equations linking the various accounts and describing the community economy. The OSU-CSModel utilizes multipliers provided by the IMPLAN database.

Computer Model Development

Microsoft Excel© spreadsheet is used initially to translate the equations into a computer program. It provides automated tools needed for data analysis, list keeping, and calculations, as well as the presentation tools needed for reporting results. There is a variety of computer programs that could have been utilized for programming this model. Microsoft Excel was chosen because of two advantages: 1) it is a user-friendly application that is easy to understand, and 2) it is most the frequently used application by undergraduate students. Since the model will be used in classroom to play a simulation game, it will be more effective in terms of learning when students already have a background of the application being used.

Using predetermined equations, the program utilizes the graphical features of the Excel program for demonstration purposes. The program provides baseline projections for economic and demographic variables using both tables and graphs. Then by playing the simulated game, impact projections are provided for the same variables. The results of the OSU-CSModel for a local community are compared to the data reported by other secondary sources to check for consistency and appropriateness of the model.

CHAPTER IV

SIMULATION MODEL FOR RURAL COMMUNITIES

The OSU-CSModel is concerned primary with economic activity at the local level. The model serves two purposes: 1) a teaching tool in experiential learning; 2) a decision aid for local leaders through impact analysis due to a change in a local economy. This chapter presents the construction of the OSU-CSModel in detail. The overview of the OSU-CSModel is presented in Figure 1. The model contains forty-six equations which link three major components of the model: economic, demographic, and community services.

The OSU-CSModel is built around the input-output model. Demand is estimated through a set of final demand predictive equations. Output requirements necessary to meet estimated demand are estimated using the input-output coefficients. The output projections are used to estimate various community economic and demographic variables such as employment, income, and population. These variables are then used to project both demand for various community services (water needs, medical needs, school enrollments, etc.) and local government revenues from local, state and federal taxes.

The data for the baseline (year 1996) are obtained from two sources: 1) Impact Analysis for PLANing (IMPLAN) developed by Minnesota IMPLAN Group. Inc., version 1996, and 2) the Bureau of Economic Analysis (BEA). Using IMPLAN, industries are aggregated to nine sectors. These sectors with their associated codes are presented in Table 2. Projections are made for years 1997 to 2004 using the trends in the IMPLAN and BEA data for the earliest year up to the most current data available in these sources. Those projections will be compared to similar projections exposed to an exogenous shock. The comparisons are the basis for exploring the economic and demographic concepts in a teaching atmosphere such as classrooms or training sessions.

Table 2.
Aggregate Scheme of Sectors

	Sector
1	Agriculture
2	Mining
3	Construction
4	Manufacturing
5	Transportation, Communication, and Public Utilities (TCPU)
6	Trade
7	Fire, Insurance, Real Estate (FIRE)
8	Services
9	Government

Detailed relationships for the model are included in this chapter. Letters represent variables and parameters. A complete listing of the variables and parameters are included in Table 3.

Table 3.
List of Variables in OSU-CSModel

Variable, Parameter	Description
A	Matrix of technical (direct) coefficients
$AD_{i-1,j,t}$	The advancement from age category i to age category i+t,
ALF_{t+1}	Total available labor force in period $t+1$
$ALFT_{t+1}$	Estimated total available labor force over all cohorts in period $t+1$
ANVPP	Matrix of annual visits to a physician per person by age-sex cohort
AV_H	The average number of a households
AVANV	4,296 = Average annual visits to primary-care physicians
AVHU	Matrix of average annual hospital usage for various disease categor age and sex cohort per 1000 population
B_i	The birth rate for women in age category i
BDDC $t+1$	Annual bed days for year $t+1$ by disease category
$BR_{i=0,j,t+1}$	Birth rate of new baby from females in year $t+1$
$BR_{i=0j,t}$	The births of sex j for year $t+1$
$C_{i,j,t}$	The initial population in age category i of sex j
CAP_{t+1}	Column vector of capital in period $t+1$
$CAPDEP_t$	Depreciation of capital in period t = CAP_t * DEP. RATE
CST_{t+1}	County sales tax revenue in period $t+1$
CSTR	County sales tax rate
$D_{i,j,t}$	The deaths by members of age category i from sex j in year t to $t+$
$D_{i,j,0}$	The initial death rate for age category i
DY_{t+1}	Disposable income
ER_{t+1}	Local employment required by sector in period $t+1$
Ex_{t+1}	Column vector of exports in period $t+1$
ΣFD_{t+1}	Column vector of total final demand in period $t+1$
$FITAX_{t+1,j}$	Federal income tax from sector j of the economy in period $t+1$
$FTRATE_{t+1}$	Federal income tax rate calculated by methodology employed in this study
$\Sigma FITAX_{t+1,j}$	Total federal income tax from all sectors of the economy in period
g	Matrix of annual growth rates of local government expenditures
HH_{t+1}	Column vector of household expenditures in period $t+1$
I	Identity Matrix
$TINCOME_{t+1}$	Total Income for wage and salary and proprietors employment in period $t+1$
$INMIGC_{ijt+1}$	Inmigration to the county of individuals (new employees and their families) of age i and sex j during period $t+1$
$INMIGCT_{t+1}$	Total inmigration of all age-sex cohorts in period $t+1$

Table. 3 (Continued)

Variable, Parameter	Description
INV_{t+1}	Column vector of inventory in period $t+1$
LGE_{t+1}	Column vector of local government expenditure in period $t+1$
$MPOPC2_{t+1}$	Predicted community population in period $t+1$ for (>15) female cohort
$MPOPC3_{t+1}$	Predicted community population in period $t+1$ for (15 - 19) male cohort
$MPOPC4_{t+1}$	Predicted community population in period $t+1$ for (>15) female cohort
$NM_{i, j, t}$	The natural immigration into age category i between year t and $t+1$
NPE_{t+1}	New investment in plant and equipment plus replacement investment in period $t+1$
$NPOPN_{t+1}$	New population by age-sex cohort in period $t+1$ (net of in-outmigration)
$OUTMIGC_{ijt+1}$	Outmigration of existing employees with their families from the county with age i and sex j in period $t+1$
PA_{t+1}	Positions available in period $t+1$ (surplus or deficit)
PER_{INM}	Percent of employment required
PCP_{Per}	62.2% = Percent of primary-care physician office visits
PHV_{t+1}	Physician visits per year for community by appropriate age-sex cohorts in period $t+1$
$PHYS_{t+1}$	Total primary care physicians needed in a community
$POPN_{t+1}$	Population in period $t+1$ by age-sex cohorts
$POPC1_{t+1}$	Predicted community population in period $t+1$ for (>15) male cohort
$POPV_{t+1}$	Population projections for the county by appropriate age-sex cohorts in period $t+1$
$PRATE_{t+1}$	Rate of participation in the community labor force by age-sex cohorts in period $t+1$
PRE_{t+1}	Proprietor employment by sector in period $t+1$
PRI_{t+1}	Proprietor's income by sector in period $t+1$
PROP1	Matrix of proportion of total cohort population going to each singl group
PROP2	Matrix of proportion of total cohort population going to each single age group
PROP3	Matrix of proportion of total cohort population going to each single age group in cohort (15 – 19) for males
PROP4	Matrix of proportion of total cohort population going to each single age group

Table. 3 (Continued)

Variable, Parameter	Description
$PRWRATE_{t+1}$	Average income of proprietors
Q_{t+1}	Output in period t+1
r	Matrix of sector export growth rates
S	One plus the annual change in labor force participation rate for each age-sex cohort in period $t+1$
$SCHC1_{t+1}$	Number of male school age children by age cohort between 1 and 14
$SCHC2_{t+1}$	Number of female school age children by age cohort between 1 and 14
$SCHC3_{t+1}$	Number of male school age children by age cohort between 15 and 19
$SCHC4_{t+1}$	Number of female school age children by age cohort between 1 and 14
SEW_{t+1}	Daily sewage flow rate for period $t+1$
$SITAX_{t+1,j}$	State income tax from sector j of the economy in period $t+1$
$TSITAX_{t+1}$	Total state income tax from all sectors of the economy in period $t+1$
$STRATE_{t+1}$	State income tax rate
$T_{i,j}$	Trend in the death rate for group i,j
TAX_{EXP}	.35 = Portion of disposable income spend on taxable expenses
$TVOLW_{t+1}$	Total annual volume of water consumed in period $t+1$ in gallons
$VOLC_{t+1}$	Collection and disposal needs for solid waste generation in cubic yards in period $t+1$
$VOLW\text{-}IN/AG_{t+1}$	Volume of water use by industry/agriculture period $t+1$
$VOLW\text{-}R_{t+1}$	Volume of water use by residential in period $t+1$
WSE_{t+1}	Wage and salary employment
WSI_{t+1}	Wage and salary income by sector in period $t+1$
$WSRATE_{t+1}$	Average income of wage and salary employment
$WSIT_{t+1}$	Total of wage and salary income for all sectors in period $t+1$

Projection of the Final Demand

The economic segment of the model consists of five accounts: (1) export demand, (2) local government expenditures (3) capital formation, (4) household expenditures, and (5) inventory change. These final uses (final demands) drive the model.

Export Demand

The export growth or decline rates for each sector, (r), are estimated by using historical data from IMPLAN for the years 1992 through 1996. Using these rates, the exports of nine sectors were estimated as follows:

$$EX_{t+1} = EX_t(1+r) \tag{1}$$

where, Ex $_{t+1}$ = Column vector of exports in period $t+1$
r = Matrix of sector export growth or decline rates

Local Government Expenditures

Prediction of federal expenditures locally is difficult because of wide variations and the lack of data. The method used in this study is to employ the past growth rate for expenditures for each sector obtained from IMPLAN. Local government expenditures are estimated as follows:

$$LGE_{t+1} = LGE_t(1+g) \tag{2}$$

where, LGE $_{t+1}$ = Column vector of local government expenditure in period $t+1$
g = Matrix of annual growth or decline rates of local government expenditures

Capital Formation

Capital expenditures can consist of new plant and equipment investment as well as replacement investment used to replace depreciated capital. The growth rates of new investments for the nine sectors were obtained from IMPLAN for the years 1992-1996. These rates have been used to project the new investment for the projection period. The depreciation rates shown in Table 4 are estimates using the national capital data published by the U.S. Department of Labor (1996). The difference between the gross stock series and the net stock series provides an estimate of depreciation value by sector. Capital formation for each sector is estimated as follows:

$$CAP_{t+1} = CAP_t + NPE_{t+1} - CAPDEP_{t+1} \tag{3}$$

where, CAP_{t+1} = Column vector of capital in period $t+1$

NPE_{t+1} = New investment in plant and equipment plus replacement investment in period $t+1$

$CAPDEP_{t+1}$ = Depreciation of capital in period t = CAP_t * DEP. RATE

Household Expenditures

Household expenditures include three categories which are durables, nondurables, and services. Statistics indicate that the purchase of each category as a percentage of total personal consumption has changed over time. However, this is not an issue for this study since these categories are aggregated. Household expenditures are a function of the number of households or population. Demand for household purchases is estimated as follows:

$$HH_{t+1} = \left(\frac{HH}{POPN}\right)_t POPN_{t+1} \tag{4}$$

where, HH_{t+1} = Column vector of household expenditures in period $t+1$,
$POPN_{t+1}$ = Population in period $t+1$ by age-sex cohorts, and

Table 4.
Depreciation Rates By Economic Sector

Sector	
Agriculture,	.0665
Mining	.0665
Construction	.0864
Manufacturing	.0886
Trade	.0891
Transportation, Communication, and Public Utilities	.0948
Finance, Insurance, and Real Estates	.0986
Services	0.109
Government	0.109

Inventory Change

Business inventories include the value of raw materials, unfinished goods, and finished goods held by business. The technique used to project inventory relates inventory level to output by sector. Inventory is estimated as follows:

$$INV_{t+1} = Q_t\left(\frac{INV_t}{Q_{t-1}}\right) \tag{5}$$

where, INV_{t+1} = Column vector of inventory in period $t+1$
Q_t = Output in period t

Final Demand

Total final demand is the sum of the individual demand components. It is calculated as follows:

$$\Sigma FD_{t+1} = EX_{t+1} + LGE_{t+1} + CAP_{t+1} + HH_{t+1} + INV_{t+1} \tag{6}$$

where, ΣFD_{t+1} = Column vector of total final demand in period $t+1$

Sectors Outputs

The sectors final demands that are calculated by equation (6) facilitate calculation of sector outputs. Using the Leontief inverse , the sector outputs are estimated as follows:

$$Q_{t+1} = (I - A)^{-1} \Sigma FD_{t+1} \tag{7}$$

where, Q_{t+1} = Column vector of sector outputs in period $t+1$,
ΣFD_{t+1} = Column vector of final demands in period $t+1$,
I = Identity Matrix, and
A = Matrix of technical (direct) coefficients.

The total output is the summation of sector outputs.

Projection of Community Economic and Demographic Variables

Employment Required

Employment by economic sector (ER) $_{t+1}$ is projected using predicted output and employment-output ratios. Changes in employment-output ratio over time are also incorporated into the equations. Employment requirements are estimated as follows:

$$\left(\frac{E}{Q}\right)_{t+1} = \left(\frac{E}{Q}\right)_{t} \Re \tag{8}$$

and

$$(ER)_{t+1} = \left(\frac{E}{Q}\right)_{t} Q_{t+1} \tag{9}$$

where, $(ER)_{t+1}$ = Local employment required by sector in period $t+1$,
Q_{t+1} = Output ($) in period $t+1$, obtained from equation 7, and
$\Re$ = One plus annual growth rate of labor-output ratio

Total employment is separated into wage and salary employment and proprietor employment using the proportional county relationships of wage and salary employment to total employment reported by the Bureau of Economic Analysis (BEA).

Population Projection

In projecting population, age and sex cohorts are utilized. The utilization of cohorts is useful in two ways. First, it projects the population more accurately. Second, it makes the model more flexible to assess the impacts on a certain age group or sex. The age cohorts are for each sex and there are 24 cohorts and are presented in Table 4.

Table 5.
Age and Sex Cohorts

Less than 15 years of age	Male	Female
15 to 19 years	Male	Female
20 to 29 years	Male	Female
30 to 39 years	Male	Female
40 to 44 years	Male	Female
45 to 49 years	Male	Female
50 to 54 years	Male	Female
55 to 59 years	Male	Female
60 to 64 years	Male	Female
65 to 69 years	Male	Female
70 to 79 years	Male	Female
Over 80 years	Male	Female

The following formulation describes the cohort-survival model and is taken from Dunn and Doeksen (1979):

$$POPN_{t+1} = \sum_{j=1}^{2} \sum_{i=1}^{12} C_{i,j,t+1} \tag{10}$$

where, $(POPN)_{t+1}$ = Population in time period $t+1$ by age-sex cohorts, and
$C_{i,j,\,t+1}$ = Population in time period $t+1$ for age category i and sex j,

Then

$$C_{i,j,t+1} = C_{i,j,t} + BR_{i=0,j,t+1} + AD_{i-1,j,t} + NM_{i,j,t} - AD_{i,j,t} - D_{i,j,t+1} \tag{11}$$

where, $C_{i,j,t}$ = The initial population in age category i of sex j,
$BR_{i=0,j,t+1}$ = Birth rate of new baby from females in year $t+1$
$AD_{i-1,j,t}$ = The advancement from age category i to age category i+t,
$NM_{i,j,t}$ = The natural immigration into age category i between year t and $t+1$, and
$D_{i,j,t}$ = The deaths by members of age category i from sex j in year t to $t+1$.

$$BR_{i=0,j,t+1} = \sum_{i=1}^{12} B_i C_{i,2,t+1} \tag{12}$$

where, $BR_{i=0,j,t+1}$ = The births of sex j for year $t+1$, and
B_i = The birth rate for women in age category i.

The natural immigration means in or out-migration due to factors other than job seeking.

$$D_{i,j,t+1} = D_{i,j,o}\; T_{i,j}\, C_{i,j,t} \tag{13}$$

where, $D_{i,j,0}$ = The initial death rate for age category i, and
$T_{i,j}$ = Trend in the death rate for group i,j.

Initial population values of cohorts are obtained from the projected population for the year 1996 based on the Census of Population for Oklahoma. Birth and death rates are obtained from Oklahoma State Department of Health. The trends are obtained from the Statistical Abstract of the U.S. (U.S. Department of Commerce, 1996).

Total Available Labor Force

Once population is projected, the participation rates are applied to the population projections to produce an estimate of the available labor force. The participation rates are available for Oklahoma from the 1990 Census of Population. The participation rates are by age-sex cohorts and are state-wide in application. The total available labor force is estimated each year as follows:

$$ALFT_{t+1} = POPN_{t+1}\, PRATE_{t+1} \tag{14}$$

$$PRATE_{t+1} = PRATE_t\ (S) \tag{15}$$

where, $ALFT_{t+1}$ = Estimated total available labor force over all cohorts in period $t+1$,
$POPN_{t+1}$ = Population in thousands for the county in period $t+1$, by appropriate age-sex cohort,
$PRATE_{t+1}$ = Rate of participation in the community labor force by age-sex cohorts in period $t+1$, and
S = One plus the annual change in labor force participation rate for each age-sex cohort in period $t+1$.

Economic- Demographic Interface

Position Vacancy (Employment Deficit or Surplus)

The labor force estimates are compared to the employment requirements generated by the input-output model to determine the excess labor level or excess employment opportunities. To compare the two sets of estimates, the available labor force is totaled over all cohorts. Position vacancy is estimated as follows:

$$PA_{t+1} = ER_{t+1} - ALF_{t+1} \tag{16}$$

where, PA_{t+1} = Positions available in period $t+1$ (surplus or deficit),
ER_{t+1} = Employment required in period $t+1$ obtained from equation 11, and
ALF_{t+1} = Total available labor force in period $t+1$ obtained from equation 12.

Migration is determined through interaction of the economic and demographic accounts. If excess labor force exists, then a net out-migration would result. If excess employment opportunities exists, then a net in-migration will occur. This relationship emphasizes the relationship between demographic and economic activity within a community. However, the migration process does not occur instantly. It depends on the existing unemployment rate in the community. The migration process is described as follows:

If $PA_{\ t} > 0$, which indicates that there is a deficit in employment required to produce projected outputs, and if the local unemployment rate is greater than six percent, then

$$INMIG_{t+1} = 0 \tag{17}$$

Equation (17) implies that in-migration does not occur when there is a deficit in employment required. In other words, when the local unemployment rate is greater than six percent, local unemployment will be hired instead of outsiders. However, if the local unemployment is less than six percent, then

$$INMIGC_{ij,t+1} = PER_{\ INM} PA_{t+1} AV_H \tag{18}$$

$$INMIGCT_{t+1} = \Sigma INMIGC_{ijt+1} \tag{19}$$

where, $INMIGC_{i,j,t+1}$ = Inmigration to the county of individuals (new employees and their families) of age i and sex j during period $t+1$

$INMIGCT_{t+1}$ = Total inmigration of all age-sex cohorts in period $t+1$

$PER_{\ INM}$ = Percent of employment required

AV_H = The average number of a households

Equation (18) implies that in-migration does occur by a certain percentage of employment required. The coefficient of AV_H can be obtained from BEA for each county.

If $(PA)_{\ t} < 0$, which indicates that there is a surplus of labor force, then out-migration occurs. In other words, when there are not enough jobs in the community, a certain percentage of residents out-migrate to other communities to find jobs.

$$OUTMIGC_{i,j,t+1} = PER_{INM}(PA_{t+1})\,AV_H \quad (20)$$

$$OUTMIGCT_{t+1} = \Sigma OUTMIGC_{ij,t+1} \quad (21)$$

where, $OUTMIGC_{ijt+1}$ = Outmigration of existing employees with their families from the county with age i and sex j in period $t+1$,

$OUTMIGCT_{t+1}$ = Total outmigration of all age-sex cohorts in period $t+1$

Once in or out-migration is determined, the migration values will be added or subtracted from population to determine new population for the next year.

$$NPOPN_{t+1} = POPN_{t+1} + INMIGCT_{t+1} - OUTMIGCT_{t+1} \quad (22)$$

where, $NPOPN_{t+1}$ = New population by age-sex cohort in period $t+1$ (net of in-outmigration).

New population will be injected to the model and the model will be simulated to determine the available labor force, employment requirement, and migration level for the next year.

Wage and Salary Income

The employment required estimated in equation (9) include both wage and salary employment and proprietors employment (self-employment). These estimated values calculated by OSU-CSModel are consistent with the values reported by BEA. The model will be useful if it provides wage and salary employment and self-employment separately. The methodology used in the model for separation is as follow:

Wage and salary employment for each year obtained from REIS is subtracted from total employment requirement calculated by the model. The difference would be the number of proprietor's employment. Then the average income of wage and salary employment obtained from REIS is multiplied by number of wage and salary employment to calculated the total of wage and salary income. The same method is used to calculate total proprietors' income.

$$WSI_{t+1} = WSE_{t+1} * WSRATE_{t+1} \tag{23}$$

$$WSIT_{t+1} = \Sigma WSI_{t+1} \tag{24}$$

$$PRI_{t+1} = PRE_{t+1} * PRWRATE_{t+1} \tag{25}$$

$$PRIT_{t+1} = \Sigma PRI_{t+1} \tag{26}$$

where, WSI_{t+1} = Wage and salary income by sector in period $t+1$,
WSE_{t+1} = Wage and salary employment in period $t+1$,
$WSRATE_{t+1}$ = Average income of wage and salary employment in period $t+1$,
$WSIT_{t+1}$ = Total of wage and salary income for all sectors in period $t+1$,
PRI_{t+1} = Proprietor's income by sector in period $t+1$,
PRE_{t+1} = Proprietor employment by sector in period $t+1$, and
$PRWRATE_{t+1}$ = Average income of proprietors in period $t+1$.

Tax Revenue

Once the total income for both wage and salary employment and proprietors' employment are estimated, the associated tax revenues can be estimated by the OSU-CSModel. These taxes include federal, state income taxes and county sales taxes.

Federal Tax

These types of revenues do not directly contribute to a community's revenues but they are included in the model to demonstrate the contribution of a community to federal and state funds.

Historical data for federal and state tax collections from wage and salary employment at the county and community level in Oklahoma is not available. In this study, the methodology to estimate the federal income tax collected from wage and salary employment is as follow:

1. Using Schedule 1040A of the Internal Revenue Service, federal income tax is calculated for a hypothetical employee. Because of the complexity of the schedule, some assumptions are made. First, a total average wage income of \$22,850 for Oklahoma, which is reported by BEA in 1996, is chosen. Second, the average of the four standard deductions is calculated as \$5290. Third, to determine the amount of Exemptions, it is assumed that on average each employee has a family size of 3 including a dependant child.
2. Calculations in (1) resulted in taxable income of \$9,460 (line 24 of the form 1040A).
3. Using the 1998 Tax Table, the tax associated with taxable income of \$9,460 is found to be \$1,421. A tax–income ratio of 0.0622 is calculated. This ratio is applied to the total income of wage and salary employment in each sector to calculate the total federal tax revenue for each sector. The equations are as follows:

$$FITAX_{t+1,j} = WSI_{t+1,j}\ FTRATE_{t+1} \tag{27}$$

$$TFITAX_{t+1} = \Sigma FITAX_{t+1,j} \tag{28}$$

where, $FITAX_{t+1,j}$ = Federal income tax from sector j of the economy in period t+1
$FTRATE_{t+1}$ = Federal income tax rate
$TFITAX_{t+1}$ = Total federal income tax from all sectors of the economy in period t+1

State Tax

The same methodology used for calculation of federal tax is employed to calculate the state-tax revenue from wage and salary employment. It should be noticed that the Form 511EZ is used for state tax calculation. Equations are as follows:

$$SITAX_{t+1j} = WSI_{t+1j}\, STRATE_{t+1} \tag{29}$$

$$TSITAX_{t+1} = \Sigma WSI_{t+1j} \tag{30}$$

where, $SITAX_{t+1j}$ = State income tax from sector j of the economy in period $t+1$,
$STRATE_{t+1}$ = State income tax rate, and
$TSITAX_{t+1}$ = Total state income tax from all sectors of the economy in period $t+1$.

County Sales Tax

This type revenue is a direct and largest source of revenue for a community. To estimate the county sales tax revenue, the disposable income and the county sales tax rates are needed. The following equations are used:

$$DY_{t+1} = TINCOME_{t+1} * TAX_{EXP} \tag{31}$$

$$CST_{t+1} = (DY_{t+1} *.\ \mathrm{CSTR}) \tag{32}$$

where, DY_{t+1} = Disposable income,
$TINCOME_{t+1}$ = Total income of wage and salary and proprietors employees
TAX_{EXP} = Portion of total income spend on taxable expenses,
CST_{t+1} = County sales tax revenue in period $t+1$,and
CSTR = County sales tax rate.

Total Tax Revenue

The total tax revenue resulted from wage and salary employment is the summation of federal, state, and county sale taxes. It is calculated as follow:

$$TTAX_{t+1} = TFITAX_{t+1} + TSITAXT_{t+1} + CST_{t+1} \tag{33}$$

Community Service Requirements

As has been noted, the economic and demographic accounts are interfaced to provide annual estimates of population based on employment levels. The resulting population data in the 24 age-sex cohort detail is described in the demographic account. The projection of population can be used to estimate the level of community service usage for a community. There are several community services that can be provided by a community. Since the OSU-CSModel will be used primarily for teaching purposes a selected group of services are incorporated into the model. These services are:

1. Hospital
2. Physician visits (clinic)
3. Primary care physicians
4. School (elementary to high school)
5. Water usage
6. Sewage flow
7. Solid waste

Hospital Usage Per Year

Hospital requirement is measured by annual bed days and is calculated in two steps. First, the average length of stays for various disease categories by the age and sex cohorts is multiplied by its corresponding incidence rate to obtain the average of annual hospital usage (Table 8). The average length of stays and incidence rates are reported by The Center for Disease Control and Prevention (1997). Both of these data are categorized by the age cohorts less than 15, 15 to 44, 45 to 64, and 65 and above for both males and females in Tables 6 and 7.

Second, the population data from the simulation model interface are aggregated to match the age groups and applied to the data in Table 7 to estimate annual bed-day usage for various disease categories. The data are then summed over disease categories to obtain a total annual figure. The equations are as follows:

$$BDDC_{t+1} = POPN_{t+1}\,AVHU \tag{34}$$

$$BDDCT_{t+1} = \sum BDDC_{t+1} \quad (35)$$

where, $BDDC_{t+1}$ = Annual bed days for year $t+1$ by disease category,
$POPN_{t+1}$ = Population in thousands for the county in period $t+1$, by appropriate age-sex cohort, and
$AVHU$ = Matrix of average annual hospital usage for various disease categories by age and sex cohort per 1000 population.
$BDDCT\ t+1$ = Total of annual bed days for year $t+1$

Table 6.
Incidence Rate for Various Disease Categories by Age Cohorts

	Both Sexes Per 100 persons			
Disease Categories	<15	15-44	45-64	65+
Infective and Parasitic	3.00	1.63	2.51	9.97
Neoplasms	0.79	2.29	10.58	24.81
Endocrine, Nutritional, and Metabolic	2.13	2.01	6.03	17.57
Blood and Blood Forming Organs	1.07	0.79	1.21	4.30
Mental Disorders	1.52	9.21	7.95	9.28
Nervous System and Sense Organs	1.51	1.08	2.08	6.45
Circulatory System	0.54	3.40	30.14	118.02
Tonsillectomy	8.60	1.90	0.10	0.00
Respiratory System	12.26	3.48	10.91	50.81
Digestive System	3.75	6.29	14.06	36.46
Genitourinary System	1.19	4.71	7.11	19.46
Maternity Care	0.00	4.09	0.00	0.00
Skin and Subcutaneous Tissue	0.64	0.96	2.11	5.38
Musculoskeletal System & Connective Tissue	0.63	2.81	8.18	19.77
Cogenital Anomolies	1.84	0.19	0.26	0.21
Certain Causes of Perinetal morbility & morbility	2.27	0.00	0.00	0.00
Symptoms &Ill-Defined Conditions	0.89	0.81	1.18	1.68
Accidents, Poisoning and Violence	3.57	6.75	8.87	29.48

Source: The Center for Disease Control and Prevention (1997)

Table 7.
Average Length of Stays for Various Disease Categories by Age and Sex Cohorts

Disease Categories	Both Sexes Per 100 persons			
	<15	15-44	45-64	65+
Infective and Parasitic	3.30	6.30	7.90	7.90
Neoplasms	6.40	4.50	5.70	7.20
Endocrine, Nutritional, and Metabolic	3.00	4.10	4.80	6.10
Blood and Blood Forming Organs	3.70	5.80	4.50	5.70
Mental Disorders	10.80	6.80	8.50	10.40
Nervous System and Sense Organs	3.70	4.80	5.60	7.00
Circulatory System	4.40	4.60	4.70	5.70
Tonsillectomy	1.60	2.60	5.00	0.00
Respiratory System	3.10	4.30	5.80	7.00
Digestive System	3.30	4.10	4.80	5.70
Genitourinary System	3.70	2.90	3.60	5.20
Maternity Care	0.00	2.50	0.00	0.00
Skin and Subcutaneous Tissue	3.60	4.20	5.60	7.50
Musculoskeletal System & Connective Tissue	4.10	3.30	3.90	5.60
Cogenital Anomolies	6.10	3.50	5.30	6.00
Certain Causes of Perinetal morbility & morbility	9.80	0.00	0.00	0.00
Symptoms &Ill-Defined Conditions	2.20	2.20	2.80	4.00
Accidents, Poisoning and Violence	4.00	4.20	5.30	6.30

Source: The Center for Disease Control and Prevention (1997)

Table 8.
Average Annual Hospital Usage for Various Disease Categories by Age and Sex Cohort

	Both Sexes Per 100 persons			
Disease Categories	<15	15-44	45-64	65+
Infective and Parasitic	9.900	10.269	19.829	78.763
Neoplasms	5.056	10.305	60.306	178.632
Endocrine, Nutritional, and Metabolic	6.390	8.241	28.944	107.177
Blood and Blood Forming Organs	3.959	4.582	5.445	24.510
Mental Disorders	16.416	62.628	67.575	96.512
Nervous System and Sense Organs	5.587	5.184	11.648	45.150
Circulatory System	2.376	15.640	141.658	672.714
Tonsillectomy	13.760	4.940	0.500	0.000
Respiratory System	38.006	14.964	63.278	355.670
Digestive System	12.375	25.789	67.488	207.822
Genitourinary System	4.403	13.659	25.596	101.192
Maternity Care	0.000	10.225	0.000	0.000
Skin and Subcutaneous Tissue	2.304	4.032	11.816	40.350
Musculoskeletal System & Connective Tissue	2.583	9.273	31.902	110.712
Cogenital Anomolies	11.224	0.665	1.378	1.260
Certain Causes of Perinetal morbility & morbility	22.246	0.000	0.000	0.000
Symptoms &Ill-Defined Conditions	1.958	1.782	3.304	6.720
Accidents, Poisoning and Violence	14.280	28.350	47.011	185.724

Physician Visits per Year

A measure of the demand placed on clinics is the number of physician visits per day or per year. One doctor can see only a given number of patients per year. Table 9 obtained from Dunn and Doeksen (1979), provides use-coefficients to estimate annual physician visits based on the population projects. This Table is in five cohorts. It is expanded for the 24 cohorts to match the one used in the simulation model (Table 10). Physician visits per year are estimated for each year as follows:

$$PHV_{t+1} = POPV_{t+1}\, ANVPP \tag{36}$$

where, PHV_{t+1} = Physician visits per year for community by appropriate age-sex cohorts in period $t+1$,

$POPV_{t+1}$ = Population projections for the county by appropriate age-sex cohorts in period $t+1$, and

ANVPP = Matrix of annual visits to a physician per person by age-sex cohorts.

Table 9.
Annual Visit to a Physician Per Person

Age Cohorts	Male	Female
>15	3.18	2.12
15 to 44	3.02	3.97
46 to 65	3.78	3.52
65 +	4.31	4.20

Table 10.
Derived-Annual Visits for the 24 Age-Sex Cohorts of the Model

Age	Male	Female
<15	3.18	2.12
15 - 19	3.02	3.97
20 - 29	3.02	3.97
30 - 39	3.02	3.97
40 - 44	3.02	3.97
45 - 49	3.78	3.52
50 - 54	3.78	3.52
55 - 59	3.78	3.52
60 - 64	3.78	3.52
65 - 69	4.31	4.20
70 - 79	4.31	4.20
80 +	4.31	4.20

Total Primary Care Physicians Needed

The specialties considered to provide primary patient care are general and family practice, internal medicine, pediatrics, and obstetrics and gynecology. Primary care comprises 62.8 percent of all doctors' office visits. Table 11 obtained from the US Department of Health and Human Services 1991, lists the percents for various specialties. Local leaders are most concerned that primary-care services are provided in their communities. Other specialties, which are also important, are of secondary interest. For this reason the estimate of primary care physicians needed is included in the OSU-Model. The equation is as follows:

$$PHYS_{t+1} = \left(\frac{PHV_{t+1} PCP_{per}}{AVANV} \right) \tag{37}$$

where, $PHYS_{t+1}$ = Total primary care physicians needed in a community,
PCP_{Per} = 62.2% = Percent of primary-care physician office visits,
$AVANV$ = 4,296 = Average annual visits to primary-care physicians

Table 11.
Number and Percent Distribution of Office Visits by Physician Specialty United States, 1989

Number of Visits Physician Specialty	visits	Distribution
General and Family Practice	206,301	29.8
Pediatrics	84,411	12.6
Internal Medicine	78,816	11.4
Obstetrics and Gynecology	58,381	8.4
Ophthalmology	38,761	5.6
Orthopedic Surgery	35,148	5.1
Dematology	26,319	3.8
General Surgery	25,379	3.7
Psychiatry	16,616	2.4
Otolaryngology	15,956	2.3
Cardiovascular Disease	10,840	1.6
Urological Surgery	10,157	1.5
Neurology	6,105	.09
All Other Specialties	56,511	11.0
Total	692,702	100.0

Source: U.S. Department of Health and Human Services, 1991

School Age Children

As has been noted, population projections are allocated to age-sex cohorts for each year. It would be useful for detailed information to be available for school-age children. As normal population growth or decline occurs, or if a new plant or development occurs, it would be helpful to know the impact on demand for educational services. The number of children in each grade category will determine the number of teachers needed as well as indicate if capital expansion is necessary. The OSU-CSModel projects population based on age-sex cohorts with the cohorts less than 15 years and 15 to 19 years as the most detailed data available for school age children.

In order to project the number of school-age children by single age cohorts, data from Oklahoma State Department of Education for counties are available and will be used. The equations for male and females are described as follows:

$$SCHC1_{t+1} = PROP1 * MPOPC1_{t+1} \tag{38}$$

$$SCHC3_{t+1} = PROP3 * MPOPC3_{t+1} \tag{39}$$

where, $SCHC1_{t+1}$ = Number of male school age children by age cohort between 1 and 14,
$PROP1$ = Matrix of proportion of total cohort population going to each single age group,
$MPOPC1_{t+1}$ = Predicted community population in period $t+1$ for (>15) male cohort,
$SCHC3_{t+1}$ = Number of male school age children by age cohort between 15 and 19
$PROP3$ = Matrix of proportion of total cohort population going to each single age group in cohort (15 – 19) for males, and
$MPOPC3_{t+1}$ = Predicted community population in period $t+1$ for (15 - 19) male cohort.

$$SCHC2_{t+1} = PROP2 * MPOPC2_{t+1} \tag{40}$$

$$SCHC4_{t+1} = PROP4 * MPOPC4_{t+1} \tag{41}$$

where, $SCHC2_{t+1}$ = Number of female school age children by age cohort between 1 and 14,
$PROP2$ = Matrix of proportion of total cohort population going to each single age group,
$MPOPC2_{t+1}$ = Predicted community population in period $t+1$ for (>15) female cohort,
$SCHC4_{t+1}$ = Number of female school age children by age cohort between 1 and 14,

$PROP4$ = Matrix of proportion of total cohort population going to each single age group,
$MPOPC4_{t+1}$ = Predicted community population in period $t+1$ for (>15) female cohort.

Total Volume of Water Consumed Annually

A community's water consumption consists of residential and industry/agriculture use. Per capita annual water use of 525,000 gallons is obtained from The Water Encyclopedia (1990) and is used to estimate the total water consumption. By the same source, percent distributions for residential and industry/agriculture are 10 and 90 percents respectively. The equations are as follows:

$$VOLW\text{-}R_{t+1} = RESID_{per}(525,000)*POPN_{t+1} \quad (42)$$

$$VOLW\text{-}IN/AG_{t+1} = INDAG_{per}(525,000)*POPN_{t+1} \quad (43)$$

$$TVOLW_{t+1} = VOLW\text{-}R_{t+1} + VOLW\text{-}IN/AG_{t+1} \quad (44)$$

where, $VOLW\text{-}R_{t+1}$ = Volume of water use by residential in period $t+1$
$Resid_{per} = (10\%)$ =Percentage of total volume of water consumed by residential
$VOLW\text{-}IN/AG_{t+1}$ = Volume of water use by industry/agriculture period $t+1$
$INDAG_{per} = (90\%)$ =Percentage of total volume of water consumed by industry/agriculture
$TVOLW_{t+1}$ = Total annual volume of water consumed in period $t+1$ in gallons,

Sewage Flow

Sewer or waste generation is also closely related to population. Nelson and Fessehayes (1981) note that 100 gallons per person is often used to estimate daily sewage rates.

$$SEW_{t+1} = 100\ POPN_{t+1} \quad (45)$$

where, SEW_{t+1} = Daily sewage flow rate for period $t+1$.

Total Volume of Solid Waste Collected per Day

To estimate the solid waste collection in a community, the waste per person per day of 4.4lbs is obtained from U.S. Environmental Protection Agency (EPA), 1997, and is used. Like other service requirements discussed earlier, the solid waste collection is a function of population.

$$VOLC_{t+1} = WASTE_{per}\, POPN_{t+1} \tag{46}$$

where, VOLC $_{t+1}$ = Collection and disposal needs for solid waste generation in cubic yards in period $t+1$,

$WASTE_{per}$= 4.4lb=Waste per person per day

The primary purpose of the community service account discussed in this chapter is to project usage levels or demand. Various usage coefficients developed for state of Oklahoma or Oklahoma counties are utilized to project service demand over time as a function of the model results. When compared to capacity constraints, these projections provide useful information for planning and teaching purposes.

CHAPTER V

APPLICATION OF OLAHOMA STATE UNIVERSITY-COMMUNITY SIMULATION MODEL (OSU-CSModel)

This chapter presents an application of the OSU-CSModel for Harper County, Oklahoma. The OSU-CSModel is designed in a way that it is applicable to any county regardless of the economic situation. The chapter is divided into two parts. Baseline projections for both economic and demographic variables are presented and discussed in the First Part. The simulation model will project the value of economic and demographic variables from the base year of 1996 to the final forecast of 2004. Potentials for impact for impact analysis using the model, as well as presenting the results of selective development that may occur in the county are discussed in the Second Part. These developments will be used to develop a role-playing game implemented in a classroom to teach economic and demographic concepts, interrelationships among the projected variables, and real world issues occurring in a community.

Part 1, baseline projections

Equation (7) in chapter IV indicates that the summation of final demands is needed to calculate the outputs of a community. The five final demands identified in chapter IV are: exports, government expenditures, capital formation, household expenditures, and change in inventory. Projections of these final demands are shown in

Table 12 through Table 16 respectively. The findings from the projections are discussed in the following section.

Table 12 reports projections for exports in Harper County. The export rate of growth is calculated based on average growth in the past seven years (1991-1996) using IMPLAN data for these years. Agricultural products are the main exports of Harper County. Table 13 indicates that there is a declining rate in government expenditures. The negative growth rate of government expenditures is calculated based on average growth in the past seven years (1991-1996) using the IMPLAN data. Table 14 shows mixed results for different sectors. Except for the construction sector, new investments in all sectors of the economy have increased slightly. However, the total in investments has decreased. Table 15 indicates a decrease in household consumption. This seems reasonable since consumption is a function of population and population of Harper County has been decreasing constantly over the last ten years prior to the base year (1996). Table 16 shows that the total inventories of all sectors in the projection periods are increasing. The data for Construction and FIRE indicate that there are no inventories for these sectors. Among all sectors, the highest rate of increase in inventory is associated with agriculture.

Once the projection of each final demand is calculated, then summation of five final demands can be calculated as shown in Table 17.

Table 12.
Projection of Domestic and Foreign Exports, Harper County, Oklahoma

		Base Year Domestic &Foreign Exports (t)	r = growth rate	1997	1998	1999	2000	2001	2002	2003	2004
1	Agriculture	**83.634040**	0.005	84.052211	84.472472	84.894834	85.319308	85.745905	86.174634	86.605507	87.03853
2	Mining	**19.920459**	0.005	20.020061	20.120162	20.220763	20.321866	20.423476	20.525593	20.628221	20.73136
3	Construction	**1.217247**	0.005	1.223333	1.229449	1.235597	1.241775	1.247984	1.254223	1.260495	1.26679
4	Manufacturing	**2.320663**	0.005	2.332266	2.343927	2.355647	2.367425	2.379262	2.391158	2.403114	2.41513
5	TCPU	**15.587669**	0.005	15.665608	15.743936	15.822655	15.901769	15.981278	16.061184	16.141490	16.22219
6	Trade	**0.220805**	0.005	0.221909	0.223019	0.224134	0.225254	0.226381	0.227513	0.228650	0.22979
7	FIRE	**0.335440**	0.005	0.337117	0.338803	0.340497	0.342199	0.343910	0.345630	0.347358	0.34909
8	Services	**0.050069**	0.005	0.050320	0.050571	0.050824	0.051078	0.051334	0.051590	0.051848	0.05210
9	Government	**0.884722**	0.005	0.889146	0.893592	0.898060	0.902550	0.907063	0.911598	0.916156	0.92073
	Totals	**124.171115**		**124.791970**	**125.415930**	**126.043010**	**126.673225**	**127.306591**	**127.943124**	**128.582840**	**129.225754**

Table 13.
Projection of Government Expenditures, Harper County, Oklahoma

		Base Year Fed.&State Govt.	g	1997	1998	1999	2000	2001	2002	2003	2004
1	Agriculture	**0.145093**	-0.02	0.142191	0.139348	0.136561	0.133829	0.131153	0.128530	0.125959	0.123440
2	Mining	**0.037783**	-0.02	0.037028	0.036287	0.035562	0.034850	0.034153	0.033470	0.032801	0.032145
3	Construction	**2.956206**	-0.02	2.897082	2.839141	2.782358	2.726711	2.672176	2.618733	2.566358	2.515031
4	Manufacturing	**0.083154**	-0.02	0.081490	0.079861	0.078263	0.076698	0.075164	0.073661	0.072188	0.070744
5	TCPU	**0.753351**	-0.02	0.738284	0.723518	0.709048	0.694867	0.680970	0.667350	0.654003	0.640923
6	Trade	**0.160581**	-0.02	0.157370	0.154222	0.151138	0.148115	0.145153	0.142250	0.139405	0.136617
7	FIRE	**0.299256**	-0.02	0.293271	0.287405	0.281657	0.276024	0.270503	0.265093	0.259791	0.254596
8	Services	**0.547616**	-0.02	0.536664	0.525930	0.515412	0.505104	0.495001	0.485101	0.475399	0.465891
9	Government	**9.236921**	-0.02	9.052183	8.871139	8.693716	8.519842	8.349445	8.182456	8.018807	7.858431
	Totals	**14.219962**		**13.935563**	**13.656851**	**13.383714**	**13.116040**	**12.853719**	**12.596645**	**12.344712**	**12.097818**

Table 14.
Projections of Capital Formation, Harper County, Oklahoma

		Base Year = 1996 Capital* t	NPE* t+1,2,3,4	CAPDEP rate	Capt Dept. 1996=t	1997 Capital (t+1)	Capdept 1997	1998 Capital(t+2)	CapDep 1998	1999 Capital(t+3)
1	Agriculture	**0.000066**	0.00	0.0665	0.000004	0.002062	0.000137	0.003925	0.000261	0.005664
2	Mining	**0.001729**	0.01	0.0665	0.000115	0.011614	0.000772	0.020842	0.001386	0.029456
3	Construction	**3.804115**	0.02	0.0864	0.328676	3.495440	0.302006	3.213434	0.277641	2.955793
4	Manufacturing	**0.000010**	0.02	0.0886	0.000001	0.020009	0.001773	0.038236	0.003388	0.054848
5	TCPU	**0.063386**	0.01	0.0948	0.006009	0.067377	0.006387	0.070989	0.006730	0.074260
6	Trade	**0.132206**	0.10	0.0891	0.011780	0.220426	0.019640	0.300786	0.026800	0.373986
7	FIRE	**0.029993**	0.01	0.0986	0.002957	0.037035	0.003652	0.043384	0.004278	0.049106
8	Services	**0.001600**	0.02	0.109	0.000174	0.021426	0.002335	0.039091	0.004261	0.054830
9	Government	**0.003480**	0.01	0.109	0.000379	0.013101	0.001428	0.021673	0.002362	0.029310
	Totals	**4.036585**				**3.88848949**		**3.752359**		**3.627253**

Table 14, Continue...
Projection of Capital Formation, Harper County, Oklahoma

		CapDep 1999	2000 Capital(t+4)	CapDep 2000	2001 Capital(t+4)	CapDep 2001	2002 Capital(t+4)	CapDep 2002	2003 Capital(t+4)	CapDep 2003	2004 Capital(t+4)
1	Agriculture	0.000377	0.007287	0.000485	0.008803	0.000585	0.010217	0.000679	0.011538	0.000767	0.012771
2	Mining	0.001959	0.037497	0.002494	0.045004	0.002993	0.052011	0.003459	0.058552	0.003894	0.064658
3	Construction	0.255381	2.720413	0.235044	2.505369	0.216464	2.308905	0.199489	2.129416	0.183982	1.965434
4	Manufacturing	0.004860	0.069989	0.006201	0.083788	0.007424	0.096364	0.008538	0.107826	0.009553	0.118273
5	TCPU	0.007040	0.077220	0.007320	0.079899	0.007574	0.082325	0.007804	0.084520	0.008013	0.086508
6	Trade	0.033322	0.440664	0.039263	0.501401	0.044675	0.556726	0.049604	0.607122	0.054095	0.653027
7	FIRE	0.004842	0.054264	0.005350	0.058914	0.005809	0.063105	0.006222	0.066883	0.006595	0.070288
8	Services	0.005976	0.068853	0.007505	0.081348	0.008867	0.092481	0.010080	0.102401	0.011162	0.111239
9	Government	0.003195	0.036115	0.003937	0.042179	0.004598	0.047581	0.005186	0.052395	0.005711	0.056684
	Totals		**3.512302**		**3.406704**		**3.309716**		**3.220653**		**3.138882**

Table 15.
Projection of Household Expenditures, Harper County, Oklahoma

		Base Year HH(t) Expend. 1996	1997	1998	1999	2000	2001	2002	2003	2004
1	Agriculture	**0.877103**	0.845386	0.816124	0.786758	0.756029	0.723588	0.689297	0.653177	0.615376
2	Mining	**0.191738**	0.184805	0.178408	0.171988	0.165271	0.158179	0.150683	0.142787	0.134524
3	Construction	**0.000000**	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
4	Manufacturing	**0.525767**	0.506755	0.489214	0.471611	0.453191	0.433744	0.413190	0.391538	0.368879
5	TCPU	**4.791169**	4.617916	4.458070	4.297660	4.129801	3.952591	3.765282	3.567976	3.361489
6	Trade	**4.678649**	4.509465	4.353373	4.196729	4.032813	3.859765	3.676855	3.484182	3.282545
7	FIRE	**5.850681**	5.639115	5.443921	5.248037	5.043059	4.826661	4.597931	4.356993	4.104844
8	Services	**7.851276**	7.567367	7.305428	7.042564	6.767494	6.477101	6.170158	5.846833	5.508464
9	Government	**1.095370**	1.055761	1.019216	0.982543	0.944167	0.903652	0.860829	0.815721	0.768513
	Totals	**25.861753**	**24.926569**	**24.063755**	**23.197890**	**22.291824**	**21.335283**	**20.324226**	**19.259206**	**18.144633**

Table 16.
Projection of Inventory, Harper County, Oklahoma
($ Million)

		Qt-1 (1995)	INV t-1 (1995)	Qt (1996)	**Base Year INVt (1996)**	1997	1998	1999	2000
1	Agriculture	69.402420	0.003060	112.861660	**4.051308**	6.588205	4.162662	4.070324	4.083687
2	Mining	21.258741	0.000423	23.504749	**0.000033**	0.000036	0.000030	0.000030	0.000030
3	Construction	9.145095	0.000000	10.049202	**0.000000**	0.000000	0.000000	0.000000	0.000000
4	Manufacturing	1.991894	0.000349	3.813971	**0.000004**	0.000007	0.000005	0.000005	0.000005
5	TCPU	33.048470	0.036787	31.381355	**0.003983**	0.003783	0.004382	0.004342	0.004327
6	Trade	13.275559	0.127527	8.549984	**0.024607**	0.015848	0.029087	0.028596	0.028338
7	FIRE	13.574446	0.000003	11.567541	**0.000000**	0.000000	0.000000	0.000000	0.000000
8	Services	14.300514	0.000247	14.102519	**0.000028**	0.000028	0.000030	0.000029	0.000029
9	Government	11.661788	0.001533	13.323599	**0.001091**	0.001247	0.001077	0.001058	0.001040
	Totals	**187.658927**	**0.169929**	**229.154580**	**4.081054**	**6.609153**	**4.197273**	**4.104383**	**4.117456**

Table 16, Continue...
Projection of Inventory, Harper County, Oklahoma

		2001	2002	2003	2004
1	Agriculture	4.101861	4.120262	4.138676	4.157094
2	Mining	0.000030	0.000030	0.000030	0.000031
3	Construction	0.000000	0.000000	0.000000	0.000000
4	Manufacturing	0.000005	0.000005	0.000005	0.000005
5	TCPU	0.004313	0.004297	0.004279	0.004260
6	Trade	0.028056	0.027732	0.027365	0.026955
7	FIRE	0.000000	0.000000	0.000000	0.000000
8	Services	0.000028	0.000027	0.000027	0.000026
9	Government	0.001023	0.001006	0.000988	0.000971
	Totals	4.135316	4.153359	4.140656	4.127098

Table 17.
Projections of Industry Final Demands, Harper County, Oklahoma ($ Million)

		Base Year 1996 (t)	1997	1998	1999	2000	2001	2002	2003	2004
1	Agriculture	**88.707611**	91.630055	89.594530	89.894140	90.300141	90.711309	91.122941	91.534858	91.947216
2	Mining	**20.151743**	20.253545	20.355729	20.457798	20.559515	20.660842	20.761788	20.862392	20.962720
3	Construction	**7.977568**	7.615855	7.282024	6.973748	6.688898	6.425529	6.181861	5.956268	5.747262
4	Manufacturing	**2.929596**	2.940527	2.951242	2.960374	2.967307	2.971963	2.974378	2.974671	2.973030
5	TCPU	**21.199558**	21.092967	21.000896	20.907964	20.807984	20.699051	20.580438	20.452268	20.315377
6	Trade	**5.216848**	5.125017	5.060487	4.974583	4.875185	4.760756	4.631076	4.486723	4.328937
7	FIRE	**6.515369**	6.306538	6.113513	5.919297	5.715546	5.499989	5.271759	5.031025	4.778822
8	Services	**8.450590**	8.175804	7.921051	7.663659	7.392558	7.104813	6.799359	6.476508	6.137728
9	Government	**11.221585**	11.011437	10.806697	10.604687	10.403714	10.203362	10.003471	9.804067	9.605336
		0.000000								
	Totals	**172.370468**	**174.151744**	**171.086168**	**170.356250**	**169.710848**	**169.037613**	**168.327070**	**167.578780**	**166.796428**

Projection of Outputs

The summation of projected final demand leads to the calculation of output for Harper County by using equation (7). Accordingly, the Leontief Inverse (inverse matrix of input-output) for the Harper County is needed. The Leontief Inverse matrix presents the direct and indirect input requirements per unit of output. This calculation recognizes that if output for final demand increases not only must purchases of direct inputs increases, but purchases of inputs by firms supplying those direct inputs must also increase. Thus the matrix displays the additional production (i.e., input supply) increases responding to the initial stimulus. This matrix is obtained from the 1996 IMPLAN database for Table 18. The values of the matrix are assumed constant over the eight years projection due to unavailability of such matrices for the years thereafter. The projected output, shown in Table 19 are calculated by multiplying the Leontief Inverse by summation of the final demands The results indicate that the output for two sectors, agriculture and mining increased while output for other sectors had declined.

Table 18.
Inverse Matrix (Input output multipliers), Harper County, Oklahoma

		1 Ag.	2 Mining	3 Const.	4 Manuf.	5 TCPU	6 Trade	7 FIRE	8 Serv.	9 Govt
1	Agriculture	1.261023	0.001187	0.008611	0.049150	0.003081	0.005610	0.005849	0.005640	0.000480
2	Mining	0.003450	1.016090	0.003797	0.014450	0.016510	0.000990	0.000560	0.001400	0.000980
3	Construction	0.031540	0.073030	1.004130	0.016600	0.038040	0.009850	0.038760	0.019660	0.015760
4	Manufacturing	0.015872	0.002857	0.014676	1.022450	0.005280	0.004002	0.001500	0.006180	0.000720
5	TCPU	0.086557	0.023130	0.034680	0.079410	1.170080	0.041480	0.025070	0.056130	0.010330
6	Trade	0.043714	0.006180	0.036680	0.037580	0.012480	1.012190	0.003570	0.012320	0.001110
7	FIRE	0.059240	0.009910	0.014030	0.019310	0.023230	0.026620	1.058560	0.045760	0.002190
8	Services	0.031950	0.011430	0.059590	0.053480	0.078070	0.059970	0.039090	1.118450	0.005030
9	Government	0.009060	0.003400	0.004950	0.017930	0.039570	0.012140	0.011020	0.018450	1.002890

Table 19.

Projections of Outputs, Harper County, Oklahoma ($million)

		Base Year 1996 (t)	1997	1998	1999	2000	2001	2002	2003	2004
1	Agriculture	**112.861660**	115.963778	113.391398	113.763676	114.269977	114.782594	115.295565	115.808663	116.322108
2	Mining	**23.504749**	21.346080	21.439523	21.540943	21.642276	21.743088	21.843350	21.943101	22.042422
3	Construction	**10.049202**	13.496829	13.085205	12.772558	12.485703	12.219251	11.971182	11.739883	11.523989
4	Manufacturing	**3.813971**	4.830281	4.801567	4.808565	4.815156	4.819588	4.821783	4.821843	4.819960
5	TCPU	**31.381355**	34.521079	34.204868	34.089492	33.974149	33.847487	33.708095	33.556103	33.392627
6	Trade	**8.549984**	10.106733	9.936021	9.846584	9.748625	9.636019	9.508249	9.365844	9.210049
7	FIRE	**11.567541**	13.493015	13.148676	12.941032	12.728732	12.503126	12.262921	12.008299	11.740468
8	Services	**14.102519**	15.170379	14.782631	14.466593	14.138170	13.790390	13.421706	13.032420	12.624283
9	Government	**13.323599**	13.149921	12.913781	12.701277	12.490052	12.278587	12.066608	11.854158	11.641503
	Totals	**229.154580**	**242.078096**	**237.703668**	**236.930720**	**236.292842**	**235.620130**	**234.899460**	**234.130313**	**233.317408**

Employment Requirements

To produce a certain level of output (production) a certain number of employees are required. This relationship is reflected in equation (9). Predicted outputs presented in Table 19 and employment-output ratios are needed to calculate the employment requirement. This ratio is calculated by using the IMPLAN data. The employment requirement by sectors are projected and presented in Table 20.

Up to this point the projections are completed for the economic components of the model (Figure 1). Demographic projection is the next step which will be explained in the following section.

Projection of Population

As has been noted, 24 age and sex cohorts are utilized to project population. The usefulness of cohorts are apparent since each age and sex cohorts have particular needs in terms of health care, school enrollment, and other community services. The cohorts assist the local leaders to understand the impacts of a change on a certain age or sex cohorts as a result of their decisions to improve welfare of a community.

Populations are projected in two steps. In Step 1, equations (10) and (11) are used to project the population of Harper County, Oklahoma. The included variable $NM_{i,j,t}$ in the equation (11) is related to the natural in- or out-migration such as retirement, climate, marriage, and other reasons to migrate. These projections do not include the in-or out-migration of residents because of the job seeking process. In Step 2, the in-or out-migrations for job reasons incorporated into calculation of population using the available labor force and required employment. This step will be accomplished after economic-demographic interactions which are discussed in the next section

Table 20.
Projections of Employment Required for Harper County, Oklahoma

		Base Year 1996	1997	1998	1999	2000	2001	2002	2003	2004
1	Agriculture	723	669	654	656	659	662	665	668	671
2	Mining	139	113.61	114.11	114.65	115.19	115.72	116.26	116.79	117.32
3	Construction	118	142.63	138.28	134.98	131.95	129.13	126.51	124.07	121.79
4	Manufacturing	19	21.66	21.53	21.56	21.59	21.61	21.62	21.62	21.61
5	TCPU	92	91.08	90.25	89.95	89.64	89.31	88.94	88.54	88.11
6	Trade	325	345.76	339.92	336.86	333.51	329.65	325.28	320.41	315.08
7	FIRE	90	94.48	92.07	90.62	89.13	87.55	85.87	84.09	82.21
8	Services	411	442.12	430.82	421.61	412.04	401.90	391.16	379.81	367.92
9	Government	455	449.07	441.00	433.75	426.53	419.31	412.07	404.82	397.56
		0								
	Total	2372	**2369**	**2322**	**2300**	**2278**	**2256**	**2232**	**2208**	**2182**

Total Available Labor Force and Economic-Demographic interface

Available labor force is defined as people who are able and willing to work. It includes both employed and unemployed individuals. Using equation (14), total available labor force for the year 1997 is estimated by multiplying total of projected population calculated in step one by the average participation rate of 66 percent obtained from Bureau of Labor Statistics Data (1997). Using equation (16), the labor force estimate for the year 1997 is compared to the required employment (equation 9) of the same year to determine the employment deficit or surplus for the year 1997. If required employment exceeds the labor force, then there is a shortage for labor. In this case, residents of other counties will in-migrate to fill the vacant jobs. If labor force exceeds the required employment, then there will be a shortage of jobs in the community and people out-migrate to find employment in other counties. This in or out migration will increase or decrease the population of previous year and will result in determination of the new population figures for the year 1997 through 2004. The projections of new population figures are presented in Tables 21 through 28.

Table 21.
New Population 1997,
Harper County, Oklahoma

Age	Male	Female	Total
<15	408	403	811
15 - 19	144	112	255
20 - 29	144	129	274
30 - 39	260	232	491
40 - 44	120	115	235
45 - 49	119	107	226
50 - 54	110	111	221
55 - 59	103	111	214
60 - 64	109	103	213
65 - 69	76	88	164
70 - 79	157	189	346
80 +	65	169	234
Total	**1817**	**1868**	**3684**

Table 22.
New Population 1998,
Harper County, Oklahoma

Age	Male	Female	Total
<15	414	409	824
15 - 19	145	113	258
20 - 29	142	128	270
30 - 39	256	228	484
40 - 44	120	114	234
45 - 49	118	106	224
50 - 54	109	108	218
55 - 59	101	109	210
60 - 64	106	102	208
65 - 69	74	86	159
70 - 79	150	183	332
80 +	54	155	208
Total	**1788**	**1841**	**3629**

Table 23.
New Population 1999,
Harper County, Oklahoma

Age	Male	Female	Total
<15	420	416	836
15 - 19	146	115	261
20 - 29	140	126	266
30 - 39	252	225	477
40 - 44	119	114	233
45 - 49	116	105	221
50 - 54	108	106	214
55 - 59	100	107	207
60 - 64	103	100	203
65 - 69	72	83	155
70 - 79	143	177	320
80 +	44	142	186
Total	**1764**	**1816**	**3580**

Table 24.
New Population 2000,
Harper County, Oklahoma

Age	Male	Female	Total
<15	426	422	849
15 - 19	148	117	265
20 - 29	138	125	263
30 - 39	249	221	470
40 - 44	118	114	232
45 - 49	115	104	219
50 - 54	107	104	211
55 - 59	98	105	204
60 - 64	100	99	199
65 - 69	70	81	151
70 - 79	137	171	308
80 +	37	13	167
Total	**1741**	**1794**	**3535**

**Table 25.
New Population 2001,
Harper County, Oklahoma**

	Male	Female	Total
<15	432	428	860
15 - 19	149	119	268
20 - 29	136	124	260
30 - 39	245	218	463
40 - 44	118	114	231
45 - 49	114	103	217
50 - 54	105	103	208
55 - 59	96	104	200
60 - 64	96	98	194
65 - 69	68	79	147
70 - 79	130	165	295
80 +	31	119	150
Total	**1721**	**1772**	**3,493**

**Table 26.
New Population 2002,
Harper County, Oklahoma**

	Male	Female	Total
<15	437	434	871
15 - 19	150	121	271
20 - 29	134	123	257
30 - 39	241	215	456
40 - 44	117	113	230
45 - 49	112	102	214
50 - 54	104	101	205
55 - 59	95	102	197
60 - 64	94	96	190
65 - 69	66	77	143
70 - 79	124	159	284
80 +	26	109	135
Total	**1702**	**1752**	**3,454**

**Table 27.
New Population 2003,
Harper County, Oklahoma**

Age	Male	Female	Total
<15	442	440	882
15 - 19	152	123	275
20 - 29	132	122	254
30 - 39	238	211	449
40 - 44	117	113	230
45 - 49	111	101	212
50 - 54	103	99	202
55 - 59	93	100	193
60 - 64	91	95	186
65 - 69	64	75	139
70 - 79	119	154	273
80 +	22	100	122
Total	**1685**	**1732**	**3417**

**Table 28.
New Population 2004,
Harper County, Oklahoma**

Age	Male	Female	Total
<15	447	445	892
15 - 19	153	125	278
20 - 29	131	120	251
30 - 39	235	208	443
40 - 44	116	112	228
45 - 49	110	100	210
50 - 54	102	97	199
55 - 59	92	99	191
60 - 64	89	93	182
65 - 69	62	73	135
70 - 79	113	149	262
80 +	19	92	111
Total	**1668**	**1713**	**3381**

Projection of Wage and Salary Income and Proprietors' Income

Applying equations 23 and 24, the wage and salary income for each sector is calculated by multiplying the average income of employees obtained from REIS by number of employees of that sector. The summation of all sectors will result in total income of wage and salary income. Table 29 presents the total income of wage and salary income. The same method is used to calculate the total proprietors' income following equation 25 and 26. Table 30 presents the total proprietors' income.

Table 29.
Projection of Wage and Salary Income Harper County, Oklahoma

Year	Wage and Salary Income
1997	$25,754,609.15
1998	$25,484,525.20
1999	$25,206,855.33
2000	$24,962,651.12
2001	$24,719,576.15
2002	$24,467,311.23
2003	$24,220,439.38
2004	$23,978,496.50

Table 30.
Projection of Proprietors' Income Harper County, Oklahoma

Year	Proprietors' Income
1997	$21,877,756.43
1998	$17,147,211.40
1999	$20,705,090.56
2000	$20,697,034.17
2001	$21,826,559.07
2002	$23,074,881.80
2003	$24,445,807.40
2004	$25,847,851.35

Tax Revenue

The procedures utilized to calculate the federal and state taxes for wage and salary income and proprietors' income are outlined in Chapter IV. Applying equations 27 through 30, the resulted tax revenues are presented in Tables 31 through 33.

Table 31.
Projection of Individual Federal Income Tax, Harper County, Oklahoma

Year	Individual Federal Income Tax
1997	$1,583,667.93
1998	$1,567,060.29
1999	$1,549,986.19
2000	$1,534,969.91
2001	$1,520,023.07
2002	$1,504,511.13
2003	$1,489,330.82
2004	$1,474,453.59

Table 32.
Projection of Individual State Income Tax, Harper County, Oklahoma

Year	Individual State Income Tax
1997	$1,066,146.38
1998	$1,054,965.89
1999	$1,043,471.38
2000	$1,033,362.22
2001	$1,023,299.81
2002	$1,012,856.96
2003	$1,002,637.38
2004	$992,621.83

Table 33.
Projection of Proprietors' Income Tax, Harper County, Oklahoma

Year	Proprietors' Income Tax
1997	$2,187,775.64
1998	$1,714,721.14
1999	$2,070,509.06
2000	$2,069,703.42
2001	$2,182,655.91
2002	$2,307,488.18
2003	$2,444,580.74
2004	$2,584,785.13

In order to calculate the sales tax for Harper County, the taxable income is calculated based on equation 31. Then, the taxable income is multiplied by the sales tax rate for Harper County. The projection of the sales tax for Harper County is presented in Table 34.

Table 34.
Projection of Sales Tax, Harper County, Oklahoma

Year	County Sales Tax
1997	$584,989.39
1998	$523,574.95
1999	$563,860.32
2000	$560,762.23
2001	$571,649.02
2002	$583,881.95
2003	$597,686.84
2004	$611,934.43

The projection of total revenue resulted from summation of federal, state, and county sales taxes is presented in Table 35. Notice that other taxes such as property tax, alcoholic beverage tax, and franchise tax are not included in OSU-CSMode. Despite an increase in proprietors' income, the total revenue is decreasing in Harper County due to reduction in wage and salary income.

Table 35.
Projection of Total Revenue, Harper County, Oklahoma

Year	Total Revenue
1997	$5,422,579.34
1998	$4,860,322.27
1999	$5,227,826.94
2000	$5,198,797.77
2001	$5,297,627.80
2002	$5,408,738.22
2003	$5,534,235.77
2004	$5,663,794.99

Community Service Requirements

The projections of population are used to estimate the level of community services usage for Harper County. As listed in Chapter IV, the selected group of services for this study are: hospital usage per hear, physicians visits per year, primary care physicians needed, school-age children, total volume of water consumption, sewage flow, and total volume of solid waste collection. Notice that not all of these services are provided directly by a local government. However, because these services are of importance to a community they are included in the OSU-CSModel. These services depend on level of population in each year. The projections of community services are discussed in the following section.

Hospital Usage Per Year

As it has been noted, The hospital requirement is measured by annual bed days. Using equations 34 and 35, with the aids of Table 6 through 8, the projections of hospital beds for Harper County needed per year are presented in Table 36.

Table 36.
Projections of Hospital Beds per Year, Harper County, Oklahoma

Year	Hospital Beds Per Year, Baseline **Projections of Hospital Beds per Year**
1996	2,713
1997	2,590
1998	2,483
1999	2,388
2000	2,301
2001	2,221
2002	2,147
2003	2,079
2004	2,015

Physician Visits per Year

The number of physician visits per year is another community service demanded by residents of a community. Using equation 36, the OSU-CSModel projects the physician visits per year for 24 age-sex cohorts and sums for all ages. These projections are presented in Table 37.

Table 37.
Projections of Physicians Visits per Year
Harper County, Oklahoma

Year	Male	Female	Total
1996	6417	6720	13137
1997	6272	6577	12849
1998	6154	6455	12609
1999	6052	6345	12397
2000	5960	6241	12202
2001	5876	6143	12019
2002	5798	6049	11847
2003	5725	5961	11685
2004	5656	5876	11532

Total Primary Care Physicians Needed

As has been noted, the primary care visits consisted 62.8 percent of all doctors' office visits. Since health care is of a great concern to local leaders, the estimates of primary care physicians are projected in the OSU-CSModel using equation 37. The projections are presented in Table 38.

Table 38.
Projections of Primary Care Physicians
per Year , Harper County, Oklahoma

Year	PHYS
1996	1.9
1997	1.9
1998	1.8
1999	1.8
2000	1.8
2001	1.8
2002	1.7
2003	1.7
2004	1.7

Notice that the number of physicians needed are demonstrated in one decimals in Table 38. The reason is to show the decline rate.

School-Age Children

The number of school-age children is vital information for local leaders to assess 'educational services' needs in a community. Using equations 38 through 41, the projections of school-age children are presented in Table 39. The projections are for the kindergarten children up to twelfth grade teens.

Table 39.
Projections of School-Age Children per Year
Harper County, Oklahoma

Year	Male	Female	Total
1996	393	406	799
1997	385	400	785
1998	367	383	749
1999	359	376	736
2000	348	364	712
2001	338	358	697
2002	335	357	692
2003	334	357	691
2004	335	359	694

The projected number of school children for the years 1996 to 1997 are compared with the number of school children reported by Oklahoma State Department of Education for the same years. Results are presented in the Table 40.The slight differences are because of existed discrepancies between projected population by the model and the population reported by U.S. Census Bureau.

Table 40
Comparison Between Reported and Projected Number of School-Age Children, Harper County, Oklahoma

Year	Projected Number of School-Age Children	Reported Number of School-Age Children	Difference
1996	799	799	0
1997	785	786	-1
1998	749	746	3
1999	736	735	1

Total Volume of Water Consumption

The volume of water consumption is based on residential and industry/ agriculture use. Using equations 42 through 44, the projections for both users for Harper County are presented in Table 41.

Table 41.
Projection of Total Volume of Water Consumption (Gallons per year), Harper County, Oklahoma

Year	Residential	Industry/Agriculture	Total Water
1996	196,980,000	1,772,820,000	1,969,800,000
1997	193,419,449	1,740,775,043	1,934,194,492
1998	190,497,952	1,714,481,565	1,904,979,517
1999	187,954,467	1,691,590,200	1,879,544,667
2000	185,597,164	1,670,374,479	1,855,971,643
2001	183,393,052	1,650,537,472	1,833,930,524
2002	181,321,166	1,631,890,498	1,813,211,664
2003	179,364,878	1,614,283,905	1,793,648,783
2004	177,507,661	1,597,568,948	1,775,076,609

Sewage Flow

The volume of wasted-water generated each year is needed to plan in establishing related facilities. Using equation 45, the projections of sewage flow for Harper County are presented in Table 42.

Table 42.
Projections of Sewage Flow
(Gallons per year), Harper County, Oklahoma

Year	Sewage Floe
1996	136,948,000
1997	134,472,569
1998	132,441,433
1999	130,673,105
2000	129,034,219
2001	127,501,836
2002	126,061,382
2003	124,701,296
2004	123,410,088

Total Volume of Solid Waste Collection

Like other service requirements discussed earlier, the volume of solid waste collection is useful information needed for providing this service to a community.
The projections of solid waste collection are presented in Table 42.

The community services accounts projected by OSU-CSModel are functions of population. Population itself depends on various economic and demographic factors. Consequently, the community services will be affected directly if a change occurs directly in the population such as in-or out-migration of retirees and indirectly if a change occurs in an economic variable such as new investment or increase in exports in economy of the community.

Table 43.
Projections of Solid Waste Collection
(Cubic yards per year),
Harper County, Oklahoma

Year	Solid Waste/cubic yards
1996	6,025,712.00
1997	5,916,793.06
1998	5,827,423.06
1999	5,749,616.64
2000	5,677,505.64
2001	5,610,080.80
2002	5,546,700.82
2003	5,486,857.04
2004	5,430,043.87

Up to this point, the baseline projections are made for economic and demographic variables by the model. In general, the results conclude that the Harper County faces decline in population, outputs, wage and salary employment, and total-tax revenue. The demands for community services are declining over the projection periods as well.

The baseline projections will be used to compare the effects of a change in the economy of Harper County. In other words, the baseline projections facilitate the impact analysis of hypothetical changes intended to improve the economy of the County. In Part 2 of this chapter, the detailed discussion of the hypothetical changes and the results of these changes will be discussed.

Part 2, impact analysis.

One objective of this study is to develop a community simulation model as a teaching tool to be used in the classroom and as a decision aid for local leaders as mentioned in the introduction of this dissertation. The model analyzes the impacts on a community resulting from changes in the local economic base. To reach this objective, the hypothetical changes will be analyzed through the OSU-CSModel and the results will be discussed. Since the model will be used for experiential learning purposes, the selected hypothetical changes (scenarios) should reflect real world issues. The possible scenarios selected for the OSU-CSModel are as follows:

1. Increase in the exports of a sector in the local economy. This option assumes that there is an external demand for goods and services produced locally by any sector of the economy.
2. Increase in investment of a sector in the local economy. This is equivalent to establishment of a new firm in the community. This scenario is based on the assumption that the additional goods and services produced by the additional investment have internal or external demand or both.
3. In-migration of retirees to the community. This scenario assumes that the community has some favorable characteristics such as low living costs, appropriate weather conditions, and nursing facilities that attract retirees to the community. The retirees will bring money to the community and they do not impose demand for jobs.
4. Tourist attraction developing in the community. This scenario is based on creating recreational and entertaining facilities. Tourists will spend money in the community.
5. Establishment of a state prison in the community. This scenario will increase government expenditures be housing a certain number of inmates. It is assumed

that the funds needed for establishing the prison will be provided by a source outside the community such as state or federal government.

6. Creation of one hundred jobs in a particular sector of the community. This scenario is similar to the increasing exports and increasing investment in the community. However, it emphasizes creating a certain number of jobs in a particular sector of the economy.

All these changes will impact the economy as of year 2000. All changes promote the economic activity in the community and will be applied to the model individually for the purpose of impact analysis and game development. There are advantages and disadvantages associated with each scenario. These are reflected in form 11 in Chapter VI. To avoid lengthy illustrations for implementation of all six scenarios, only the impact of the last scenario "creation of 100 jobs" will be explained in details. The impacts for other changes will be outlined briefly in Tables 44-45.

Referring to Figure 1, the OSU-CSModel is a final-demand driven model. These demands are exports, government expenditures, capital formation, household expenditures, and inventory changes has been noted earlier. Any change in the sectors of economy needs to be injected in the related final demand in order to take effect through the whole economy. The choice of final demand depends on the discretion of the decision-maker, students who play the game. In this study, manufacturing exports has been chosen to create one hundred jobs. Figure 2 presents the increase in jobs for year 2000. The years thereafter increased slightly more than one hundred. This is because there had been a slight growth in the historical data related to the used to project employment requirement of manufacturing sector (Table 12).

The impacts of creation of one hundred new jobs in manufacturing sector by increasing the exports of that sector on economic and demographic variables are illustrated in Figures 2 through 20. Population of Harper County (Figure 3) will increase approximately by 24 due to in-migration of laborers and their families as illustrated in Figure 4. The outputs (Figure 5) will increase by $28.6 million because of expansion in exports of the manufacturing sector in Harper County. The employment in other sectors will be affected positively (Figure 6). As this form indicates, the creation of 100 jobs in the manufacturing sector has impacted the economic activities of other sectors and as a result they hire 94 employees in year 2000 to response to the economic growth. The impacts on employment of individual sectors are shown on Table 46. For the year 2000, the largest increases in employment of sectors occur for Trade by 25 and Services by 24. As mentioned earlier, the total increase in employment of other sectors for year 2000 equals to 94 if 100 jobs are created in the manufacturing sector.

Since a total of 194 jobs are created in the county, the totals of wage and salary income (Figure 7) and proprietors' income (Figure 12) will increase in the year 2000 by $27,094,902.33 and $22,464,926.3 respectively. Accordingly, the total revenues for the county resulting from federal, state, and county sales taxes will also increase. The demand for community services (Figures 14 through 20) will increase due to the increase in population. For instance, Figure 17 shows that on average, six more children will attend school in Harper County due to in-migration of people seeking employment

The results of the impacts shown in Figures 3 through 20 can be used as multipliers. For example, the total employment will be 194.61 (Figure 7) which implies that for every additional 100 jobs in the manufacturing sector, there will be 94.62

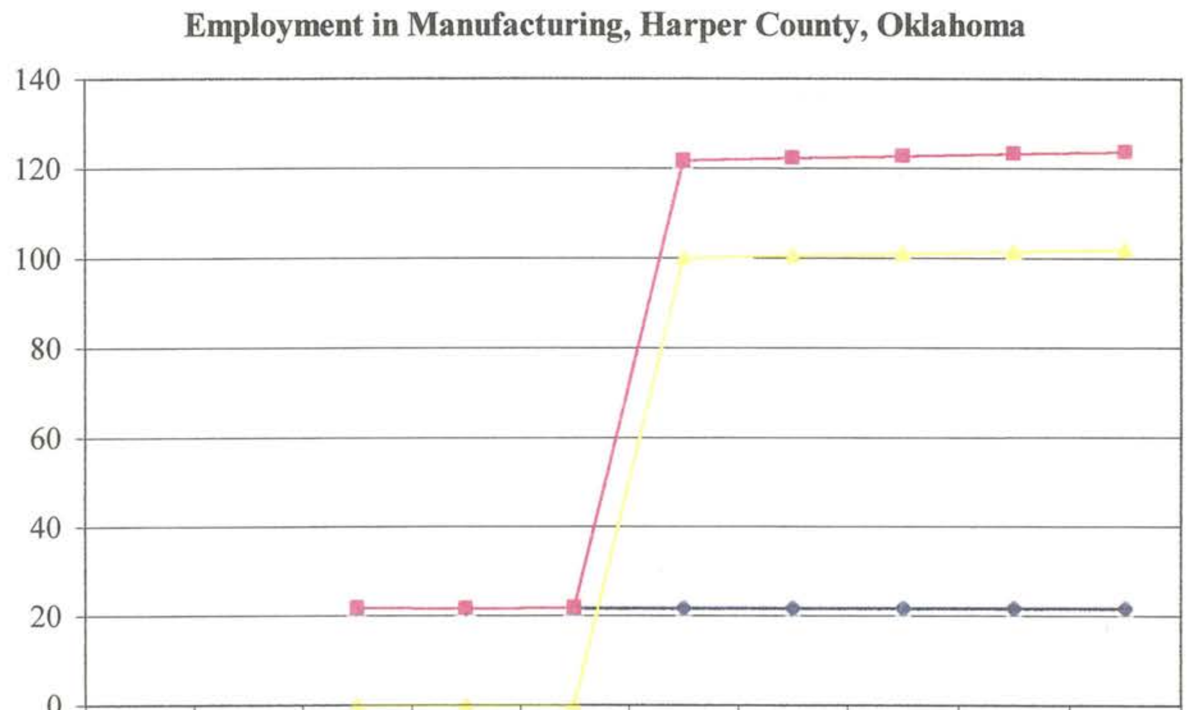
additional jobs (indirect effect) in other sectors of the Harper County economy. Similarly, as Figure 14 indicates, for every 100 jobs created in the manufacturing sector, 16 more hospital beds are required (induced effect). The multipliers developed for each impact are useful tools for teaching economic concepts in classrooms. They are also helpful for local leaders in conducting sensitivity analysis.

As mentioned above, the choice of "creation of hundred jobs in manufacturing sector" is one of the six possible changes. Similar analysis can be done by choosing other possible changes and running the OSU-CSModel. The summary impacts of other choices listed on pages 119-120 are presented in Tables 44 and 45. Table 44 outlines the impacts of six choices on economic and demographic variables, while Table 45 outlines the same impacts on community services. These two tables can be interpreted as follows: if the change of "increase in investment of a sector in the local economy" (say the agriculture sector) is chosen, then the impacts for year 2000 are reflected on the first rows of Tables 44 and 45. The baseline projections are included for a comparison exercise. The interpretation of results in Table 44 are as follows: if there is an investment of $15 million (hypothetical amount) in the agriculture sector, then total employment will increase to 2,444, total wage and salary income will increase to $26,782,336.24, production will increase to $259,428,900, and local sales tax revenue will increase to $601,639.72. Similarly, the interpretation of the results in Table 45 are as follows: if there is an investment of $15 million in the agriculture sector, then hospital beds will increase to 2,315, physician visits will increase to 12,273, school enrollment will increase to 717, water use will increase to 1,866,780,012 gallons, sewage flow will increase to 129,785,658 gallons and solid waste collection will increase to 5,710,569 cubic yards.

The impact of investment of the same amount in other sectors such as mining, manufacturing, services, and government are shown in the same tables. A comparison of the results for investment of $15 million in five sectors indicates that the investment in the government sector will create the largest employment and generate the largest local sales tax revenue for the county. However, it also imposes highest demand for community services. A similar comparison analysis can be conducted for an increase of $13 million in exports for the five sectors of the economy. The government sector will account for the largest employment and sales tax revenue, while demanding more community services. The impacts of other changes (in-migration of retirees, tourist attraction, establishment of a state prison) on the economy and community services are different. Since these changes are not homogeneous, their results are not comparable. However, among the six scenarios, the results of the OSU-CSModel indicate that the establishment of a state prison will bring the highest employment, production, and local sales tax revenue and will result in the highest demand for community services. One reason for this is because the establishment of a state prison affects government expenditures. The government sector in the Harper County may have more local inter-industry transactions than other sectors in the county. The magnitude of the impact related to the state prison may be large related to the other scenarios as well.

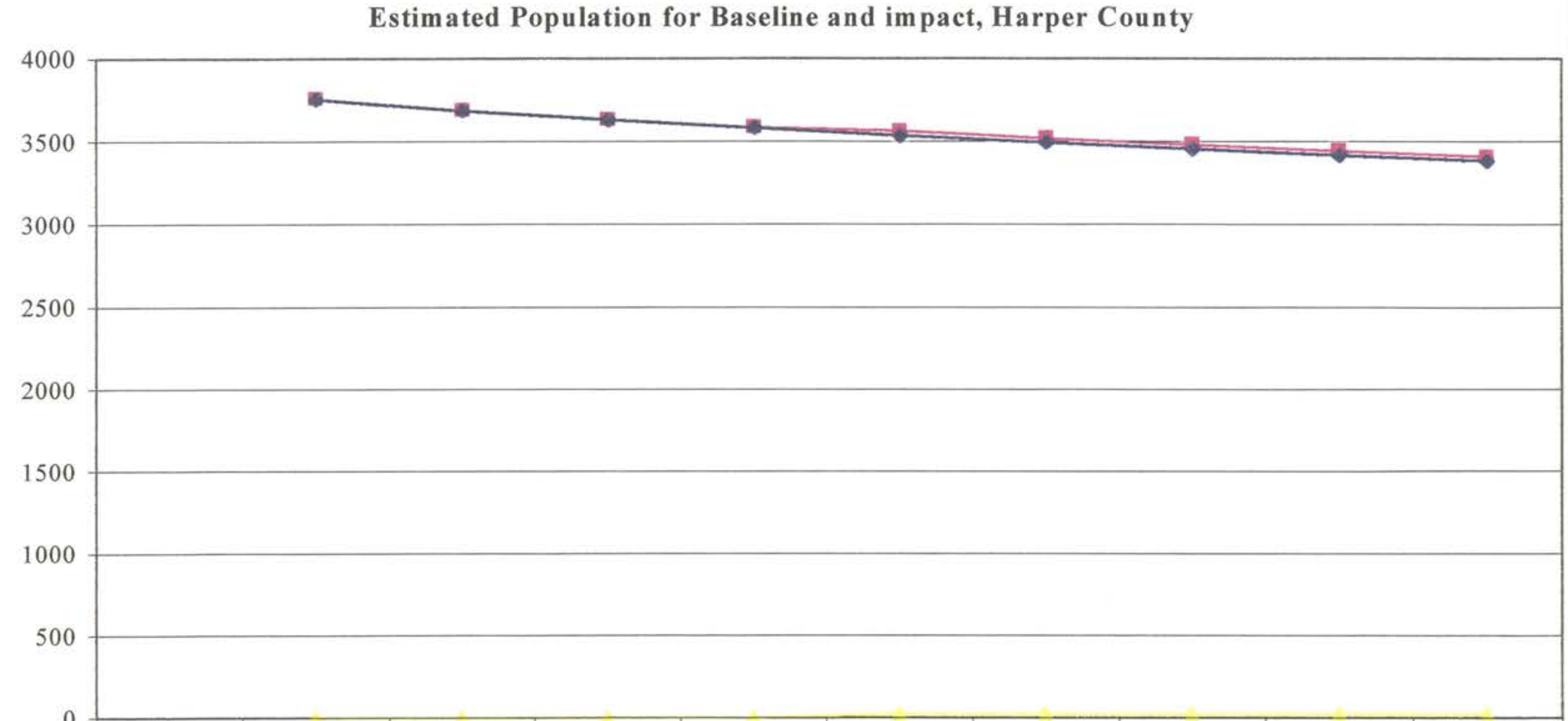
The decision on choosing the change which yields the best results is dependent upon the social and environmental preferences of Harper-County residents. If they are concerned about potential pollution they must consider that a new firm may increase pollution. Residents may not choose the scenario of investment in a sector, despite the fact that this scenario will result in higher employment and tax revenue. The detailed discussion about learning of economic and demographic concepts and benefits from application of the OSU-CSModel will be presented in the next chapter.

Figure 2
Results for Creation of 100 New Jobs in the Manufacturing Sector



Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
Employ-Manufacturing Baseline		21.66	21.53	21.56	21.59	21.61	21.62	21.62	21.61
Employ-Manufacturing Impact		21.66	21.53	21.56	121.59	122.10	122.60	123.09	123.58
Employ-Manufacturing Difference		0.00	0.00	0.00	100.00	100.49	100.98	101.47	101.97

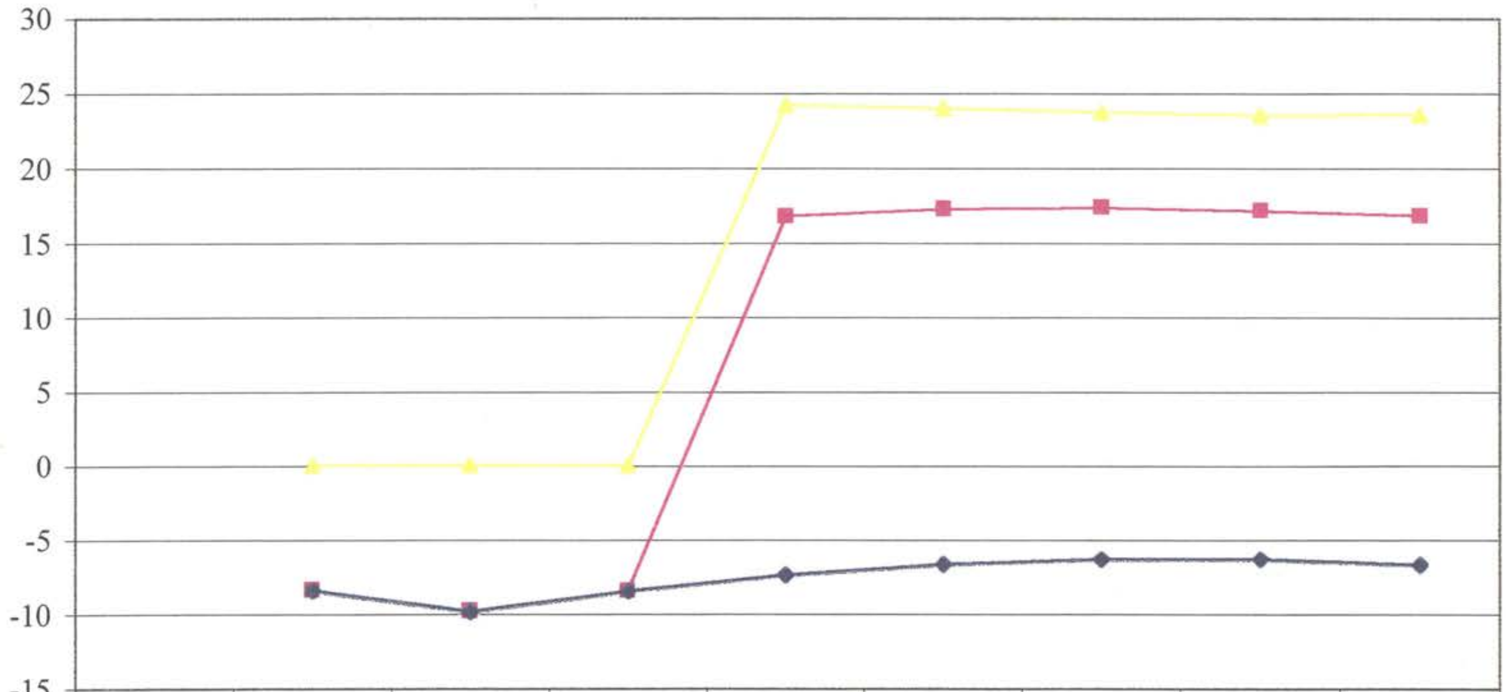
Figure 3.
Results from Creation of 100 New Jobs in the Manufacturing Sector



	Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
Impact		3,752	3,684	3,629	3,580	3,559	3,517	3,477	3,440	3,405
Baseline		3,752	3,684	3,629	3,580	3,535	3,493	3,454	3,416	3,381
Difference		0.00	0.00	0.00	0.00	24.12	23.90	23.65	23.45	23.49

Figure 4
Results from Creation of 100 New Jobs in the Manufacturing Sector

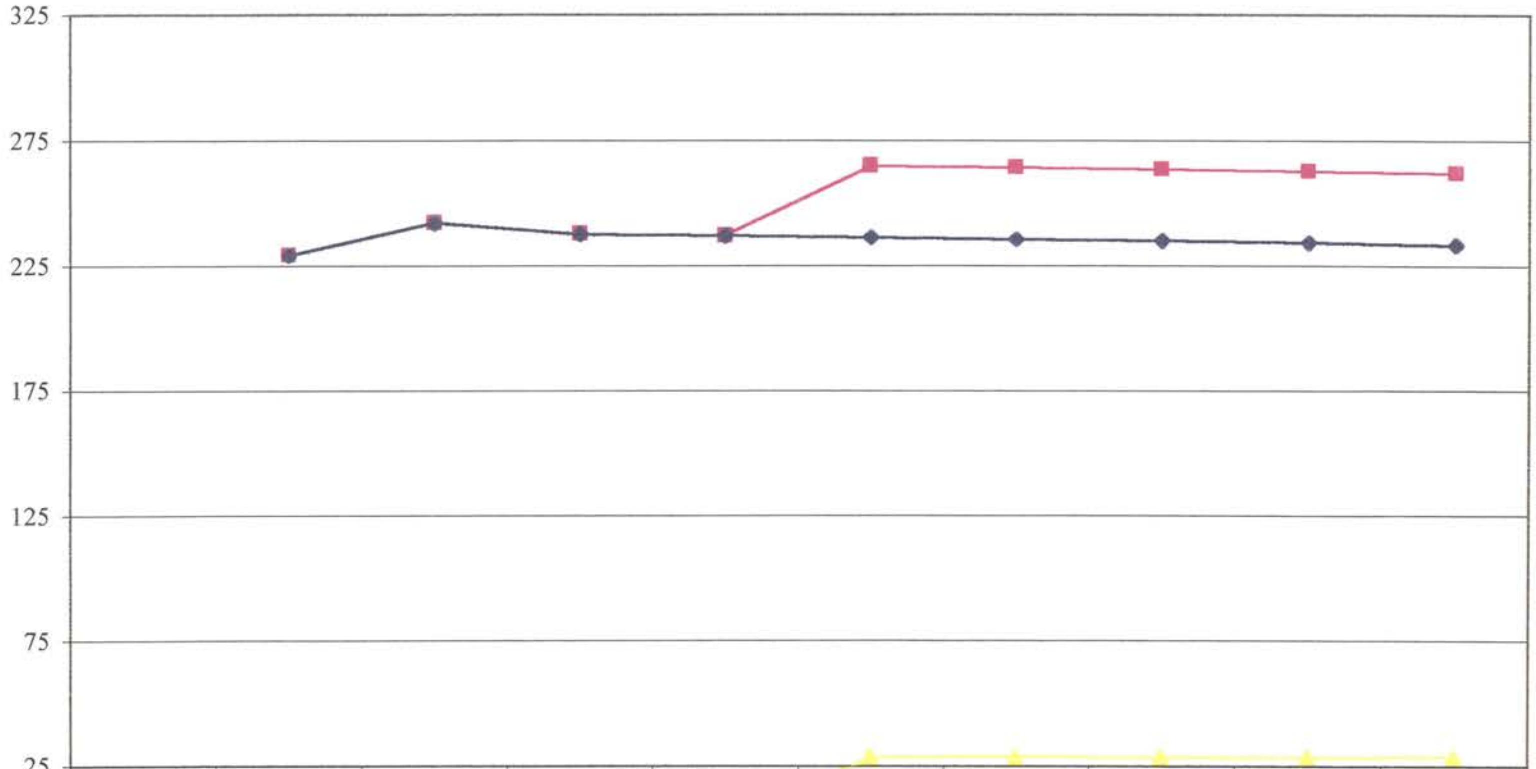
In-Outmigration for Baseline and Impact, Harper County



	Year	1997	1998	1999	2000	2001	2002	2003	2004
Impact		-8	-10	-9	17	17	17	17	17
Baseline		-8	-10	-9	-7	-7	-6	-6	-7
Difference		0.00	0.00	0.00	24.12	23.90	23.65	23.45	23.49

Figure 5
Results from Creation of 100 New Jobs in the Manufacturing Sector

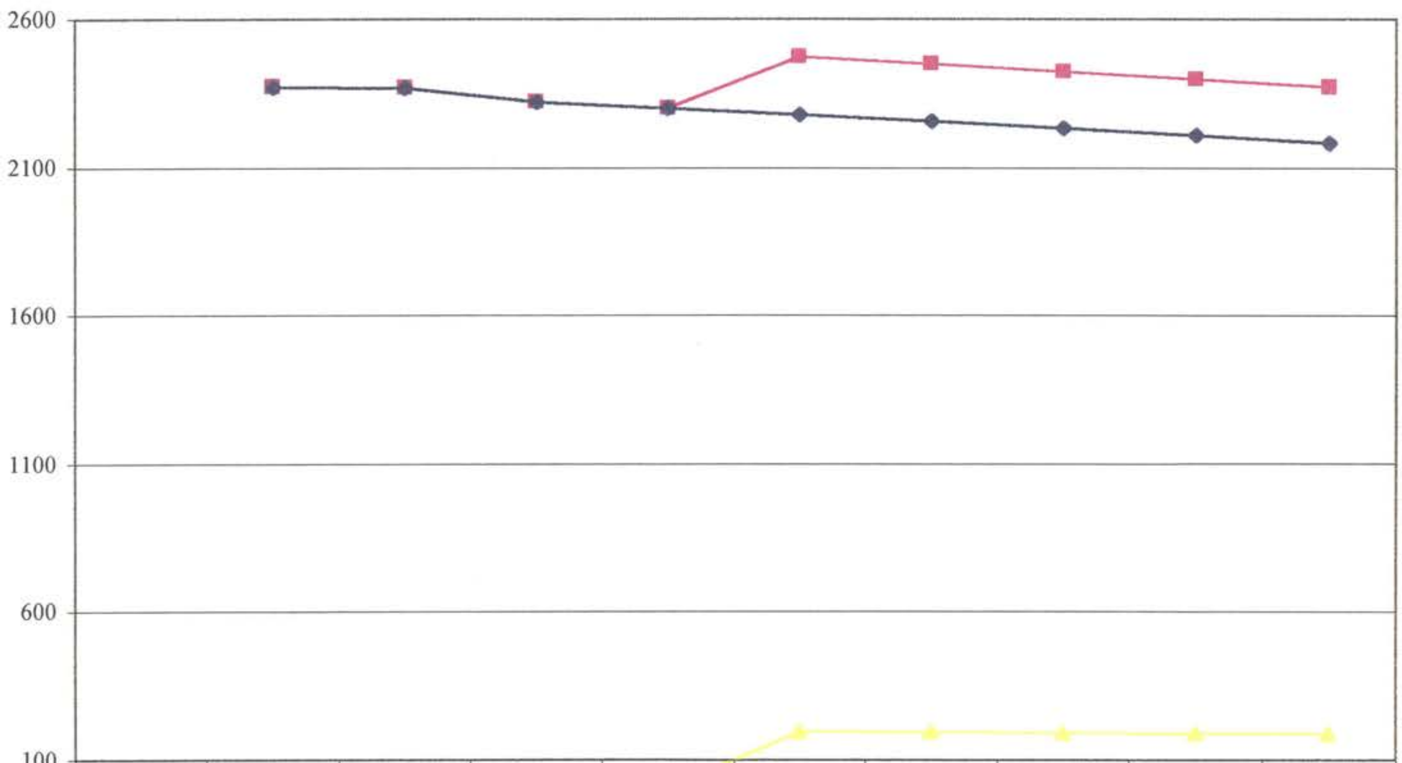
Output for Baseline and Impact ($Million), Harper County



	Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
Impact		$229.15	$242.08	$237.70	$236.93	$264.88	$264.23	$263.49	$262.72	$261.93
Baseline		$229.15	$242.08	$237.70	$236.93	$236.29	$235.62	$234.90	$234.13	$233.32
Difference		$-	$-	$-	$-	$28.59	$28.61	$28.59	$28.59	$28.61

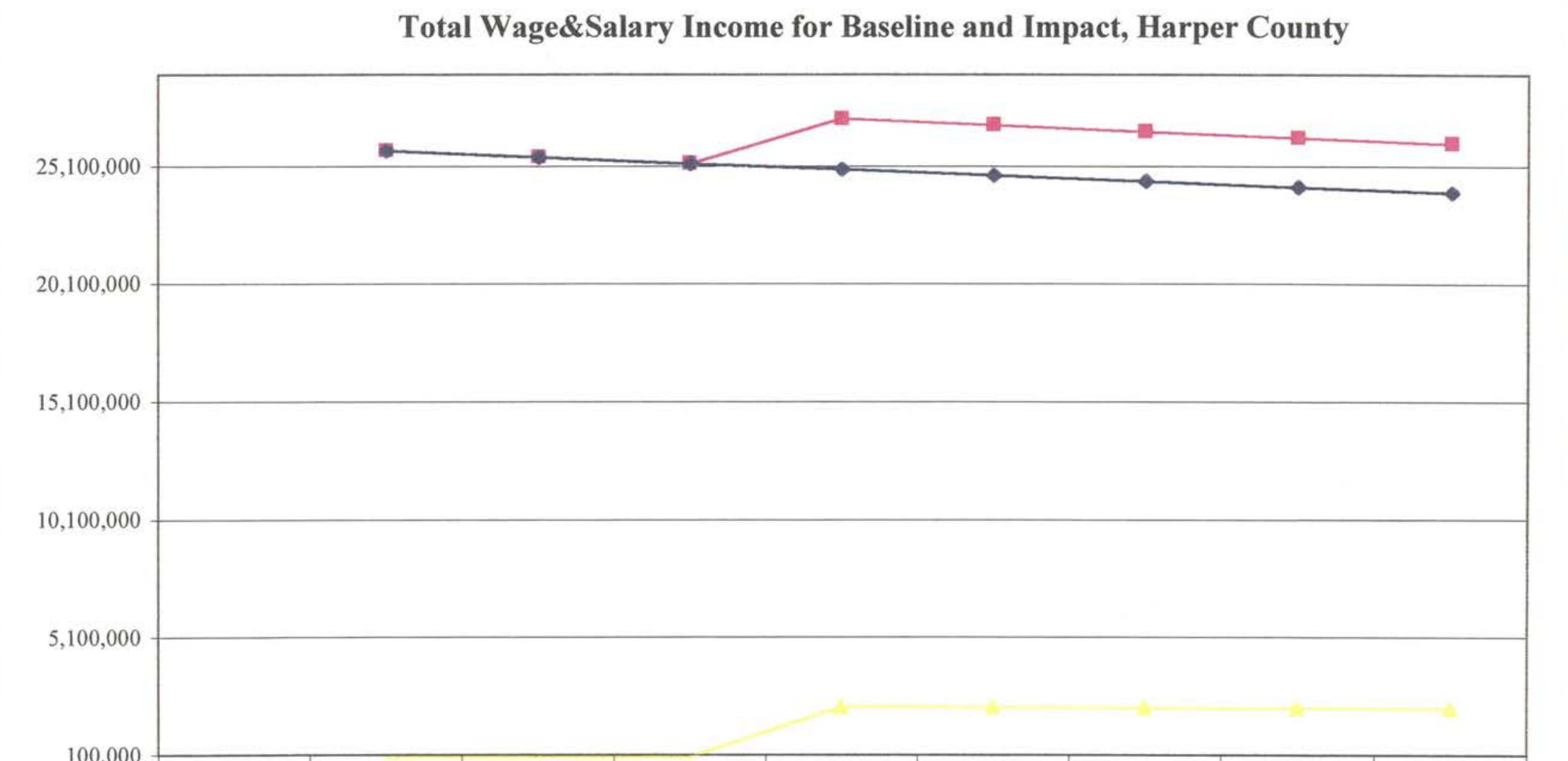
Figure 6
Results from Creation of 100 New Jobs in the Manufacturing Sector

Employment Required for Baseline and Impact, Harper County



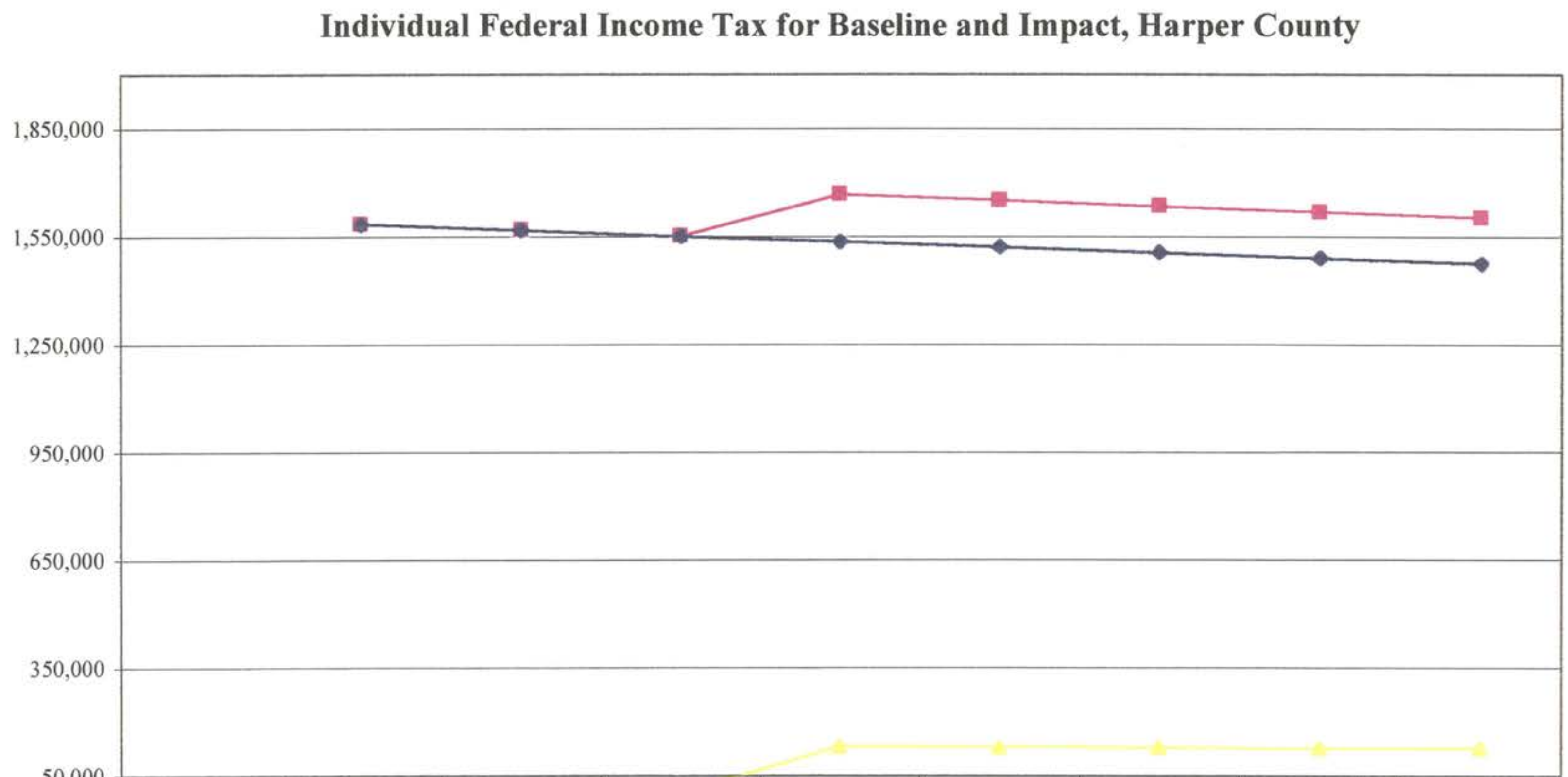
	Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
Employ.Req. Impact		2,372	2,369	2,322	2,300	2,473	2,449	2,423	2,397	2,370
Employ.Req. Baseline		2,372	2369	2,322	2,300	2,278	2,256	2,232	2,208	2,182
Employ.Req. Difference		0.00	0.00	0.00	0.00	194.62	192.80	190.81	189.17	187.90

Figure 7
Results from Creation of 100 New Jobs in the Manufacturing Sector



Year	1997	1998	1999	2000	2001	2002	2003	2004
Impact	$25,754,609.15	$25,484,525.20	$25,206,855.33	$27,094,902.33	$26,832,145.18	$26,558,589.69	$26,295,647.26	$26,043,116.19
Baseline	$25,754,609.15	$25,484,525.20	$25,206,855.33	$24,962,651.12	$24,719,576.15	$24,467,311.23	$24,220,439.38	$23,978,496.50
Difference	$-	$-	$-	$2,132,251.21	$2,112,569.04	$2,091,278.46	$2,075,207.88	$2,064,619.69

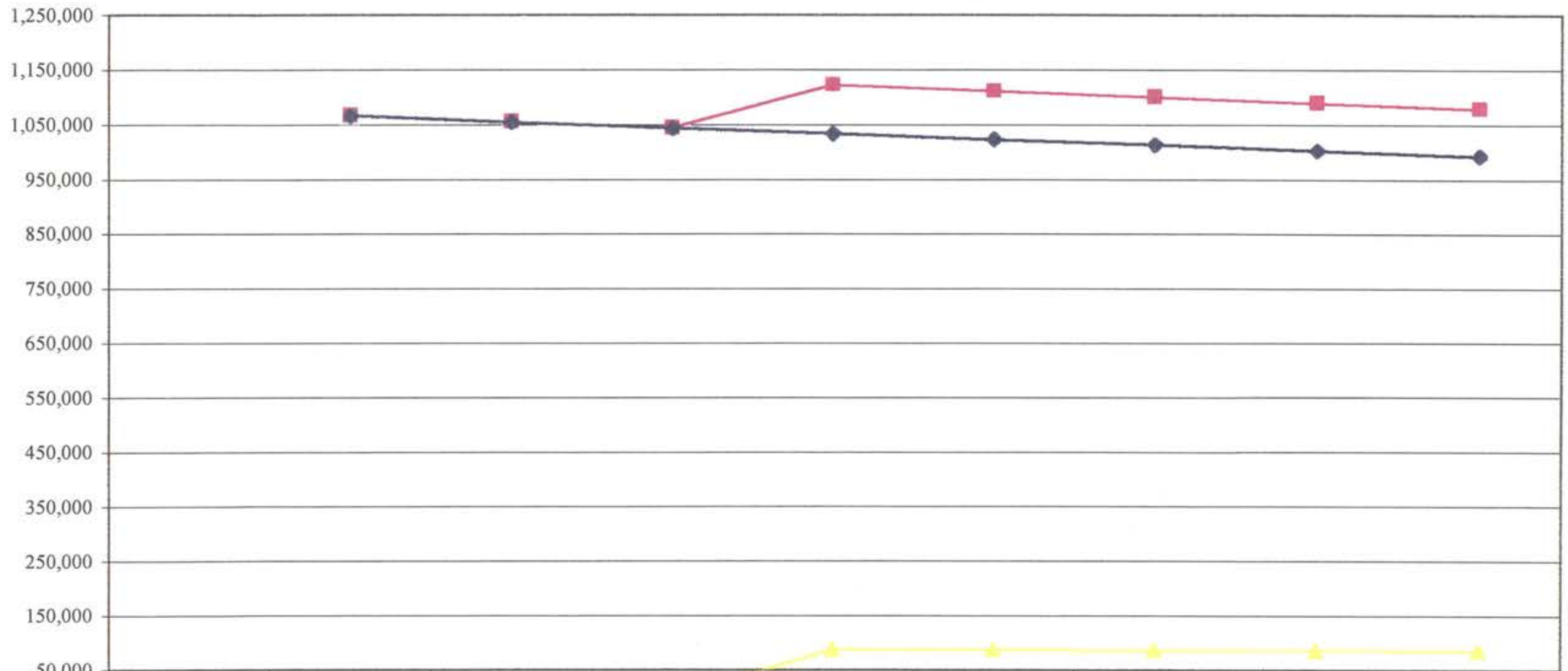
Figure 8
Results from Creation of 100 New Jobs in the Manufacturing Sector



Year	1997	1998	1999	2000	2001	2002	2003	2004
Impact	$1,583,667.93	$1,567,060.29	$1,549,986.19	$1,666,083.44	$1,649,926.33	$1,633,105.22	$1,616,936.72	$1,601,408.42
Baseline	$1,583,667.93	$1,567,060.29	$1,549,986.19	$1,534,969.91	$1,520,023.07	$1,504,511.13	$1,489,330.82	$1,474,453.59
Difference	$-	$-	$-	$131,113.54	$129,903.27	$128,594.09	$127,605.90	$126,954.83

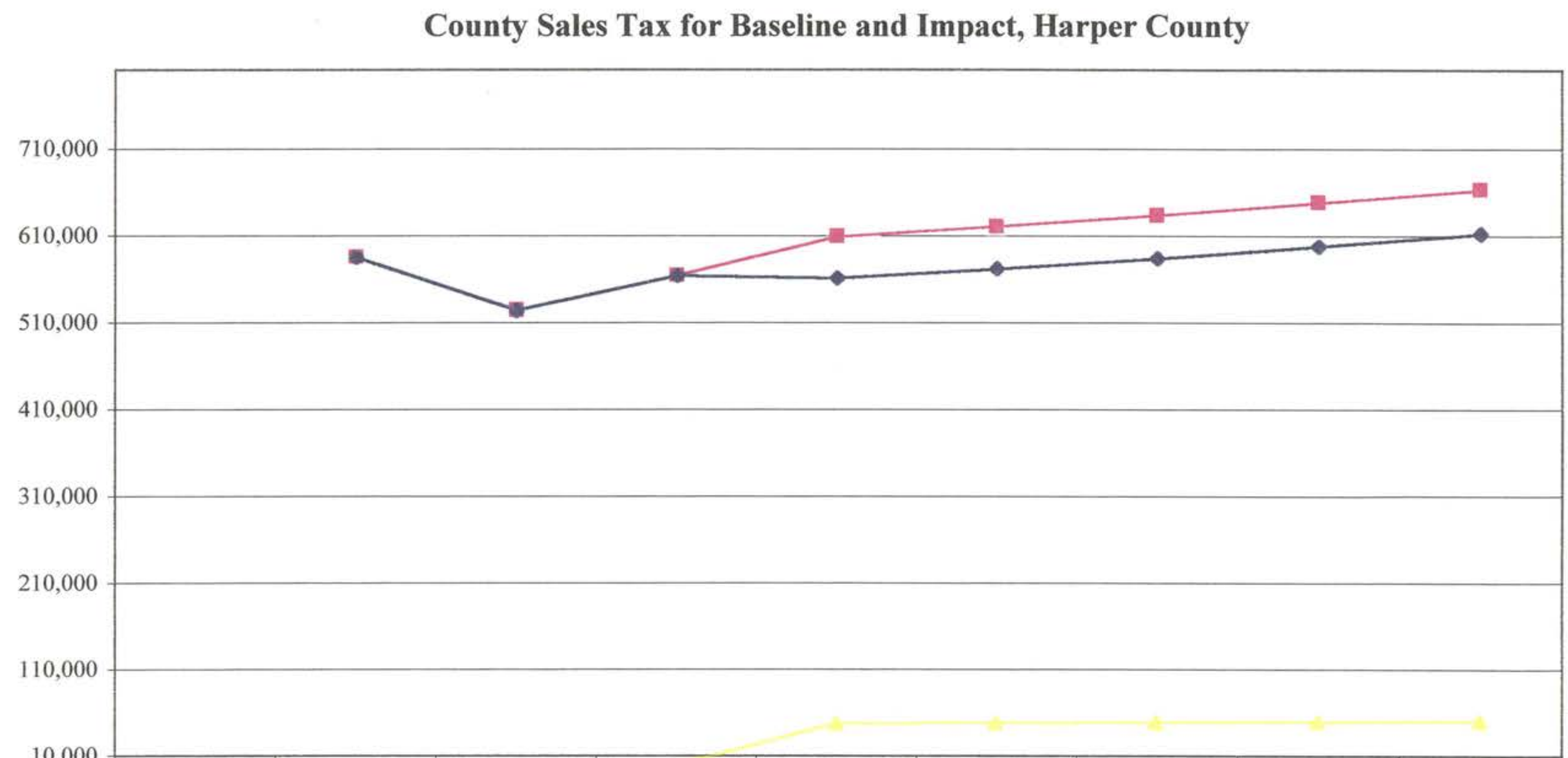
Figure 9
Results from Creation of 100 New Jobs in the Manufacturing Sector

Oklahoama State Tax from W &S Employees for Baseline and Impact, Harper County



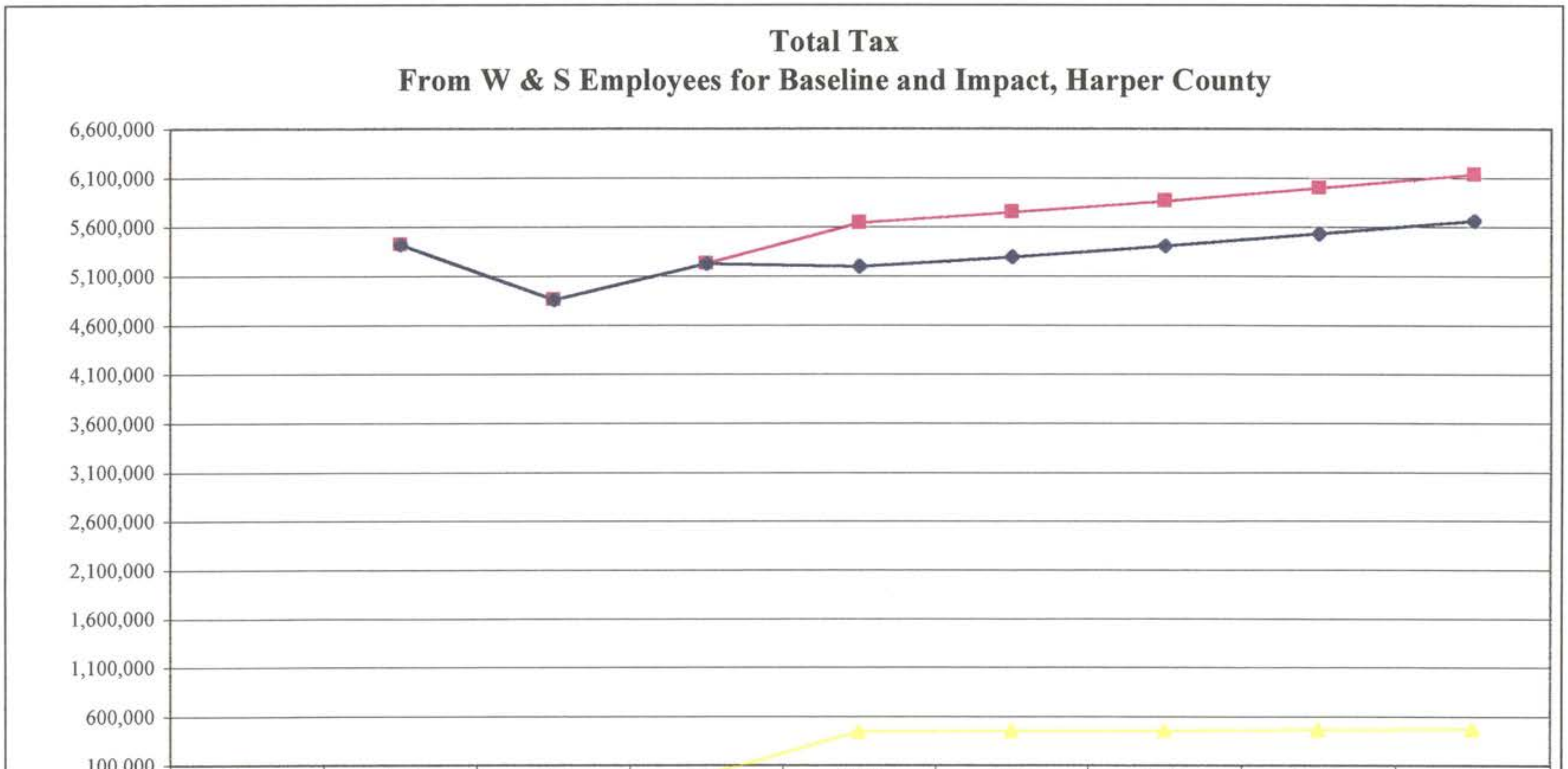
Year	1997	1998	1999	2000	2001	2002	2003	2004
Impact	$1,066,146.38	$1,054,965.89	$1,043,471.38	$1,121,629.60	$1,110,752.42	$1,099,428.22	$1,088,543.37	$1,078,089.51
Baseline	$1,066,146.38	$1,054,965.89	$1,043,471.38	$1,033,362.22	$1,023,299.81	$1,012,856.96	$1,002,637.38	$992,621.83
Difference	$-	$-	$-	$88,267.38	$87,452.61	$86,571.26	$85,906.00	$85,467.68

Figure 10
Results from Creation of 100 New Jobs in the Manufacturing Sector



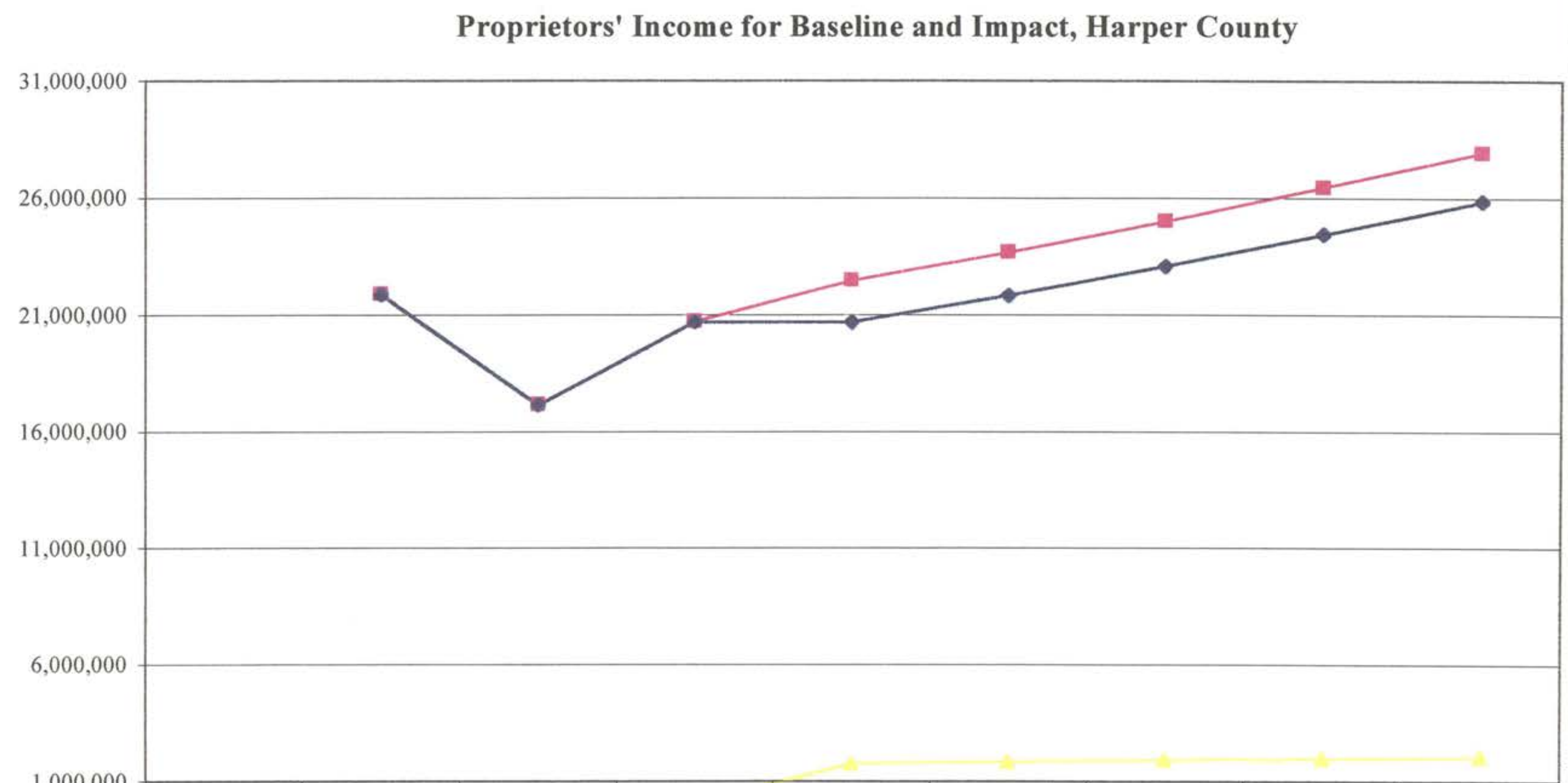
Year	1997	1998	1999	2000	2001	2002	2003	2004
Impact	$584,989.39	$523,574.95	$563,860.32	$608,661.22	$620,201.69	$633,049.58	$647,564.80	$662,632.89
Baseline	$584,989.39	$523,574.95	$563,860.32	$560,762.23	$571,649.02	$583,881.95	$597,686.84	$611,934.43
Difference	$-	$-	$-	$47,899.00	$48,552.67	$49,167.63	$49,877.96	$50,698.45

Figure 11
Results from Creation of 100 New Jobs in the Manufacturing Sector



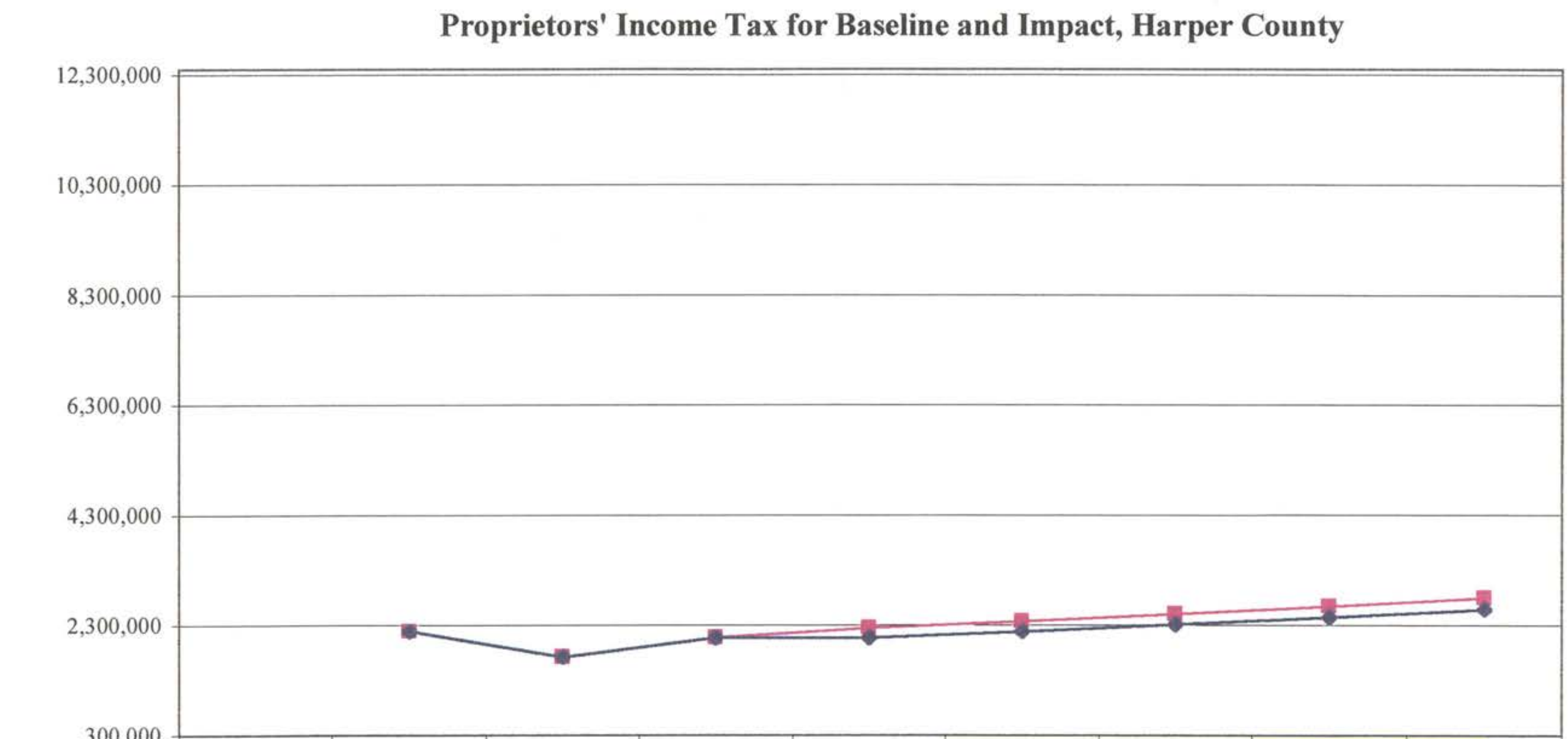
	Year	1997	1998	1999	2000	2001	2002	2003	2004
Impact		$5,422,579.34	$4,860,322.27	$5,227,826.94	$5,642,866.90	$5,747,616.32	$5,864,287.47	$5,996,232.80	$6,133,262.69
Baseline		$5,422,579.34	$4,860,322.27	$5,227,826.94	$5,198,797.77	$5,297,627.80	$5,408,738.22	$5,534,235.77	$5,663,794.99
Difference		$-	$-	$-	$444,069.13	$449,988.52	$455,549.25	$461,997.04	$469,467.71

Figure 12
Results from Creation of 100 New Jobs in the Manufacturing Sector



Year	1997	1998	1999	2000	2001	2002	2003	2004
Impact	$21,877,756.4	$17,147,211.4	$20,705,090.5	$22,464,926.3	$23,667,358.7	$24,987,044.4	$26,431,879.1	$27,911,318.7
Baseline	$21,877,756.43	$17,147,211.40	$20,705,090.56	$20,697,034.17	$21,826,559.07	$23,074,881.80	$24,445,807.40	$25,847,851.35
Difference	$-	$-	$-	$1,767,892.20	$1,840,799.70	$1,912,162.67	$1,986,071.71	$2,063,467.41

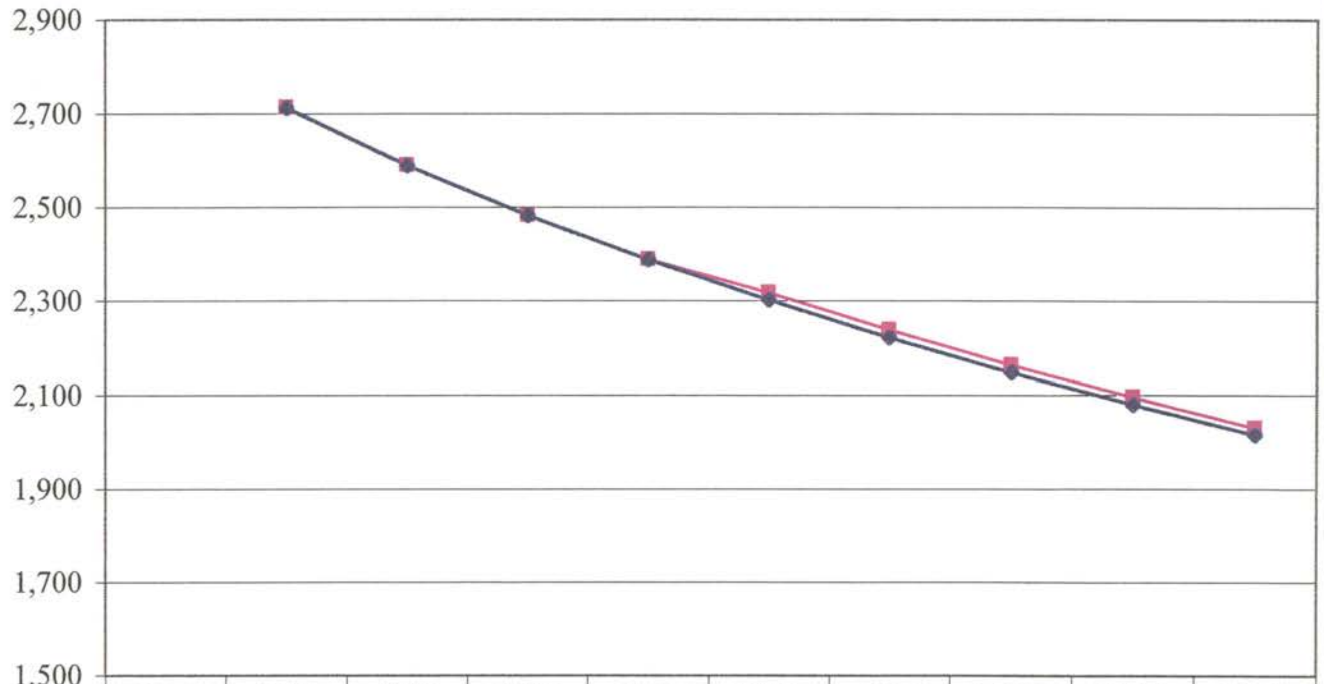
Figure 13
Results from Creation of 100 New Jobs in the Manufacturing Sector



	Year	1997	1998	1999	2000	2001	2002	2003	2004
Impact		$2,187,775.64	$1,714,721.14	$2,070,509.06	$2,246,492.64	$2,366,735.88	$2,498,704.45	$2,643,187.91	$2,791,131.88
Baseline		$2,187,775.64	$1,714,721.14	$2,070,509.06	$2,069,703.42	$2,182,655.91	$2,307,488.18	$2,444,580.74	$2,584,785.13
Difference		$-	$-	$-	$176,789.22	$184,079.97	$191,216.27	$198,607.17	$206,346.74

Figure 14
Results from Creation of 100 New Jobs in the Manufacturing Sector

Required Hospital Beds per Year for Baseline and Impact, Harper County

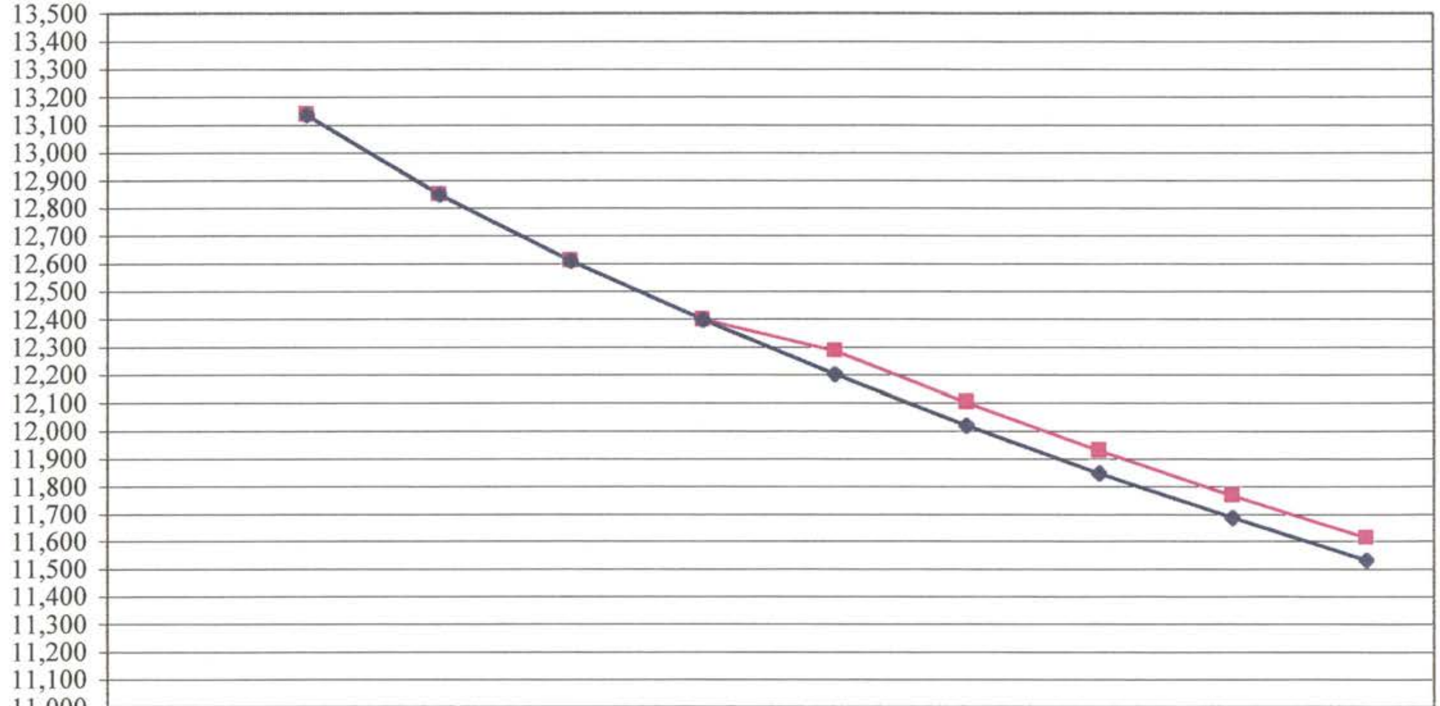


Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
Hosp. Beds per Year, Impact	2,713	2,590	2,483	2,388	2,317	2,237	2,163	2,093	2,029
Hospital Beds Per Year, Baseline	2,713	2,590	2,483	2,388	2,301	2,221	2,147	2,079	2,015
Difference	0.00	0.00	0.00	0.00	16.09	15.56	15.04	14.58	14.29

Figure 15

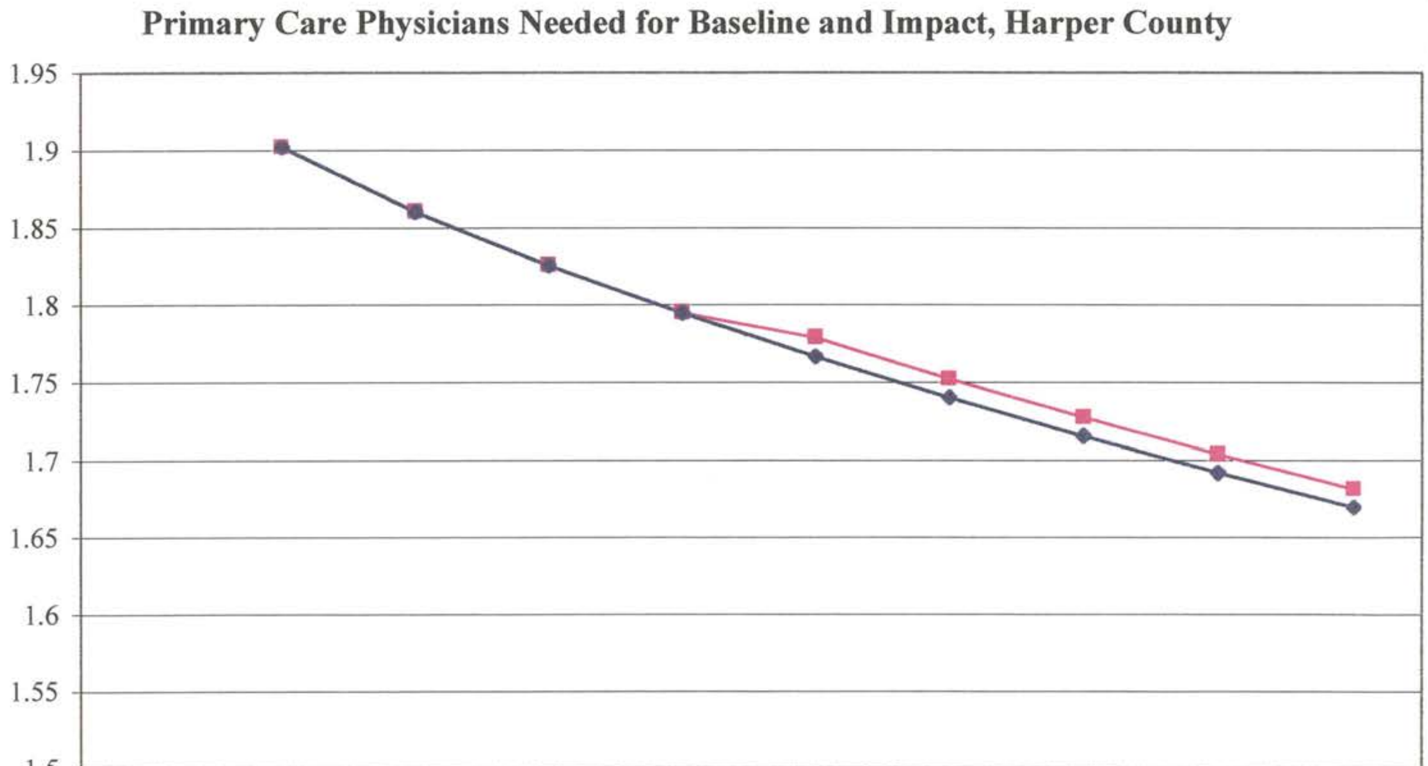
Results from Creation of 100 New Jobs in the Manufacturing Sector

Physician Visits for Baseline and Impact, Harper County



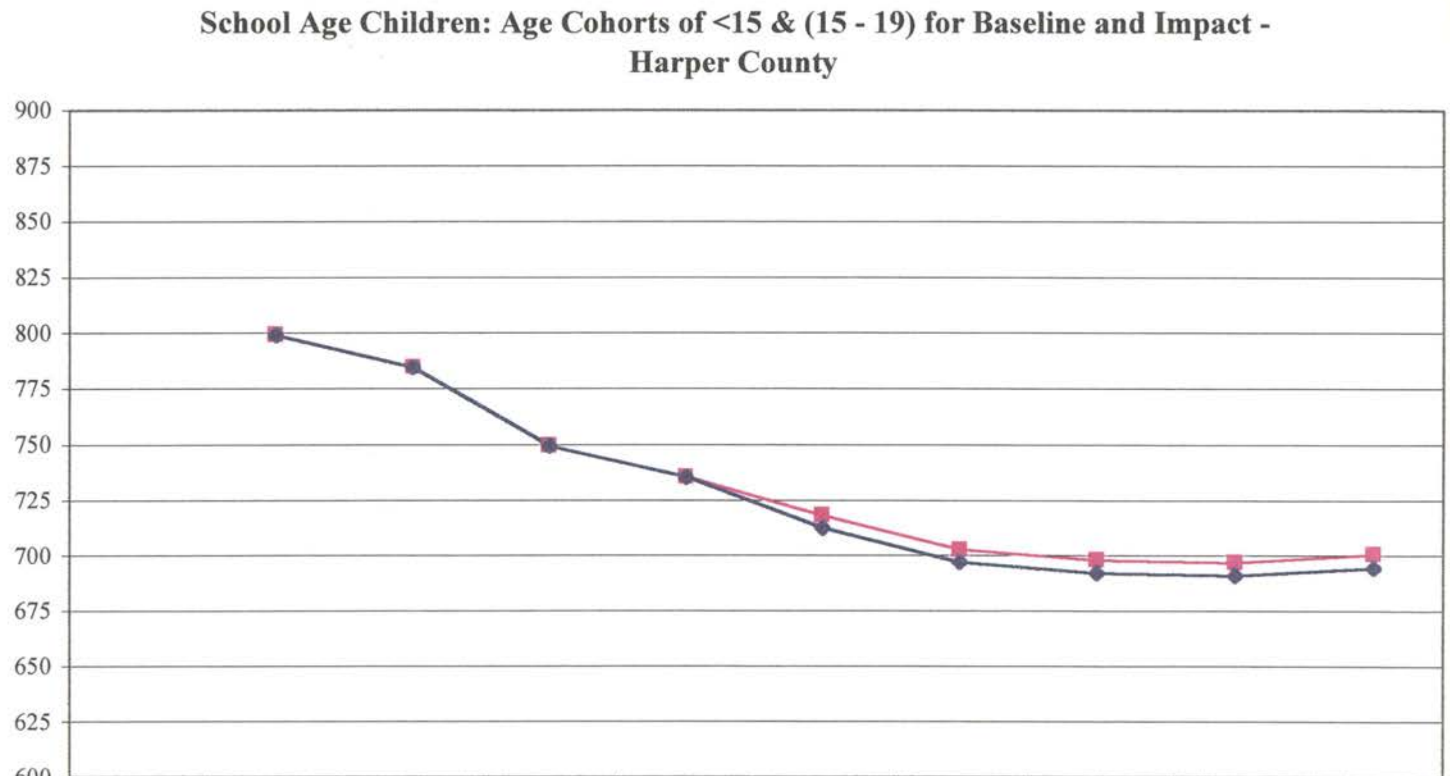
	Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
Physician Visits Impact		13,137	12,849	12,609	12,397	12,285	12,101	11,928	11,766	11,612
Physician Visits Baseline		13137	12849	12609	12397	12202	12019	11847	11685	11532
Physician Difference		0.00	0.00	0.00	0.00	83.54	82.49	81.38	80.43	80.33

Figure 16
Results from Creation of 100 New Jobs in the Manufacturing Sector



	Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
PHYS Needed Impact		1.90	1.86	1.83	1.79	1.78	1.75	1.73	1.70	1.68
PHYS Needed Baseline		1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.7
Difference		0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01

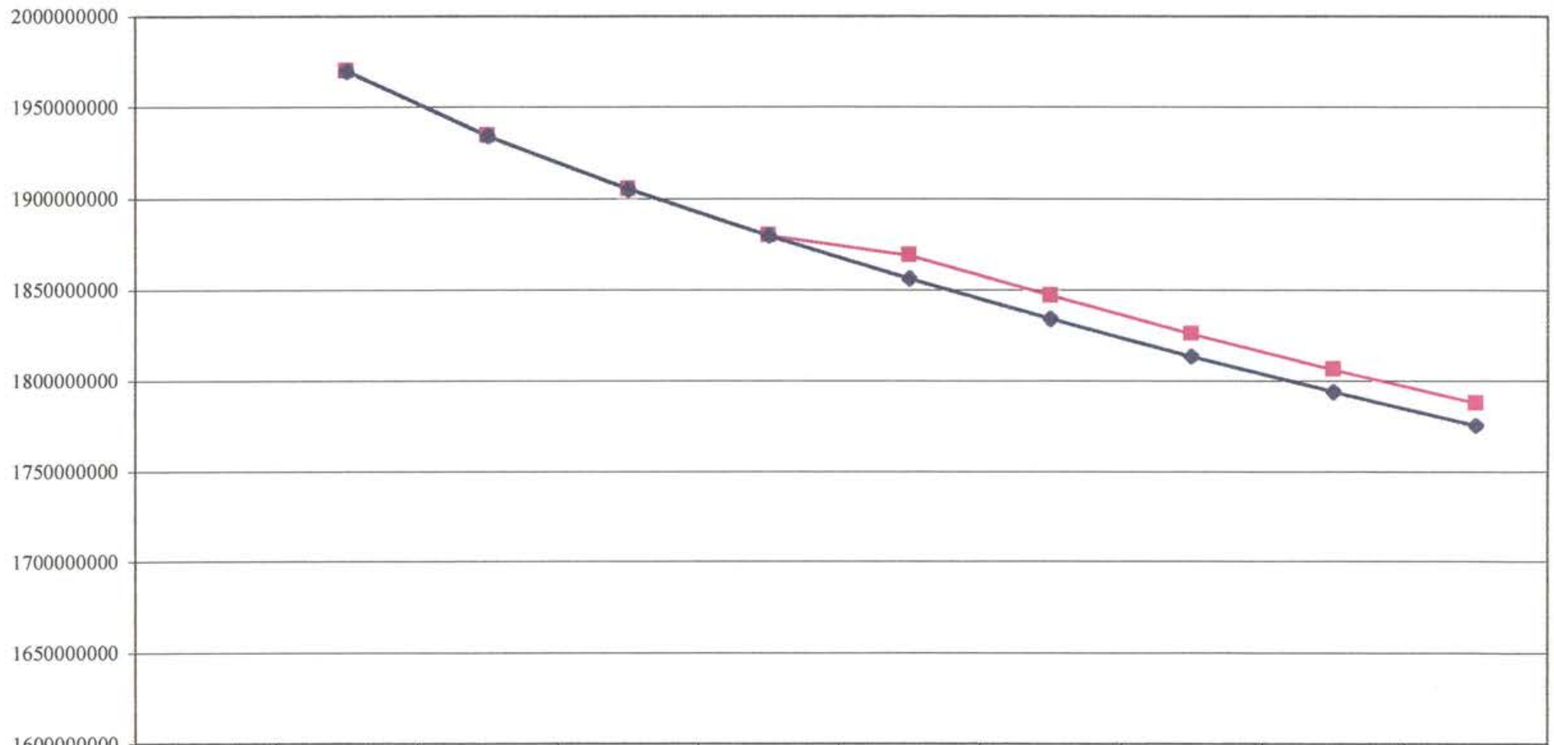
Figure 17
Results from Creation of 100 New Jobs in the Manufacturing Sector



	Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
School Children Impact		799	785	749	736	718	703	698	697	700
School Children Baseline		799	785	749	736	712	697	692	691	694
Difference		0	0	0	0	6	6	6	6	6

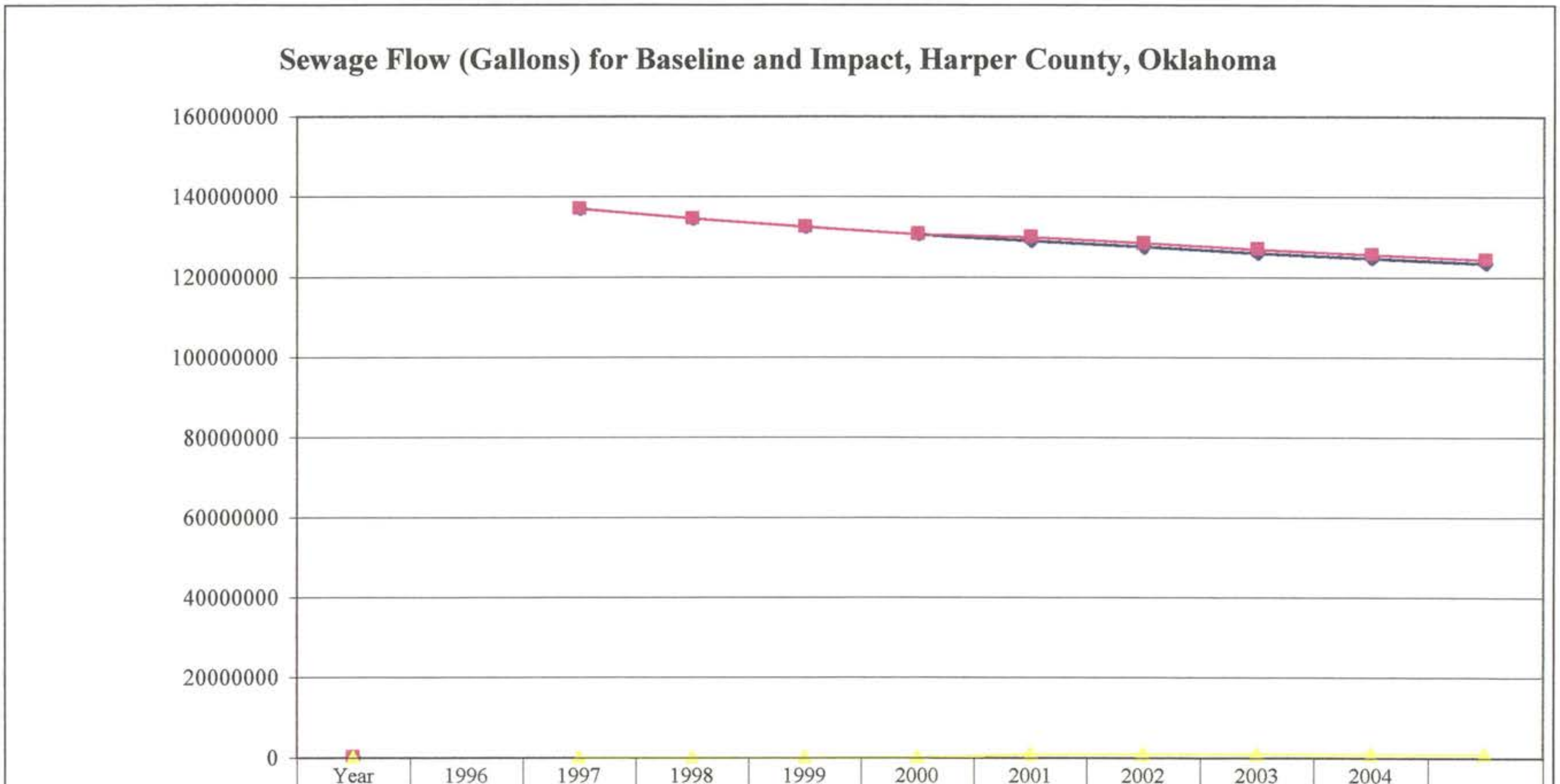
Figure 18
Results from Creation of 100 New Jobs in the Manufacturing Sector

Annual Water Use per Capita (Gallons) for Baseline and Impact, Harper County



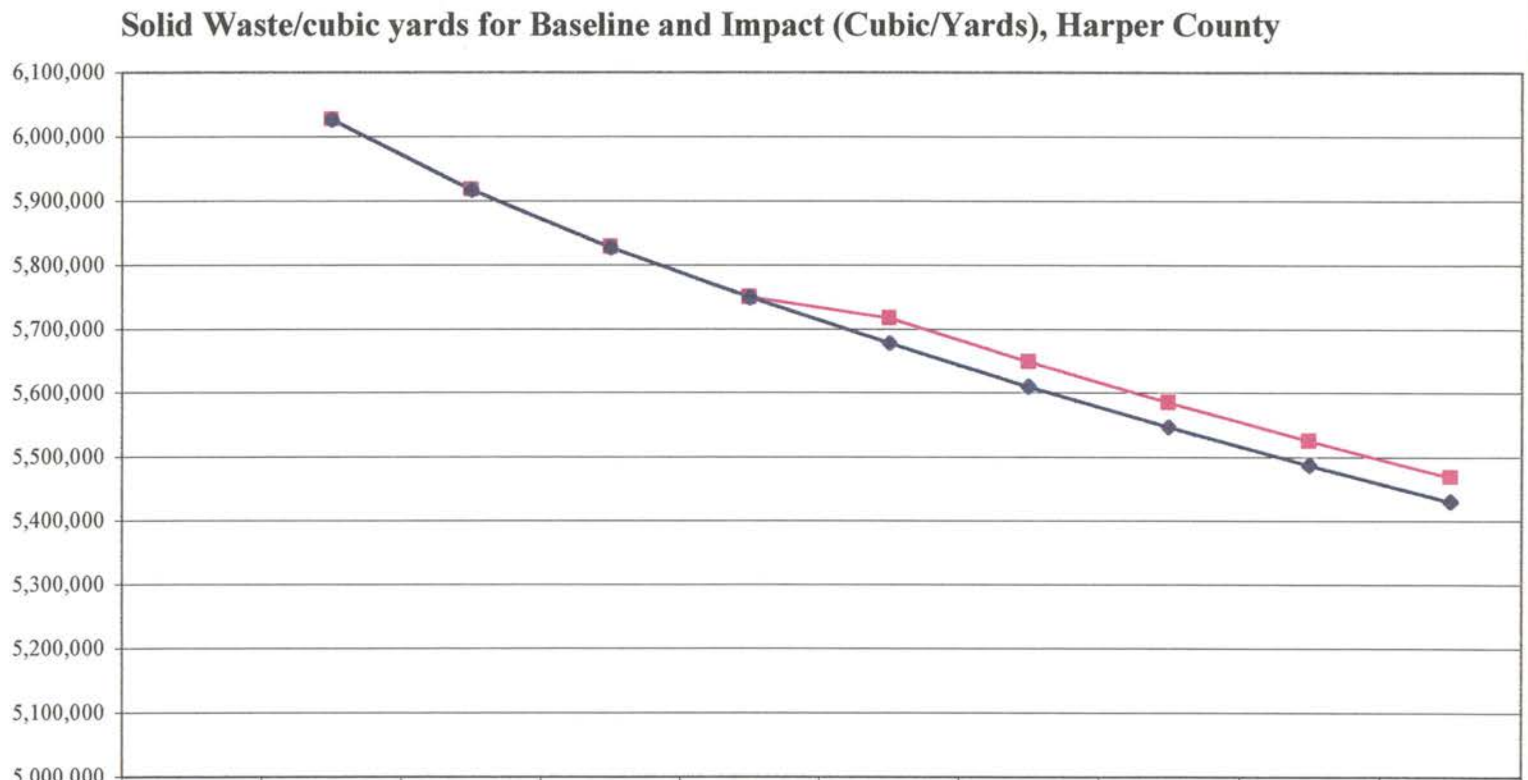
	Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total Water Impact		1,969,800,000	1,934,194,492	1,904,979,517	1,879,544,667	1,868,636,559	1,846,477,191	1,825,629,087	1,805,959,152	1,787,407,361
Total Water Baseline		1,969,800,000	1,934,194,492	1,904,979,517	1,879,544,667	1,855,971,643	1,833,930,524	1,813,211,664	1,793,648,783	1,775,076,609
Total Water Difference		0.00	0.00	0.00	0.00	12,664,915.28	12,546,666.77	12,417,422.69	12,310,368.67	12,330,752.22

Figure 19
Results from Creation of 100 New Jobs in the Manufacturing Sector



	Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	
Sewage Flow	0		136,948,000	134,472,569	132,441,433	130,673,105	129,034,219	127,501,836	126,061,382	124,701,296	123,410,088
Sewage Flow Impact	0		136,948,000	134,472,569	132,441,433	130,673,105	129,914,732	128,374,129	126,924,689	125,557,160	124,267,369
Sewage Flow Difference	0		0.00	0.00	0.00	0.00	880,513.16	872,292.07	863,306.53	855,863.73	857,280.87

Figure 20
Results from Creation of 100 New Jobs in the Manufacturing Sector



	Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
Solid Waste Impact		6,025,712.00	5,916,793.06	5,827,423.06	5,749,616.64	5,716,248.22	5,648,461.66	5,584,686.31	5,524,515.04	5,467,764.23
Solid Waste Baseline		6,025,712.00	5,916,793.06	5,827,423.06	5,749,616.64	5,677,505.64	5,610,080.80	5,546,700.82	5,486,857.04	5,430,043.87
Solid Waste Difference		0.00	0.00	0.00	0.00	38,742.58	38,380.85	37,985.49	37,658.00	37,720.36

Table 44
Impacts of Listed Scenarios on Economic Variables

Impact Results(Summary)

Strategy	Effective year 2000									
		Increase in Investment	Total Employment		Total Wage & Salary Income ($)		Production (Output) $		Local SalesTax Revenue ($)	
New Firm (Investment)	Industry	Million $	Baseline	Impact	Baseline	Impact	Baseline	Impact	Baseline	Impact
	Agriculture	15	2,278	2,444	24,962,651.12	26,782,336.24	236,292,841.62	259,428,900.00	560,762.23	601,639.72
	Mining	15	2,278	2,383	24,962,651.12	26,111,489.24	236,292,841.62	253,501,100.00	560,762.23	586,569.78
	Manufacturing	15	2,278	2,412	24,962,651.12	26,428,787.63	236,292,841.62	255,948,200.00	560,762.23	593,697.59
	Services	15	2,278	2,794	24,962,651.12	30,614,641.72	236,292,841.62	255,552,700.00	560,762.23	687,728.82
	Government	15	2,278	2,798	24,962,651.12	30,657,738.53	236,292,841.62	251,885,200.00	560,762.23	688,696.95
Exports		Increase in Exports(M$)								
	Agriculture	13	2,278	2,422	24,962,651.12	26,539,711.56	236,292,841.62	256,344,100.00	560,762.23	596,189.39
	Mining	13	2,278	2,369	24,962,651.12	25,958,310.82	236,292,841.62	251,206,600.00	560,762.23	583,128.77
	Manufacturing	13	2,278	2,394	24,962,651.12	26,233,302.77	236,292,841.62	253,327,500.00	560,762.23	589,306.21
	Services	13	2,278	2,725	24,962,651.12	29,861,042.97	236,292,841.62	252,984,700.00	560,762.23	670,799.94
	Government	13	2,278	2,729	24,962,651.12	29,898,393.54	236,292,841.62	249,806,200.00	560,762.23	671,638.99
Inmigration of Retirees		# of Retirees								
		200	2,278	2,308	24,962,651.12	25,287,396.50	236,292,841.62	237,923,300.00	560,762.23	568,057.32
Tourist Attraction		# of Tourists								
		3500	2,278	2,291	24,962,651.12	25,105,475.59	236,292,841.62	236,703,300.00	560,762.23	563,970.64
State Prison		# of Inmates								
		1000	2,278	2,726	24,962,651.12	29,868,595.13	236,292,841.62	254,025,300.00	560,762.23	670,969.59

		Increase in	Total Employment		Total Wage & Salary Income ($)		Production (Output) $		SalesTax Revenue ($)	
New Jobs	Industry	Jobs	Baseline	Desired	Baseline	Impact	Baseline	Impact	Baseline	Impact
	Agriculture	100	2,278	2,426	24,962,651.12	26,576,105.26	236,292,841.62	256,806,800.00	560,762.23	597,006.94
	Mining	100	2,278	2,407	24,962,651.12	26,371,892.55	236,292,841.62	257,401,600.00	560,762.23	592,419.49
	Manufacturing	100	2,278	2,475	24,962,651.12	27,121,498.71	236,292,841.62	265,052,700.00	560,762.23	609,258.68
	Services	100	2,278	2,394	24,962,651.12	26,228,697.01	236,292,841.62	240,607,000.00	560,762.23	589,202.74
	Government	100	2,278	2,387	24,962,651.12	26,151,026.02	236,292,841.62	239,546,400.00	560,762.23	587,457.94

Table 45
Impacts of Listed Scenarios on Community Services

Impact Results(Summary)

Strategy	Effective year 2000													
		Increase in												
New Firm		Investment	Hospital Beds		Physician Visits		School Enrollments		Water Use		Sewage Flow		Solide Waste Collection	
(Investment)	Industry	Million $	Baseline	Impact	Baseline	Impact	Baseline	Impact	Baseline	Impact	Baseline	Impact	Baseline	Impact
	Agriculture	15	2,301	2,315	12,202	12,273	712	717	1,855,971,643	1,866,780,012	129,034,219	129,785,658	5,677,505.64	5,710,569
	Mining	15	2,301	2,310	12,202	12,247	712	715	1,855,971,643	1,862,795,388	129,034,219	129,508,632	5,677,505.64	5,698,380
	Manufacturing	15	2,301	2,312	12,202	12,259	712	716	1,855,971,643	1,864,680,043	129,034,219	129,639,660	5,677,505.64	5,704,145
	Services	15	2,301	2,344	12,202	12,423	712	727	1,855,971,643	1,889,542,726	129,034,219	131,368,209	5,677,505.64	5,780,201
	Government	15	2,301	2,344	12,202	12,425	712	727	1,855,971,643	1,889,798,708	129,034,219	131,386,005	5,677,505.64	5,780,984
Exports		Increase in Exports(M$)												
	Agriculture	13	2,301	2,313	12,202	12,263	712	716	1,855,971,643	1,865,338,897	129,034,219	129,685,466	5,677,505.64	5,706,161
	Mining	13	2,301	2,309	12,202	12,241	712	715	1,855,971,643	1,861,885,555	129,034,219	129,445,377	5,677,505.64	5,695,597
	Manufacturing	13	2,301	2,311	12,202	12,251	712	716	1,855,971,643	1,863,676,897	129,034,219	129,456,360	5,677,505.64	5,701,076
	Services	13	2,301	2,338	12,202	12,393	712	725	1,855,971,643	1,885,066,582	129,034,219	131,057,010	5,677,505.64	5,766,508
	Government	13	2,301	2,339	12,202	12,395	712	725	1,855,971,643	1,885,288,433	129,034,219	131,072,434	5,677,505.64	5,767,187
Immigration of Retirees		# of Retirees												
		200	2,301	2,864	12,202	13,029	712	713	1,855,971,643	1,962,900,531	129,034,219	136,468,323	5,677,505.64	6,004,606
Tourist Attraction		# of Tourists												
		3500	2,301	2,303	12,202	12,208	712	713	1,855,971,643	1,856,977,951	129,034,219	129,104,181	5,677,505.64	5,680,584
State Prison		# of Inmates												
		1000	2,301	2,339	12,202	12,395	712	725	1,855,971,643	1,885,269,414	129,034,219	131,071,112	5,677,505.64	5,767,129
		Increase in	Hospital Beds		Physician Visits		School Enrollments		Water Use		Sewage Flow		Solide Waste Collection	
New Jobs*	Industry	Jobs	Baseline	Impact	Baseline	Impact	Baseline	Impact	Baseline	Impact	Baseline	Impact	Baseline	Impact
	Agriculture	100	2,301	2,314	12,202	12,265	712	717	1,855,971,643	1,865,555,064	129,034,219.02	129,700,494.92	5,677,505.64	5,706,821.78
	Mining	100	2,301	2,312	12,202	12,257	712	716	1,855,971,643	1,864,342,103	129,034,219.02	129,616,165.28	5,677,505.64	5,703,111.27
	Manufacturing	100	2,301	2,317	12,202	12,285	712	718	1,855,971,643	1,868,636,559	129,034,219.02	129,914,732.18	5,677,505.64	5,716,248.22
	Services	100	2,301	2,311	12,202	12,251	712	716	1,855,971,643	1,863,491,566	129,034,219.02	129,557,032.69	5,677,505.64	5,700,509.44
	Government	100	2,301	2,310	12,202	12,248	712	715	1,855,971,643	1,863,030,224	129,034,219.02	129,524,958.45	5,677,505.64	5,699,098.17

Table 46.
Employment Required
Results from Creation of 100 New Jobs in the Manufacturing Sector, Harper County, Oklahoma

	Base Year 1996	1997	1998	1999	2000	2001	2002	2003	2004
1 Agriculture	723	669	654	656	665	668	671	674	677
2 Mining	139	113.61	114.11	114.65	116.87	117.40	117.94	118.47	119.00
3 Construction	118	142.63	138.28	134.98	135.78	132.95	130.31	127.86	125.57
4 Manufacturing	19	21.66	21.53	21.56	121.59	122.10	122.60	123.09	123.58
5 TCPU	92	91.08	90.25	89.95	94.21	93.81	93.38	92.93	92.45
6 Trade	325	345.76	339.92	336.86	361.55	357.03	351.94	346.45	340.62
7 FIRE	90	94.48	92.07	90.62	92.08	90.26	88.36	86.37	84.33
8 Services	411	442.12	430.82	421.61	446.04	434.53	422.53	410.10	397.29
9 Government	455	449.07	441.00	433.75	439.89	432.45	425.01	417.58	410.18
Total	2372	**2369**	**2322**	**2300**	**2473**	**2449**	**2423**	**2397**	**2370**

CHAPTER VI

DEVELOPMENT OF OSU-CSM GAME FOR CLASSROOM USE

This chapter primarily concerns a main objective of the study: structuring the OSU-CSM Game and playing it in a classroom environment to effectively teach economic and demographic concepts to students. The first section of this chapter is devoted to describing the game and the second section explains how to play it in a classroom. The last section of this chapter is devoted to evaluating student learning from the OSU-CSModel Game and its effectiveness as a teaching tool.

Description of the OSU-CSM Game

The game is based on the OSU-CSModel, which was discussed in chapters IV and V. Despite the fact that most games developed in the last decade for experiential learning purposes such as Agland and Packer Feeder are "winner or loser" game, the OSU-CSM game is not designed in the same venue. The most important characteristic of the game is to introduce real world issues to participating students and create decision-making situations for them in order to observe the effect of their decision on the economy of a selected community. As has been noted, Microsoft Excel is used for programming and illustration of the results. Baseline projections are compared to projections following the impact for the years 1997 to 2004. The results emphasize the differences and are shown graphically for economic and demographic variables.

The required equipment for conducting the game in a classroom is as follows:

one personnel computer (PC) loaded with Windows 98 and Microsoft Excel along with a projector and LaserJet printer both connected to the PC. The projector will be used to illustrate the results in the classroom.

Game playing in a classroom using the OSU-CSM (How to play the OSU-CSM Game?)

The OSU-CSM game is conducted in two-class sessions requiring a total time of 100 minutes. The step by step approach in the first session is explained as follows:

Step 1. (Five minutes)

The game manager will introduce him/herself and the assistants to students as well as introducing the game and its objectives.

Step 2. (10 minutes)

A pre-test examination will be offered to game participants to evaluate the pre-game knowledge of the students about the community economy. The sample questions in this test are presented in Form 1.

Step 3. (Five minutes)

The game manager will divide the students into four teams each with four or five members and explain the roles and objectives of each team. Teams arrangement is as follow:

Team #1: Export-Base firms (Investors).This team represents the **Manufacturers Council**. The objective of this team is to maximize sales or exports.

Team #2: Households. This team represents the **Neighborhood Association** and provides labor to the export-based firm and purchases goods and services from it. The objective of this team is to have more employment and income opportunity bringing enhanced quality of life.

Team #3: Main Street Businesses. This team represents the **Merchant Association** and provides inputs to the export-based firm and sells goods to Households and acquires labor from them. The objective of this team is to maximize sales to the export-base firms and households.

Team #4: Local Government. This team represents **the City Manager or City Council**. This team is responsible for providing community services. The objectives of this team are collecting enough tax revenue to provide desired services and make sure any decision by other teams considers the welfare of the whole community.

Step 4. (Five minutes)

The game manager explains the roles of each team. Teams are gathered in the City Hall responding to a call from the Mayor and will play two important roles. First, each team plays the role of what actually represents the business in their community. Second, they play the role of residents who care about their community, and consider this issue in their decisions when choosing a scenario. Trams essentially need to keep in mind that their decision on choosing a change (scenario) should bring "economic growth" to the community. This means that the collective decision of teams should improve the economy of the community.

Step 5. (10 minutes)

A package containing three sets of materials will be distributed to teams for their decision making process. The first set regards the economic and demographic situation of the example county. The second set is a list of scenarios that they can choose to implement in the county. The third set contains information expressing the advantages and disadvantages of implementing each scenario. The game manager will explain these handouts.

The first set's economic and demographic materials contain the baseline projections for population, in-or out-migration, outputs, total employment required, county sales tax revenue, required hospital beds per year, and the number of school age children (see Form 3 through 9). The team members will shortly understand the economic and demographic situation of the county and can determine whether the county is performing well.

The second set includes a list of scenarios (Form 10) from which teams can choose to improve the county's economy or bring economic growth. Also, the projections of employment by sectors (Form 11) are presented to the participants.

The third set assists teams to identify the advantages and disadvantages of each scenario as presented in Forms 12-13. This information will enable the teams to choose the most favorable scenario for the county.

Step 6. (10 minutes)

The members of each team will choose a scenario that they believe is the best one to fulfil the team's objective and brings economic growth for the county after considering all social and economic issues. The teams announce their scenario selections and discuss and interact among each other to agree on one scenario for the county.

Step 7. (Five minutes)

The agreed upon scenario will be announced to the Mayor (game manager) and he/she will enter the selected scenario into the model and run it. The results, which are produced in the form of graphs (Figures 2-20) show the changes in the economic and demographic variables. These will be printed and distributed to the teams and illustrated on the white board of classroom. The game manager will discuss the causes and reasons for the changes in the economy.

Step 8.

At the end of the first session, the students will be given an opportunity to ask any questions about the procedures. The game manager will answer the questions and clarify any ambiguity. Since the steps mentioned for the first session are the basic procedure to actually play the game, careful explanation of these steps will ease the playing of the game in the second session.

The second session begins with actually playing the OSU-CSM Game for the selected Harper County Oklahoma, following the steps explained in the first session. As mentioned earlier, the game was played in a classroom for a policy course at the senior level in the Department of Agricultural Economics. The majority of enrollees is economic students. Students from other disciplines such as management, agriculture, finance, and environmental engineering enroll and participated. The diversity in majors of participants benefits the game since each student views the economic and social issues from his/her major perspective. At the beginning of session two, the game manager will assure that all teams have received all needed information. He/she also will assure the equipment is functioning properly and will supervise the game.

Form 1.
Pre-test Questions for Testing the Students Participating in the OSU-CSModel

Oklahoma State University Community Simulation Model (OSU-CSModel) as Experiential Learning

Please circle all letters that are correct answers.

1. Final demands for goods and services produced by a community are from:
   A: Households and local government of the community
   B: Inventory in that community and consumers of the other counties (Exports)
   C: Only States and Federal institutions
   D: Reinvestment in the community

2. Funding local governments have control over are:
   A: State funds
   B: Federal funds
   C: Sales and property taxes
   D: Individual and corporate income taxes

3. The element(s) that may increase or decrease the population of a community is (are):
   A: Birth and death
   B: In or out-migration
   C: Creation of new jobs or reducing the number of existing jobs
   D: All of the above

4. Locating a new firm in a community with a certain level of capital has the same effect on employment and income in the community as:
   A: Increasing exports by the same amount of investment in the new firm
   B: In-migration of retirees to the community
   C: Tourist attraction
   D: Locating a government institution in the community
   E: None of the above

5. Which of the following are considered as community services and typically provided by a local government:
   A: Water treatment and distribution
   B: Elementary and junior high schools
   C: Sewer facilities
   D: Solid Waste facilities
   E: Main street clothing store

Form 1. Continue...
Pre-test Questions for Testing the StudentsPparticipating in the OSU-CSModel

6. In general, there is a positive link between population and:
   A: Water use in a community
   B: Number of physicians required
   C: Level of agricultural production
   D: School enrollment
   E: Solid waste generation

7. Which of the following policies may lead to economic growth in a community?
   A: Increase exports
   B: More tourists coming to the community
   C: Reducing population
   D: Distribution of food stamps

8. All changes in the local economy (new firms, more tourists, expanded levels of exports) will impact the communities in approximately the same way
   A: True
   B: False

9. All residents or groups in a community will typically agree on development choices and what should be done to stimulate growth
   A: True
   B: False

Form 2.
Students Evaluation of the Model

Oklahoma State University Community Simulation Model (OSU-CSModel)
Game Evaluation – Classroom Experiment
Department of Agricultural Economics, Oklahoma State University

Location & Date

Your honest evaluation is appreciated. We are interested in your reaction to the OSU-CSModel as a realistic and as an experiential learning tool.

1. Given that this simulated community has to reflect the real world conditions to some extent, do you think is it realistic? How would you rate community realism captured by the OSU-CSModel?

Very Effective 1 2 3 4 5 6 7 Not Very Effective

2. What changes could be made to the OSU-CSModel which would improve its realism? We want to identify crucial elements of the real world which may not now be incorporated.

---

3. How would you rate the effectiveness of the OSU-CSModel as a teaching tool for educating participants about a community economy and impacts of a change on population, employment, income, in-outmigration, and community services?

Very Effective 1 2 3 4 5 6 7 Not Very Effective

4. What are the most important things that participating in the OSU-CSModel game accomplished? In other words what does the simulation teach?

---

5. What are the most important things that the OSU-CSModel game failed to accomplish? In other words, what are its limitations?

---

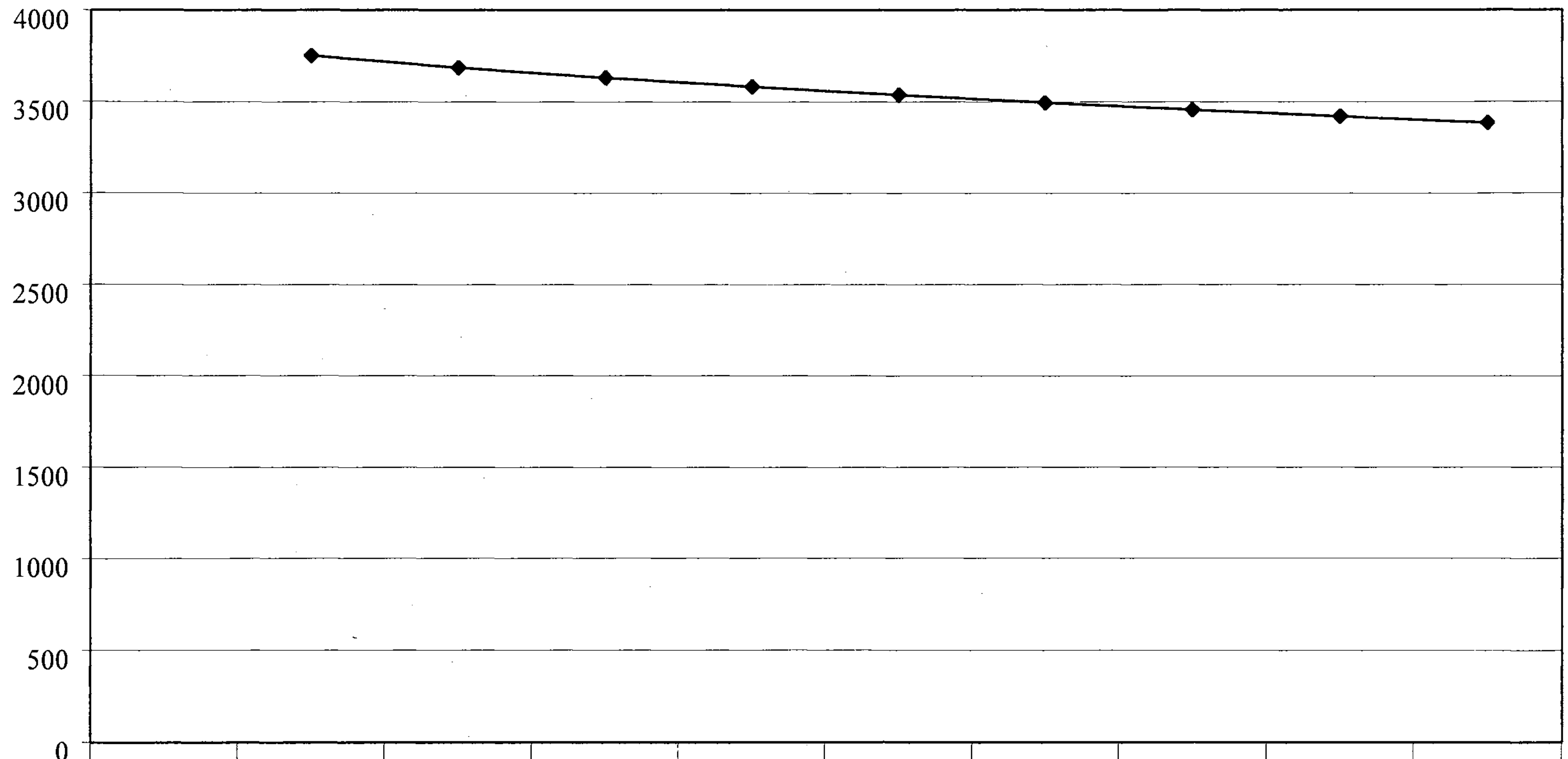
6. Would you be interested in participating in the OSU-CSModel again? YES NO

7. Please continue your comments and suggestions on the back of this page if necessary.

THANK YOU for participating in this game and completing this evaluation

Form 3.

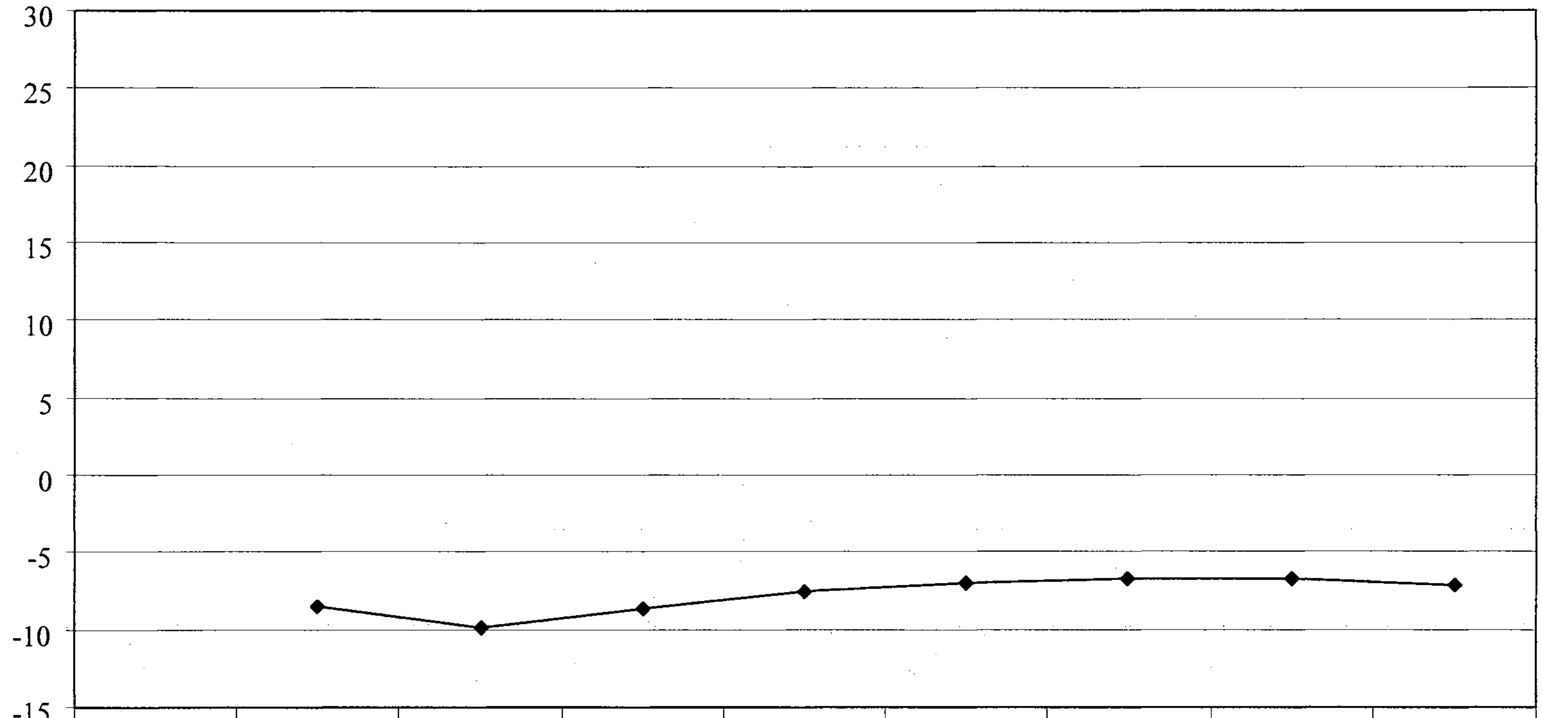
Estimated Population, Harper County



Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
	3,752	3,684	3,629	3,580	3,535	3,494	3,454	3,416	3,381

Form 4.

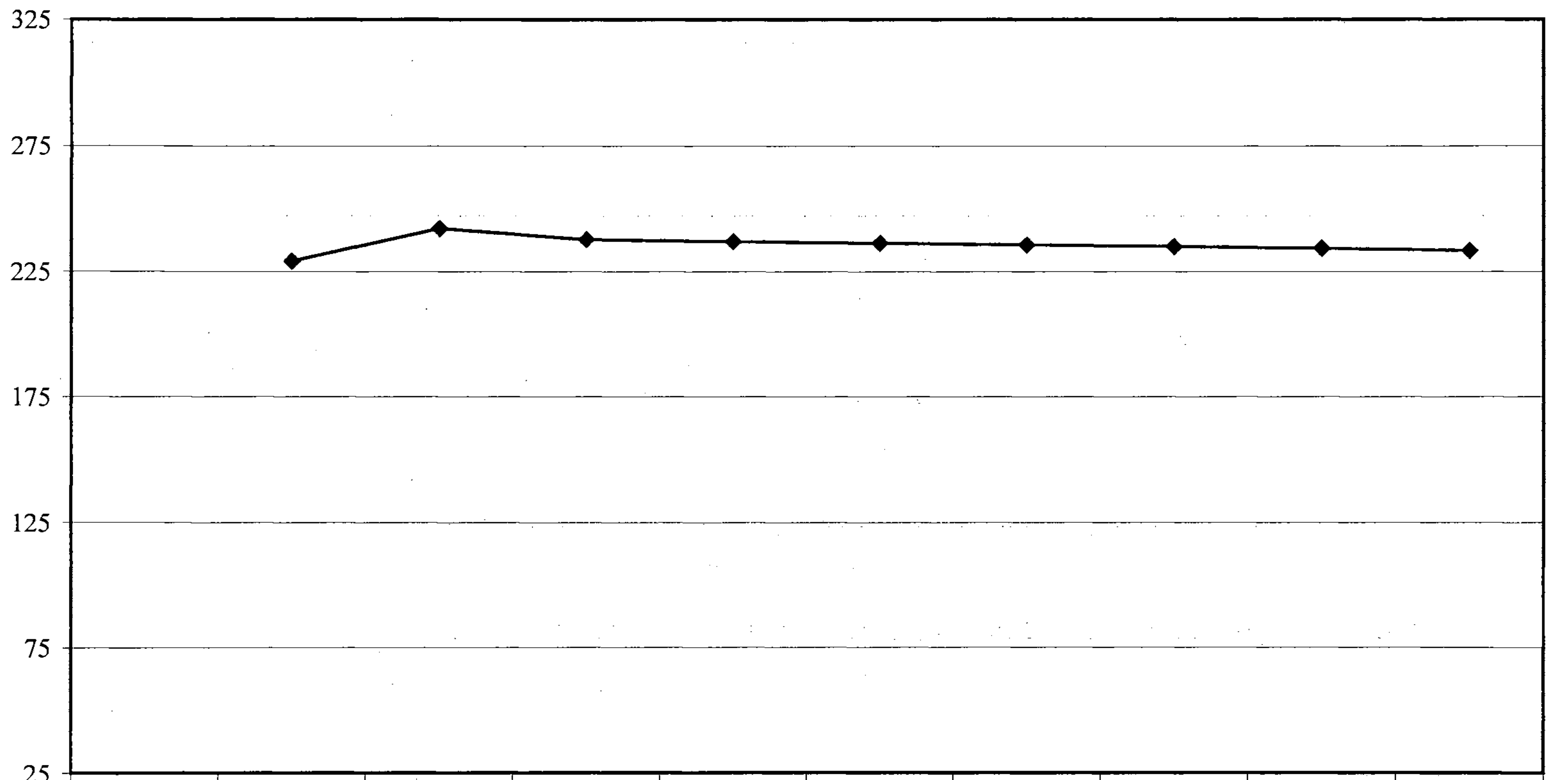
In-Outmigration for Baseline, Harper County



Year	1997	1998	1999	2000	2001	2002	2003	2004
	-8	-10	-9	-7	-7	-6	-6	-7

Form 5

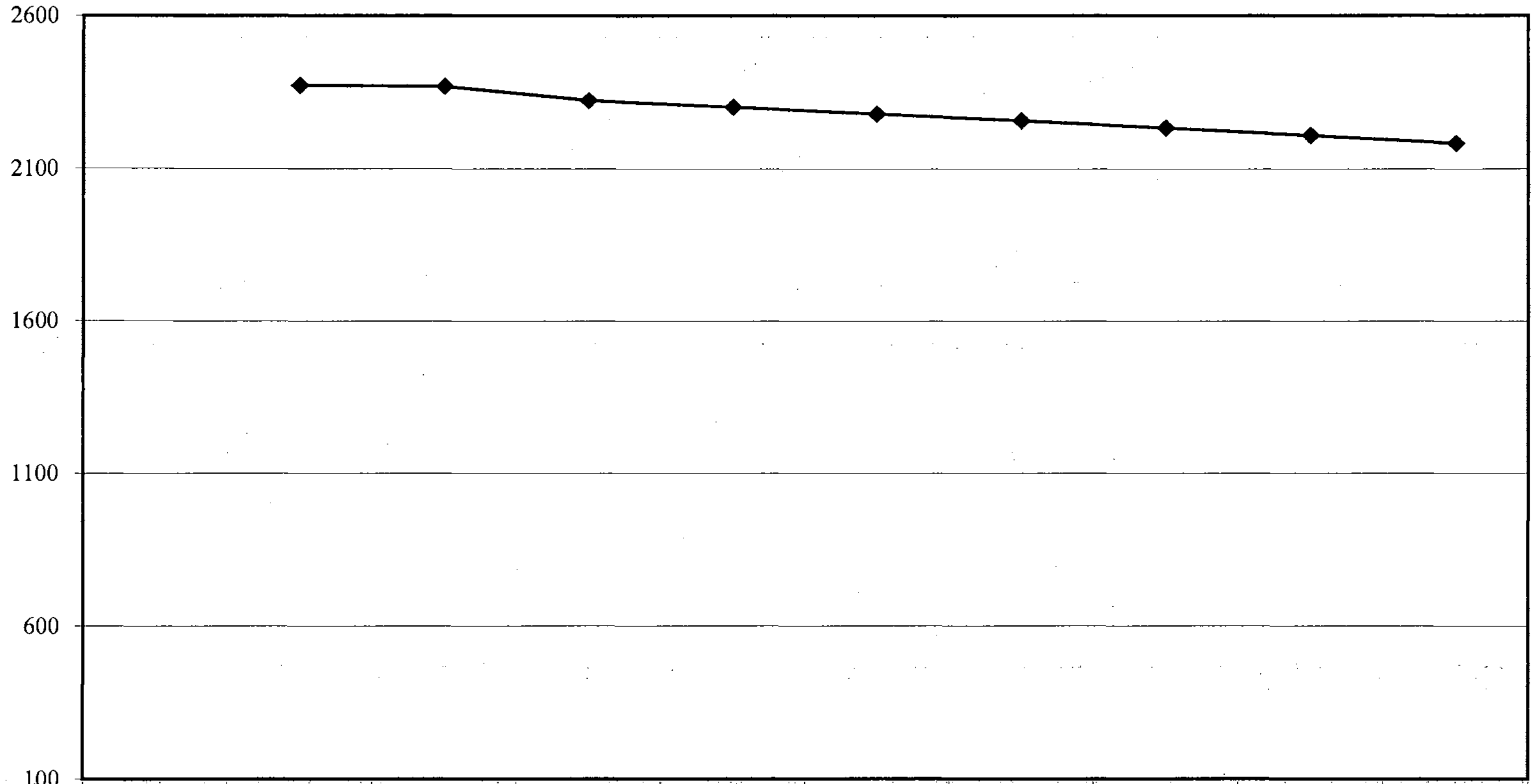
Output for Baseline ($Million), Harper County



Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
	$229.15	$242.08	$237.70	$236.93	$236.29	$235.62	$234.90	$234.13	$233.32

Form 6

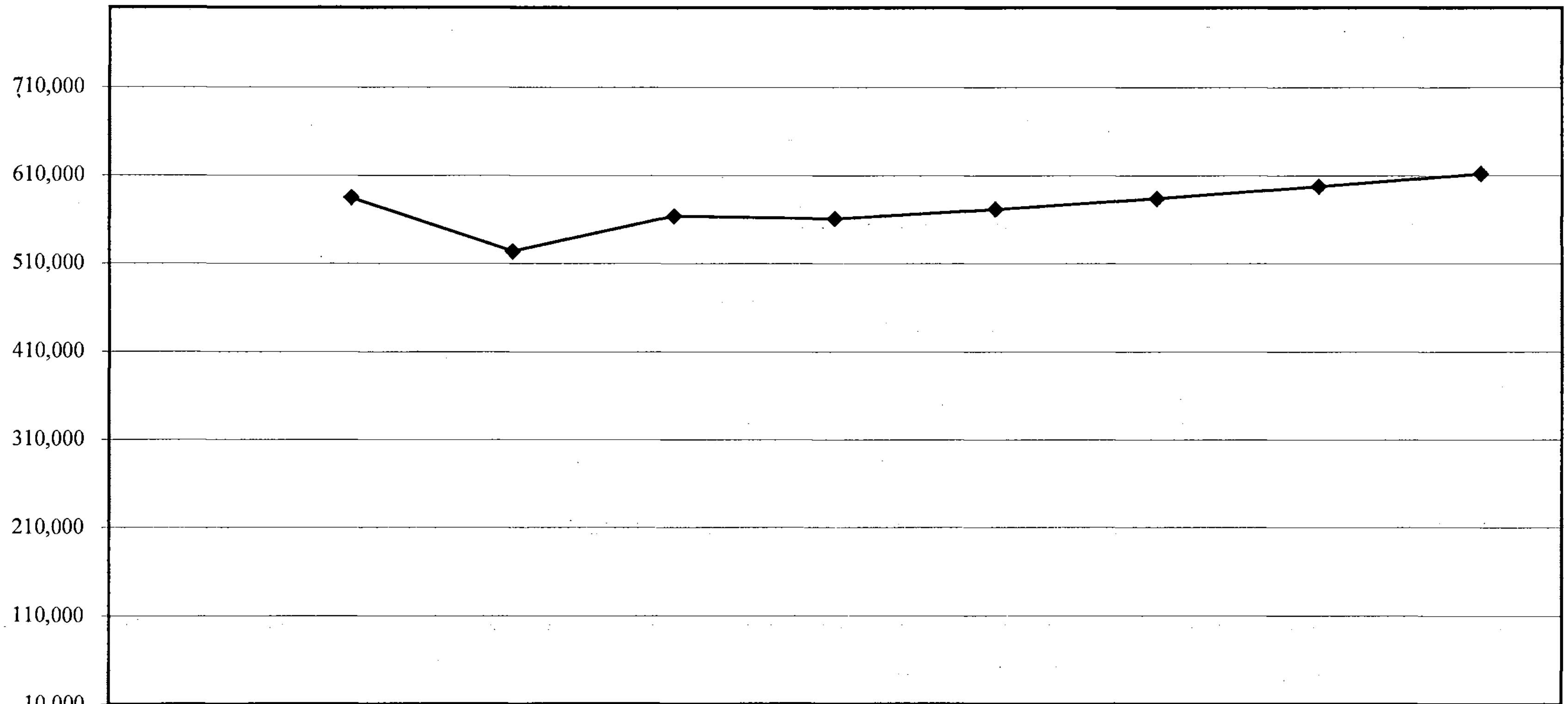
Employment Required for Baseline, Harper County



Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
	2,372	2369	2,322	2,300	2,278	2,256	2,232	2,208	2,182

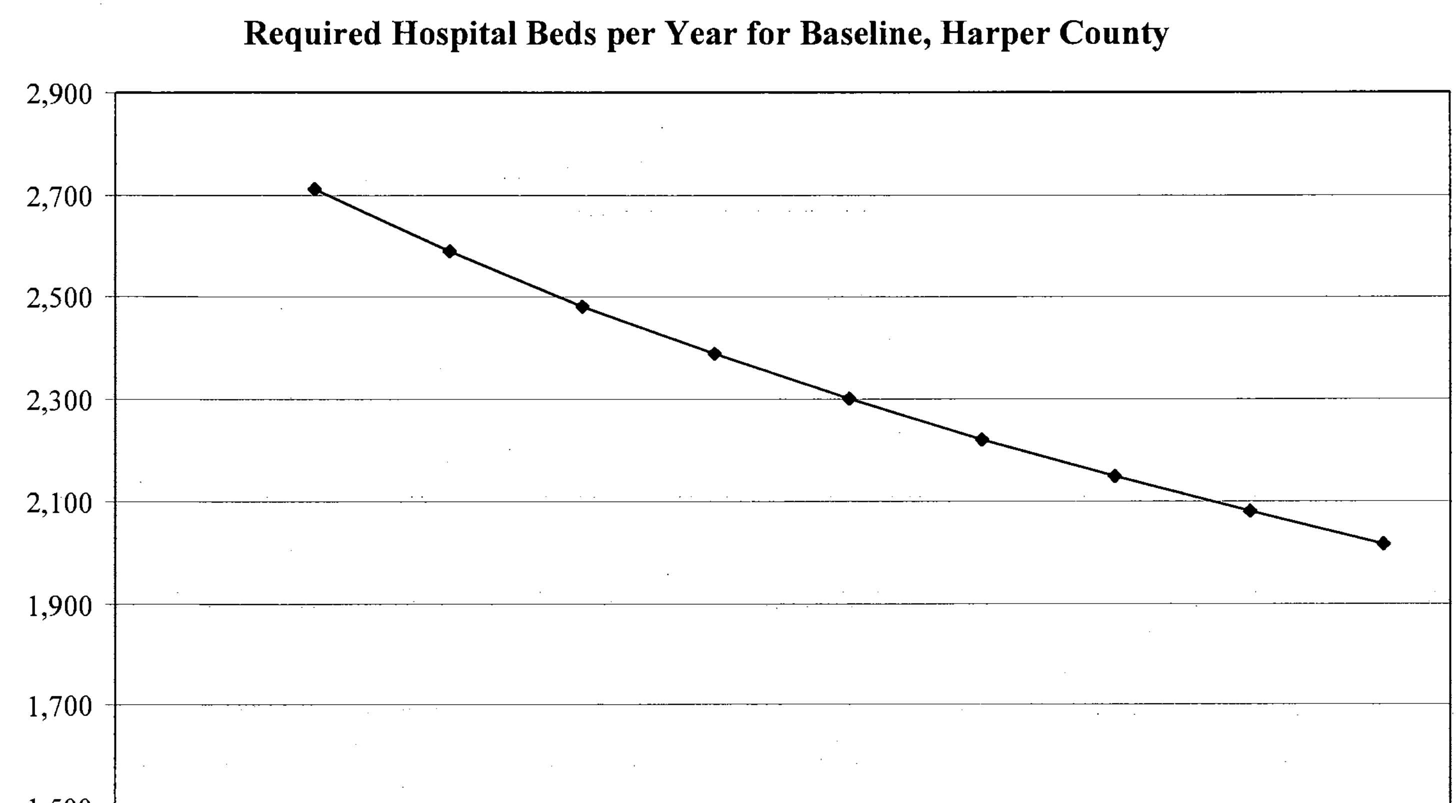
Form 7

County Sales Tax for Baseline, Harper County



Year	1997	1998	1999	2000	2001	2002	2003	2004
	$584,989.39	$523,574.95	$563,860.32	$560,762.23	$571,649.02	$583,881.95	$597,686.84	$611,934.43

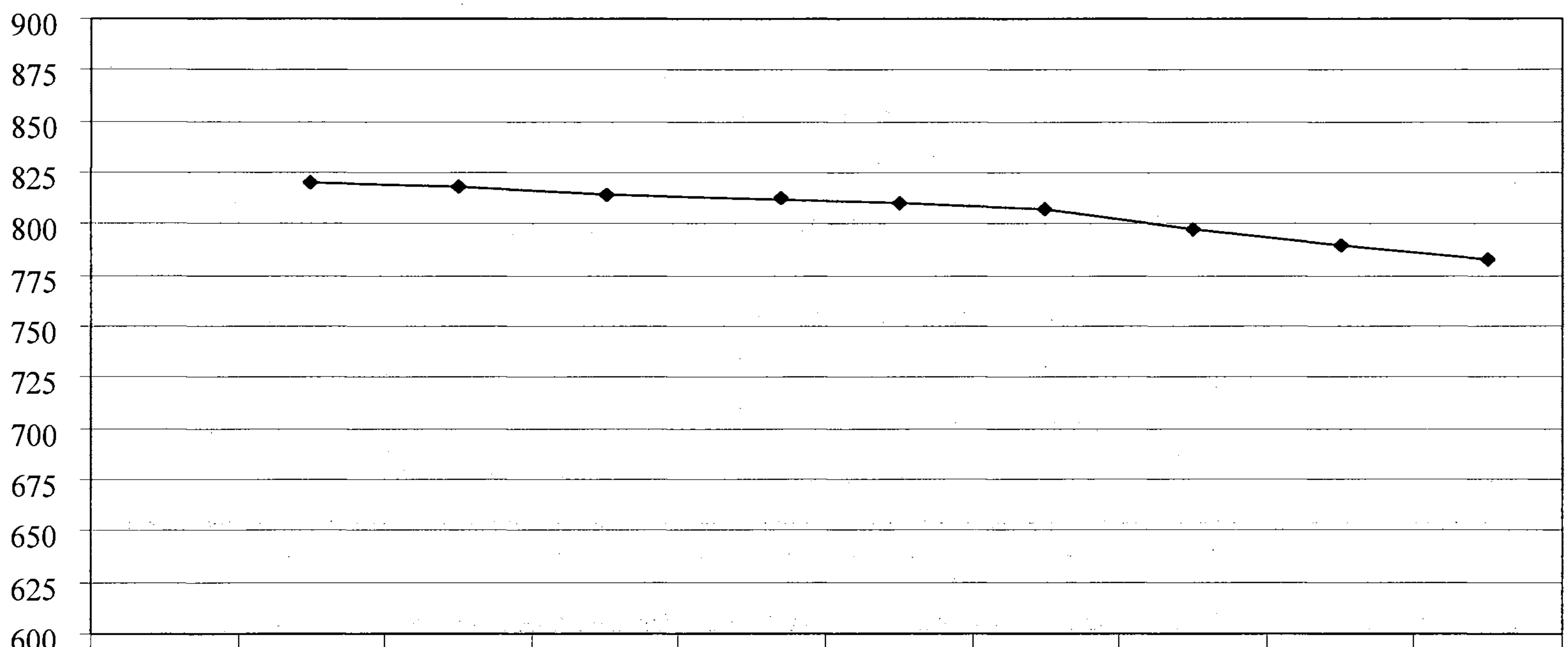
Form 8



Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
	2,713	2,590	2,483	2,388	2,301	2,221	2,147	2,079	2,015

Form 9

School Age Children: Age Cohorts of <15 & (15- 19) for Baseline, Harper County



Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
	799	785	749	736	712	697	692	691	693

Form 10.
List of Selected Scenarios

1.	Establishing a new business in a sector of the economy such as agriculture, mining, manufacturing, etc. The default dollar amount is $15 million investment in a wheat farm for Harper County
2.	Increasing exports in a sector of the economy such as agriculture, mining, manufacturing, etc. The default dollar amount is $13 million in exports of manufacturing sector for Harper County.
3.	In-migration of Retirees to the community. The default number is 200 retirees for Harper County
4.	Tourist attraction. The default number is 3500 tourists per year for Harper County
5.	Establishment of a state prison. The default number is 1000 inmates served by the new prison for Harper County
6.	Create a certain number of jobs in a certain sector of the economy. The default number is 100 new jobs for Harper County.

Form 11.
Baseline Projection of Employment Required by Sectors, Harper County, Oklahoma

		Base Year 1996	1997	1998	1999	2000	2001	2002	2003	2004
1	Agriculture	723	669	654	656	659	662	665	668	671
2	Mining	139	113.61	114.11	114.65	115.19	115.72	116.26	116.79	117.32
3	Construction	118	142.63	138.28	134.98	131.95	129.13	126.51	124.07	121.79
4	Manufacturing	19	21.66	21.53	21.56	21.59	21.61	21.62	21.62	21.61
5	TCPU	92	91.08	90.25	89.95	89.64	89.31	88.94	88.54	88.11
6	Trade	325	345.76	339.92	336.86	333.51	329.65	325.28	320.41	315.08
7	FIRE	90	94.48	92.07	90.62	89.13	87.55	85.87	84.09	82.21
8	Services	411	442.12	430.82	421.61	412.04	401.90	391.16	379.81	367.92
9	Government	455	449.07	441.00	433.75	426.53	419.31	412.07	404.82	397.56
		0								
	Total	2372	**2369**	**2322**	**2300**	**2278**	**2256**	**2232**	**2208**	**2182**

Form 12.

Economic Issues Related to Selected Scenarios

	Advantages			**Disadvantages**		
Strategy	New employment	W&S Income	Economic Diversity	Time Needed for Establishment	Costs for Community	Community Services
Locating a new firm	High	High	High	Long process	Tax subsidy	High demand
Increase in exports	Moderate	Moderate	Low	Short	None	Moderate
Inmigration of retirees	Low	Low	None	Short	None	Low
Tourist Attraction	Moderate	Moderate	High	Short	Moderate	Low
Establish a State Prison	High	Moderate	Low	Moderate	Moderate	Moderate

Form 13.
Social Values Related to Selected Scenarios

Strategy	Possible Positive Values	Possible Negative Values
Locating a new firm	Diversification- change in lifestyle, new technology	Need to make sure it bring the sustainable development. Brings up environmental issues such air and water pollutions
Increase in exports	Easier and faster to implement and costless	Depends on External demand
Inmigration of retirees	Trivial demand on schools No investment needed	High demand for medical services
Tourist Attraction	Creates new businesses such as hotels, restaurants and gas station	Needs descent roads, may create a higher crime rate, needs hospital or fast ambulance services
Establish a State Prison	More police force in the community	Increases traffic from prisoners' family in the community

As with the first session, a step by step approach will be used to complete the game.

Step 1. (10 minutes)

The Mayor starts the game by announcing that four representatives (teams) from Harper County have gathered in the City Hall to decide how to improve the economy of the county. The Mayor raises the question of "what is the best scenario to choose for Harper County?" Then he gives five minutes for each team to choose their best scenario. At this stage, the members of each team discuss and contemplate the different scenarios and announce their decisions to the Mayor. The teams chose the following scenarios:

Team 1: Locating a new dairy firm in the county with investment (capital) of $15 million,

Team 2: Creation of 100 jobs in the county by increasing the exports from the existing manufacturing sector by $13.3 million,

Team 3: Developing a tourist attraction facility such as a catfish aquarium to host 3,500 tourists per year, and

Team 4: Establishment of a state prison in the county with the capacity to serve 1,000 inmates

Each team will be given one minute to give the reasons why they chose a particular scenario.

Step 2. (10 minutes)

The Mayor asked the teams to cooperate with each other and end up with one decision. This process is very tedious since it creates conflicts of interest among and between the teams. It was observed that each team was defending its position and would like to prove that it is to best interests of the county to be implemented. A challenging and argumentative atmosphere was created. The Mayor advised team members that cooperation and compromise for sake of the welfare of the county is necessary to reach a united decision. After discussing the possibilities with each other, the teams collectively decided to choose the scenario of "creation of 100 jobs by increasing the exports of the manufacturing sector" for $13.3 million.

Step 3. (Five minutes)

The Mayor entered the decision into the computer and ran the OSU-CSModel. The impacts on the economic and demographic variables were printed, and are also shown on the board. Notice that these results are the same as those presented in Figures 2 through 20 in the previous chapter. The printed results were distributed to the teams.

Step 4. (15 minutes)

The Mayor discussed the results and causes for the impacts. This debriefing is a very important part of the game, since the main learning process from the game evolves at this stage. Referring the team members to Figures 2 through 20, the game manager (Mayor) discussed the following issues:

The impacts resulting from creation of 100 new jobs for Harper County shows, in general, that the county benefits from an increase in employment, income, production, and county-sales tax revenue. However, because of this change, Harper County faces increases in demand for community services such as hospital beds, physician visits, and educational facilities for school-age children.

The causes of demographic impacts begin with job creation. Since opportunity for employment was created in Harper County, in-migration of residents from other counties occurred. Notice that the number of immigrants (seventeen) is not equal to number of jobs created (one hundred). This is because Harper County had an unemployment rate of

3.3 percent in year 1996, prior to implementation of the change. Therefore, a fraction of created jobs has been filled by local labor, which is 90 percent of created jobs. The remaining 10 percent (10 new jobs) filled by in-migrants. Since average family size of 2.5 is assumed for Harper County, each in-migrant comes to the county with 1.5 family members. This causes a 24 - person increase in population of Harper County in 2000. The increase in population in turn caused more demand for community services, as shown on Figures 14 through 20. This indicates a simple fact that there is a positive relationship between population and demand for community services.

Next, the game manager (Mayor) discussed the causes for impacts on economic variables. As has been noted, 100 new jobs are created in the manufacturing sector by the increase in exports of the manufacturing sector. The increase in exports has boosted up production by $28.6 million. Also, it stimulates the employment in other sectors of economy (agriculture, mining, construction, transportation and pubic utilities, finance and insurance and real states, trade, services, and government) as shown in Form 11. A total of 94 employees were hired in other sectors of the economy for Harper County. It can be concluded that total employment has increased by 194 in the year 2000. Here, the concept of multipliers has been developed. This means for every 100 additional jobs in manufacturing sector there would be 94 additional jobs in other sectors. As a result of the increase in employment, total income for both wage and salary and proprietors employment has increased, which in turn has increased total tax revenue including the county sales tax.

Linkage between demographic and economic variables is emphasized again. This is important for participants in order to grasp the general picture of effects from the starting point to the end. As mentioned above, it was the increase in population due to job-seeking immigrants, which affected economic and demographic variables.

Step 5. (Five minutes).

After debriefing, students were given the opportunity to ask questions.

A few of the questions brought up by students are worth mentioning here.

(1) Why was the model set up for default dollars and numeric values for scenarios? Does the model function with any other numbers?

(2) Which scenario will result in the best economic improvement?

(3) can the OSU-CSModel be applied to any other counties in Oklahoma or counties in other States?

(4) Why do the trends in economic and demographic variables show declines even after an improvement has taken place in the county (Scenario 6 implemented)?

The game manager's response to the first question was that default values were set up for two reasons: First, to ensure ease and timelines in completing the game. Second, the numbers chosen are based on the logic that condition and capacity of the county permit reasonable numbers to be used. It facilitates processing of the game with numbers that are realistic and doable. For example, if the number of new jobs created would have been chosen as a large number, say 5000, instead of 100 for the sixth scenario, the scenario would not have been realistic or possible to implement for Harper County. In choosing the default numbers, the consideration was given to magnitude of population, and total employment of 2,278 in the year 2000. The answer to the second part of the first question is yes; the model can be simulated with any numbers.

The response to the second question is that the fifth scenario, "establishment of a state prison" will result in the greatest increase in economic variables for Harper County. However, it also requires additional community services. In addition, social preferences need to be taken into consideration for this scenario. For example, the residents of Harper County may be concerned about the traffic of prisoners' families in the county. In selecting a scenario, a combination of economic and social factors should be considered.

The answer to the third question is "yes." The game can be applied to any county in any state. The necessary data for counties are available in IMPLAN and BEA.

The answer to the fourth question is because the baseline projections are based on historical data and they had shown declining trends in the variables. Although an improvement occurred when a scenario is implemented, it occurred only in one sector of the community.

Step 6. (Five minutes)

A post-test was taken by students who participated in the game. Also, they were asked to fill out a game evaluation form (Form 2). The post-test examination contains the same questions as the pre-test examination (Form 1) in order to be consistent in evaluating students' learning from the game.

Step 7.

When the game is over, the game manager thanked the students for their participation. Benefits from participating in the game for participants are discussed in the next section

Evaluation of Students' Learning from the Model and effectiveness of OSU-CSGame.

The extent to which students learned from participating in the game can be estimated by using two methods: (1) comparing pre-test and post-test examinations and (2) evaluating the questions addressed by students while the game was playing. The game was played in two classes separately. Each classroom has 32 students. It was also played with a group of eight voluntary students.

The comparison of pre-test and post-test results revealed that participants' learning in two classroom improved about community economy. Evidence of this is the fact that the scores of 40 out of 64 students on the post-test were higher than those of the pre-test examination taken during the game.

The questions asked by participants (mentioned earlier) indicate that the game stimulated their curiosity and critical thinking as well as improving their understanding of the community economy.

Using Form 2, the effectiveness of OSU-CSGame in teaching the concepts related to community economy was assessed. Question 1 scaled from 1 (very effective) to 7 (not effective) and is related to the degree that the OSU-CSGame captured community realism. Responses to this question from the total of 64 participating students are as follows:

six students marked number 1, thirty-three students marked number 2, nineteen students marked number 3, four students marked number 4.and, two students marked number 5. Accordingly, the majority of the participants ranked the effectiveness of the game in capturing the realism of a community effective.

Question 3 on Form 2 is 1 scaled from 1 (very effective) to 7 (not effective) and is related to the effectiveness of OSU-CSGame as a teaching tool. The responses to this question from the total of 64 participating students are as follows:

Sixteen students marked number 1, thirty-five students marked number 2, nine students marked number 3, and two students marked number 5. These show that a majority of participants believe that the OSU-CSGame is an effective tool for teaching community economics. They all were interested participating in the OSU-CSGame again.

The responses on questions 2 and 5 will be discussed in the next chapter, when limitations of the model are discussed.

Frustration created in decision making within and outside the group, along with curiosity, and critical thinking were observed during the game. This is an essential part of experiential learning. The majority of students agreed that learning by playing a simulation game such as OSU-CSGame is retained longer than materials only memorized.

CHAPTER VII

SUMMARY AND EVALUATION

Summary

The primary objective of this dissertation is to develop and present the community simulation model (OSU-CSModel) as an experiential tool in a classroom environment. An additional objective is to make the simulation model useable for decision-makers in rural communities.

As a specific objective of this dissertation, the OSU-CSModel is constructed using the Excel program allowing interactive-student scenarios. The model built around a database comprised of various accounts. The accounts provide the input data for the model equations and consist of an economic account, a demographic account, community services and revenue accounts (Figure 1). The economic account contains five final demands (exports, government expenditures, capital formation, household expenditures, and inventory changes) and community- specific input-output multipliers. Final demands are projected for years 1997 to 2004 based on trends for the past eight years, and are utilized with the multipliers to project yearly output. This procedure is the driving force of the model.

The demographic account uses an age-sex cohort survival technique to project population. Yearly projections are utilized to estimate the labor force, which in turn is compared to employment requirements calculated by the economic account. Migration levels for the community are estimated by comparing labor force data with labor demanded in the community.

The community service account comprises various community services. Levels of demand are estimated for services such as hospital bed days, physician visits, physicians needed, number of school-age children, water, sewer, and solid waste collection. These are based on the economic and demographic projections of the model. Community revenue by source is also estimated for the years 1997 to 2004 based on model projections.

Harper County, Oklahoma is used as an illustrative community to present and describe model output. Baseline projections for the years 1997 to 2004 are provided for economic and demographic variables such as population, immigration, employment required, output, wage and salary income, proprietors' income, individual federal tax, state tax, and local sales tax. In addition, community service demand and revenue projections are provided for the county. Impact analyses were conducted for applications of six hypothetical scenarios in Harper County, Oklahoma. Baseline projections are compared to projections following the impact for each scenario for the years 1997 to 2004. The results emphasize the economic growth for all scenarios with different scales.

Another specific objective of this dissertation is to use the OSU-CSModel to develop a game (OSU-CSGame) to effectively teach economic and demographic concepts to students. The game was played in two classrooms in the Department of Agricultural Economics. The participants' learning from the game were evaluated by taking pre-test and post-test examinations. The post-test scores were compared to pre-test scores, with results indicating substantial improvement.

As another specific objective, the OSU-CSModel was tested for applicability by applying the model to a second county in Oklahoma, Osage County, to ensure the model is adaptable and transferable for use by other institutions and states. The results indicate that the model works properly and is usable by any county in any state.

As mentioned earlier, the final objective of OSU-CSModel is to apply the model in an extension setting for community leaders. The scenarios utilized with this study are taken from extension applications. The extension-setting application of the model is similar to that of the students setting application explained in detail. The main difference would be the type of targeted audience.

Evaluation

Three important characteristics of the OSU-CSModel should be noted when evaluating the model.

First characteristic is that the model is comprehensive in terms of containing six different scenarios for impact analysis. Each scenario has a different starting point to impact the community economy. This is the unique characteristic of the model, since the previous on community impact models do not contain various options. Therefore, this characteristic of the OSU-CSModel is valuable enough to warrant additional explanation in detail as follows:

Each scenario can be implemented into the OSU-CSModel through different final demand values. The first scenario, "establishment of a new firm" will affect the capital equation, through a $15 million expansion. The second scenario, "increase in exports" will affect the exports equation by causing an increase of $13 million. The third and fourth scenarios, "in-migration of retirees" and "tourist attraction" will both affect the household equations in a different ways. The number of in-migrating retirees will add directly to the population variable in the year of in-migration (POP_{t+1}). The number of tourists is multiplied by the average amount that a tourist may spend per day ($100) and then the calculated total amount spent by all tourists will be added to the household expenditure for the affected year 2000. The fifth scenario will affect the government equation by calculating the total expense of serving 1,000 inmates. The number of inmates is multiplied by an average expense per inmate ($10,000) to obtain the total expenses. The total expenses will be allocated to the nine sectors of the economy by using pre-calculated ratios obtained from the government expenditure account in the base year (1996). The sixth scenario can affect either the capital or export equations, depending on account in which the new jobs are created.

The inclusion of different scenarios in the OSU-CSModel is based on the concept that economic development refers to all forms of economic activity that improve the job and income situation within a community, and is not limited to attracting a manufacturing plant, for example. If a community is to make an informed judgement about economic development, it needs to have as complete a list of impacts as possible. It should be noted that the OSU-CSModel is not limited to the six scenarios mentioned above. Any change that can be quantified and incorporated in one of the final demand equations can be applied to the model. The following are examples of some possible additional scenarios:

1. Loss of an employer,
2 Local businesses established,
3 Increase or decrease the distribution of food stamps to needy people,

4. Encouraging or limiting hunting.

The second characteristic of the OSU-CSModel is that it is capable of producing a game for teaching purposes. A game (OSU-CSGame) is developed based on the OSU-CSModel and conducted in a classroom. The following are the learning concepts that resulted from playing the game:

1 Effects of different type of economic activities (scenarios) on employment, income, production, and local tax revenue.

2 Linkage within a local economy (role of multipliers)

3 Employment and income changes related to migration

4 Effect of population change on community service needs

5 Effects of population change on economic sectors

6 Difference between labor force and employment

7 Critical thinking as well as students' involvement in practical learning

8 Improved cooperation among students

9 Higher curiosity of students about economic content

10 Greater involvement of weaker students

11 Better students' performance

The third characteristic is that the OSU-CSMmodel is applicable to any county in any state with current data. This aspect of the model makes it useful for local leaders of different communities.

Reliability or accuracy is an obvious criterion in evaluating the usefulness of a simulation model. The problem associated with local models is a lack of published data.

The OSU-CSModel relies on the employment and income data from the U.S. Department of Agriculture (BEA) database. The IMPLAN data for five final demands and input output multipliers was also utilized. Preliminary census data were used to check population projections. Population projections for Harper County for 1997 to 2004 are slightly lower than the associated figures published by the U.S. Census Bureau. Employment and income projections for Harper County are close to the data provided by BEA; both total figures and sectoral values for the years 1997 to 1999

It must be noted that the model evaluation is not necessarily a static process, but rather a dynamic process. Future work with the OSU-CSModel needs to compare its results with detailed 2000 census numbers when the data are published. Data and methodology should be continually evaluated as the model is utilized. Accordingly, further refinements and improvement will be necessary.

Useful output from the model can be produced using impact analysis. By comparing the impact projections to baseline results, model users can better understand the results from implementing various possible scenarios. The scenario, which was explained in detail, was "creation of 100 new job in the manufacturing sector." It shows increases in each of population, in-migration, employment, income, and local sales tax in the Harper County. It also shows increases in demand for community services. Implementing each scenario will result in economic improvement; however, the general trends in economic and demographic variables for Harper County are downward.

Limitations

The assumptions of the input-output model were outlined in Chapter II. The most restrictive assumption in the OSU-CSModel is that the input-output multipliers are constant. This limitation implies that technology remains constant over time and no new price or material substitutions occur. The effect of this limitation is that it imposes a constraint upon the time horizon for which the projections are appropriate. However, for reasonable period of eight years the assumption is not too restrictive (Woods 1981). In addition, when future input-output data for counties are available, they can be introduced into the model.

Another limitation of the model is that industries within a sector are assumed to be homogeneous and different from other sectors' industries. In the case of Harper County, the 528 industries were aggregated to nine sectors for ease of use. The implication of this assumption is that if a new firm comes to the county, it will have the same technology as other industries within its sector.

One final limitation should be mentioned. The average growth or decline rates are used to project final demands. These rates are calculated based on short-term historical data (eight years). Therefore, the yearly value of these projections may not match with the real values when these data are published in the future. This however does not seriously detract from the usefulness of the model.

Need for Further Research

There are opportunities to expand and improve the OSU-CSModel in the future. The OSU-CSModel sector aggregation can be expanded in more sub-sectors to illustrate the impacts of each scenario in more detail. For example, the manufacturing sector can be divided into durable and non-durable goods or government expenditures can be divided into state and federal expenditures.

Further study may include the labor quality as a variable to assess the quality changes resulted from in-migration of new laborers.

Updating the database is an essential task needed for future work with a simulation model for rural development. More recent data for the base year as well as updated input-output multipliers are desirable, given economic changes due to technological advancement that have occurred in recent years. Community-specific input-output data and final demand data are necessary to provide more accurate projections.

Testing assumptions built into the OSU-CSModel is necessary for future work with the model. For example, the equations for estimating final demands are assumed to have linear relationships with their corresponding variables (equations 1 through 5). Future research may seek other relationships for estimations of final demands which may result in more accurate projections of final demands.

The rates and averages used in the model change over time and should be continually updated. Average expense for an inmate, local tax rate, capital depreciation rate, growth rates in wage and salary income, incidence rate for various disease categories by age cohorts, and average number of annual visits to a physician are changing constantly over time. The updated rates and averages will enhance accuracy of the results.

More sources of tax revenue, such as property tax, alcohol and beverage taxes, and franchise tax need to be included in the model. The relationships of community growth and revenue should be closely explored. Continual refinement is possible as more recent data and new methodologies become available.

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Appendix A

Oklahoma State University
Institutional Review Board

Protocol Expires: 10/5/01

Date : Friday, October 06, 2000 IRB Application No AG019

Proposal Title: DEVELOPMENT OF A COMMUNITY SIMULATION MODEL AS AN EXPERIENTIAL LEARNING. PHD DISSERTATION

Principal
Investigator(s) :

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Reviewed and
Processed as: Exempt

Approval Status Recommended by Reviewer(s) : Approved

Signature :

Carol Olson, Director of University Research Compliance

Friday, October 06, 2000
Date

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modifications to the research project approved by the IRB must be submitted for approval with the advisor's signature. The IRB office MUST be notified in writing when a project is complete. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

2

VITA

Massood Saffarian-Toussi

Candidate for the Degree of

Doctor of Philosophy

Thesis: DEVELOPMENT OF A COMMUNITY SIMULATION MODEL FOR CLASSROOM TEACHING

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Mashhad, Iran, September 7, 1951, the son of Reza and Seddigheh.

Education: Graduated from Fiuzat High School, Mashhad, Iran, in 1970; received Bachelor of Science Degree in Accounting from College of Accounting, Teheran, Iran, in 1974; received Master of Science Degree in Accounting from Oklahoma State University in 1993; completed requirements for the Doctor of Philosophy Degree at Oklahoma State University in December, 2000.

Professional Experience: Computer Laboratory Instructor for Management Information Course, College of Business, Oklahoma State University, 1994-97; Graduate Research Assistant, Department of Agricultural Economics, Oklahoma State University, 1998-2000.