SHORT-TERM ENROLLMENT PROJECTIONS BASED ON TRADITIONAL TIME SERIES ANALYSIS

DISSERTATION

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Short-term projections were made of student semester credit hour enrollments at two universities based on traditional time series analysis. Undergraduate, graduate, and total enrollments were projected.

Enrollment projections are vital to planning for higher education institutions. Several studies have shown that higher education enrollments are related to economic activity.

A mathematical model was developed which incorporates an economic component which is related to the predicted variable. Economic cycles used in the projection equations had high correlations with enrollment cycles that had been identified by traditional times series analysis. In selecting the appropriate economic cycles seven were correlated with lags of zero, one, two, and three periods with each of the six enrollment cycles.

Multiple linear regression equations containing trend, seasonal, and cyclical terms were developed to project enrollments for the two universities. These six explanatory equations were analyzed using coefficients of determination, Durbin-Watson statistics, and residuals from the equations.

The equations fit the data well, and no autocorrelation in the data was indicated. The residuals seemed to be randomly distributed, but consideration of summer residuals separately from those for the regular academic year made the existence of contemporaneous correlation apparent. Similar patterns were discovered in the data of another worker.

Consequently, it is recommended that summer enrollments be analyzed separately from regular academic year enrollments. Furthermore, enrollments should be analyzed by academic college or division since degree offerings that are related to job opportunities appear to influence enrollments appreciably. Other recommendations are that the technique used in this work be compared with other quantitative methods, with mixed strategies, and that analyses be made by category in special situations. Any projection should be blended with other information and subjective judgment in the planning process.

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CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

Introduction

Institutions of higher education need accurate enrollment forecasts to facilitate planning. Because enrollment influences budget, programs, policies, and personnel, adequate projections of enrollment are crucial to effective planning, budgeting, and decision making. Enrollment projections are easier in a time of rapid growth when the overall trend dominates the erratic variations which occur. Planning, too, is easier in a time of expansion. When short-term variations dominate the shallower trend increases, they become more important in the projection process. Since planning becomes more difficult and more crucial in times of limited growth, good enrollment projections become more critical.

A method of analysis which utilizes a composite of long-term trend, periodic seasonal variation, and short-term cyclical fluctuations is called traditional time series analysis or decomposition of time series. This procedure can help to identify rather stable short-term enrollment patterns and yield more realistic projections of student semester credit hour enrollments than merely looking at the trend (10, p. 11).

It has been found that higher education enrollment is related to economic activity (5, p. 6; 9, p. 14; 10, p. 7; 11, p. 327; 14). Making use of this fact in predicting enrollment improves the accuracy of the forecast. Data on economic activity abound from national, state, and local sources. The United States Department of Commerce publishes an index of coincident indicators, an economic data series which has in the past roughly coincided with business cycles. It also publishes an index of leading indicators whose cycle precedes the business cycle (1). The Texas Employment Commission publishes information on various aspects of employment in the state of Texas and in the Dallas-Fort Worth Standard Metropolitan Statistical Area (SMSA) (2, 13). These data can be correlated with credit hour enrollment (4; 9, p. 12; 10, p. 7; 11, p. 328).

The cyclical indicator with the highest correlation to the credit hour enrollment cycle can be used in a standard linear regression equation which also contains seasonal and trend terms to project student semester credit hour enrollment on a short-term basis. A method which incorporates cyclical and seasonal variations as well as long-term trend patterns allows a more nearly accurate analysis than looking at trends alone. Consideration of cyclical fluctuations is especially important at a time when the trend is moderate and the short-term variations are more pronounced. Administrators using such a method for enrollment projections will not be inclined to interpret each variation in enrollment as a lasting trend change (10, p. 2). Better decisions are possible when they are based on better information. More nearly accurate projections permit better planning by institutional leaders.

Several forecasting methods are available for use. Each has advantages and disadvantages. A method must be chosen which is appropriate for the time interval over which the projection is to be made and which fits the pattern of the data. Each method has with it certain conditions which must be satisfied and certain capabilities and limitations for projection. Once the conditions are satisfied, a model can be chosen on the basis of cost, accuracy, and ease of application. It is wise to select a straightforward, relatively unsophisticated method of forecasting which will produce acceptable accuracy (16, pp. 8-10).

A straightforward, well-known technique such as regression is more likely to be used by administrators than methods which are not well understood (16, p. 10). Regression analysis is the technique most commonly used in the analysis of change (8, p. 5). Regression permits the development of mathematical models of student enrollment patterns using the relationship between the dependent variable, enrollment, and one or more independent variables. This method has fewer limitations than most techniques (5, p. 3). Time series regression analysis has the advantage that it can be used to explain the past and to predict the future (8, p. 9).

This study focuses on the application of the method of traditional time series analysis which utilizes seasonal and cyclical data as well as long-term trend projections to predict student semester credit hour enrollment for two universities. Trend studies provide general long-term projections of enrollments; the method emphasized here uses the decomposition of time series into seasonal and cyclical components in addition to trend analysis for a more nearly accurate projection of enrollment on a short-term basis. Undergraduate and graduate as well as total credit hour enrollments are analyzed.

Statement of the Problem

The problem of this study was to make short-term projections of student semester credit hour enrollments, at each of two state universities of comparable size, based on traditional time series analysis.

Statement of Purposes

1. The first purpose of the study was to identify the cyclical component of deseasonalized enrollment data.

2. The second purpose was to determine a cyclical economic indicator having a high correlation with the cyclical component of the enrollment data. The selected

economic indicator was used in establishing explanatory equations for projecting enrollment.

3. The third purpose was to compare projected 1979-1980 academic year enrollment figures obtained from explanatory equations for each institution with actual enrollment figures of each institution for that year.

4. The fourth purpose was to compare the explanatory equations developed for the two institutions and the projections of student semester credit hour enrollments they yielded.

5. The fifth purpose was to discuss enrollment projections for each institution and the uses of enrollment projections in planning.

Definition of Terms

For the purposes of this study the following terms are defined, principally by using a synthesis of the definitions given in three publications (3, 6, 12).

Time series analysis is the study of observations taken at specified times, usually at equal intervals, over a period of time to discover patterns and to form a basis for possible forecasts.

Trend is the long-term upward or downward movement of the time series. The trend may be thought of as the core of the series, indicating its general increase or decrease over time.

Seasonal variation is the identical, or almost identical, pattern a time series follows during corresponding intervals (seasons) of successive fixed periods of a year or less. The period is the time required to complete one pattern cycle. For this study the period is one year.

Cyclical variation is the upward and downward variation about the trend, recurring with irregular periods and often having dissimilar patterns. The time interval involved is always longer than one year, and the oscillation is slower and less predictable than seasonal variation.

Decomposition of time series is the separating of a time series into its basic components: trend, seasonal, cyclical, and irregular or error terms.

Moving averages are arithmetic means of successive time series data over an interval equal to the period of the seasonal variation, placed at the middle of the range of the time covered, and moved forward by one item each time.

Seasonal indices are numbers showing relative values of a variable for each interval (season) of the period of seasonal variation. Intuitively, these numbers indicate the "seasonal effect" of the particular season on the data.

Deseasonalized (seasonally adjusted) data are the time series data derived from a given series by dividing the raw data by the appropriate seasonal index to form a new series without seasonal variation.

Economic indicators are certain economic time series which tend to lead, coincide with, or lag behind the business cycle which is a sequence of expansions and contractions in aggregate economic activity. These indicators are used to analyze current economic conditions and prospects (1, p. 1).

Serial correlation (autocorrelation) is the statistical dependence of errors on preceding errors (15, p. 136).

Standard Metropolitan Statistical Area (SMSA) is the demographic classification of cities and their economic and business-related suburbs or counties as established by the Census Bureau (7, p. 217n).

Enrollment is student semester credit hour enrollment.

Delimitations

Delimitations of this study are listed.

1. Enrollment projections were made for two universities in the North Central Texas Area.

2. The economic indicators utilized were those found in national and regional sources.

3. Analysis of enrollment data was limited to traditional time series techniques.

Limitations

The projections obtained in the study are not expected to be perfect because of the impossibility of encompassing all factors that influence university enrollments.

Basic Assumption

It is assumed that reliable short-term projections of student semester credit hour enrollments can be made based on long-term trend effects and seasonal fluctuations in enrollments and on cyclical variations in enrollments which are related to the cyclical variations in an economic indicator having a high correlation with the enrollment cycle.

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CHAPTER II

BACKGROUND, RELATED LITERATURE, AND SIGNIFICANCE

Need for Planning

Enrollment, the size of the student body for which the colleges and universities exist, is a prime concern of all institutions of higher learning especially in periods of declining numbers. It is well known that the explosive growth in higher education in the 1960s has dissipated and that higher education is experiencing the problems and perplexities associated with limited growth or even declining enrollments and decreasing public support (44).

The annual enrollment increases which were typically above 10 per cent in the 1960s shrank to around 3 per cent in the early 1970s, and by 1979 many institutions saw practically no increase. Besides the decline in the numbers of the typical college age population, the sectors of the economy which draw heavily on college graduates have experienced slowed growth (12, p. 50). The dominant finding by Minter in his ongoing study of economic trends in higher education is that the economic growth of higher education during the past decade is slowing down along with the slowing of enrollment growth (45, p. 19). The financial problems faced by higher education as a consequence of the state of the national economy are serious (8, p. 149). Factors such as these make careful planning extremely important for institutions of higher education. New strategies for management and planning are needed (34, p. 1).

The purpose of planning is to define and effect the optimum relationship between an institution and its environment (55). There has been a growing interest in planning in higher education in the years following the growth period of the 1960s. Institutional leaders began to think seriously about planning when they began to grapple with the problems of rising costs, stable or decreasing enrollments, tight money, and lowered public confidence in education (24, p. 37). Higher education has begun to investigate a number of planning techniques, most of which were developed in business management, in an effort to improve the management of colleges and universities.

Resource considerations have dominated the interest in planning (24, p. 41). With limited resources, the scope and quality of academic and support programs can only be maintained through increased efficiency (24, p. 37). Thus, university administrators seek to devise strategies and cost efficient methods to develop and maintain effective programs within existing budgetary constraints (30, p. 55). Planning for growth involves cornering more resources, but planning for stability or decline deals with reallocating existing resources. The two planning functions are different (56, p. 41).

The financial obligations of higher education institutions which were accumulated in a time when enrollments were climbing continue into the present (17, p. 40). During the growth period in which there were increasing enrollments and easy money, administrators found little incentive for prudent management of resources. Little attention was given to carefully integrated comprehensive planning with a view to long-range consequences (24, p. 36). Mistakes were easily corrected or even neglected, because of their relative insignificance during affluent times.

Problems have resulted from unplanned growth (17, p. 44). With the influx of students during the period of growth classrooms became crowded, faculty were hired and facilities were expanded. Many of the faculty have now earned tenure; they are no longer mobile because of the depressed job market in academia. The facilities require maintenance and repairs, and inflation has strained already scarce resources. Stable or declining enrollments, or even modest enrollment increases, and the attendant leveling of revenues coupled with rising inflation have caused difficulties and have magnified the problems faced by higher education. The purchasing power of higher education resources has been eroded by inflation. Likewise, inflation puts a bind on students who return to school for better career preparation or because of unemployment.

The effects and consequences of high level decisions are felt for years throughout an institution. When decisions are made on the basis of guesswork, expediency, or the personalities involved the results can be grave. Systematic planning based on institutional goals and adequate data enhances the likelihood of institutional survival and success.

Comprehensive institutional planning systems need to be developed in order to maintain and improve academic programs under severe limitations of resources that higher education is likely to experience in periods of economic uncertainty (24, p. 34). Planning does not guarantee success, but it provides information and insight that can aid decision makers. All organizations plan, but many do not plan systematically or well. Often planning and management take the form of sequential problem solving (55). The most successful planning processes are those that are developed for an individual institution. These tend to result in better implementation than the imposition of a standardized system (2, p. 47). Monitoring and control are often included in planning (33, pp. 115-116).

Resource constraints have forced attention on the need for better planning. Contemporary societal attitudes and political climate have demanded accountability. However, these stringent conditions can have certain beneficial effects if administrators exert their leadership, ignore narrow self-interest, and focus on quality. Wise, considered, informed decisions based on comprehensive plans for an institution can help to correct some of the careless decisions made in the past.

Planning is an organizational process that is concerned with the future states of an institution and how to achieve these states. It involves assessing the strengths and weaknesses, constraints and opportunities which have a potential impact on beneficial changes (48, p. 114).

It is better to begin planning in other than crisis times, but any time is better for a beginning than never (55). It is important to consider problems before they really emerge so that difficulties can be handled in a fashion that prevents the best from being eroded while the second best prospers (36, p. 31). Planning is costly in terms of time and money. There is resistance to planning in academia, but planning is essential for the vitality of an institution. Administrators need to recognize the need to plan for tough times (56, p. 43). By the time problems are apparent, it is often too late to do more than retrench (61, p. 652).

There are difficulties involved in developing a planning system for a college or university. The very magnitude and diversity of such an institution makes planning difficult. Formal, integrated, comprehensive planning is relatively new in this setting, and there is a scarcity of effective models. Although a planning system should involve all segments of an institution, a complex process is inappropriate (2, p. 45).

Planning requires the existence of values and goals, the generation of alternative courses of action, and the assessment of these alternatives followed by the implementation of the alternative selected. In order to generate and assess alternatives and predict future states of the environment forecasts are needed.

Importance of Institutional Planning

It is necessary that planning be done on an individual institution basis, for figures from national aggregate data do not give reliable projections for specific institutions. Some highly selective institutions with limited enrollments are somewhat buffered against changes in population, and their enrollments are the most stable in times of change. Other institutions experience a greater than average decrease in enrollment as the traditional college age population declines (61, p. 652). Many private colleges face an uncertain future because their heavy dependence on revenues from tuition makes them particularly vulnerable to decreases in enrollment (9, p. 4).

There is evidence that serving a specialized clientele produces viability (44, p. 171). Some special purpose institutions such as Pace University have flourished while traditional institutions have experienced at best limited growth. The increased demand for accountants, innovative academic practices, reliance on financial leaders, and skillful management of money have contributed to the success of this institution (20, p. 39). While the unique nature of Pace University precludes close imitation by traditional universities, it serves as an example of an institution which has utilized careful planning to help it remain dedicated to the fulfillment of its mission.

There is a place in higher education for unique institutions which serve special populations and fulfill unique needs, for diversity enriches society. Yet not all such schools fare as well as Pace University. Special mission, Black, and single sex institutions contribute to higher education in our nation, but they sometimes experience severe problems in times of economic distress. Careful planning is especially important for these institutions.

Each institution of higher education needs to determine its mission and strengthen the elements which contribute to its goals (17, p. 49). Quality of programs should be maintained in any event. With reduced enrollment and with attrition of faculty, new programs should be begun only when less important ones can be dropped (36, p. 30). Watered down educational programs tend to produce watered down results. Decisions dictated by political and economic concerns rather than by the findings of educational research violate higher education's aim of stimulating educational achievement (5, p. 43).

Institutions should focus on what they do well. Expediency and narrow self-interest should not be the bases for starting or for continuing programs. Realistic planning is essential, and institutions should cooperate to reduce duplication, share resources, and emphasize what each does best. Precedence should be given to the advancement of learning and the welfare of the public (16, p. 25). Ideally institutions should share ideas, efforts, and resources in order to provide maximum opportunities for their constituents through cooperative ventures based on sound research and data. Because such programs would be a threat to vested interests and institutional independence they are unlikely to be developed (17, p. 63). Both individuals and institutions could benefit from cooperative arrangements that would allow access to specializations or expensive graduate programs that a single institution might not readily provide.

Even without cooperation it is possible to enjoy its benefits through planning. For example, Wing (63, p. 234) suggests that, when enrollment forecasts are developed for an institution, forecasts should also be developed for competing institutions. This information can then be used by planners to maintain quality programs for prospective students, to seek students the institution can serve effectively, and to reorganize and respond to changes in the competition in terms of programs, costs, or services. Thus, strategies can be planned to attract students with quality educational programs that are consistent with the educational mission and strengths of the particular institution (22, p. 40). For example, if the university is in a large growing city, it could emphasize programs dealing with urban problems and focus on professional programs to meet the needs of the population (59, p. 9).

The quality and integrity of programs offered by colleges and universities should be carefully guarded. When institutions begin to compete for students and recruit intensively, administrators and faculty can resort to practices that would compromise the integrity of higher education (29, p. 4). Activities that already exist which contribute to the deterioration of educational quality are proliferation of off-campus programs of dubious quality, lowering of standards for admission and retention of students, questionable practices in the recruitment of nontraditional and foreign students, recruitment and admission of unqualified students, and lowering of academic standards along with grade inflation (54, pp. 1, 21). Some institutions have resorted to unethical and illegal practices by falsifying reports, permitting spurious enrollments, and reclassifying courses to gain advantage under enrollment-driven formula appropriations (29, p. 5).

The integrity of a college or university is not assured by any planning process. However, planning which is institution wide, which involves respected faculty members in advisory roles, which is based on reliable data and careful predictions, and which includes open communication is likely to guard the quality and integrity of programs offered by the institution.

Financial and Human Resources for Institutions of Higher Education

The presidents of well over 500 colleges and universities in the United States responded to the inquiry about what they perceived to be the most important issues currently confronting higher education. Fiscal concerns dominated the list of problems cited by the presidents of both public and private institutions. Inflation and financial concerns, enrollment considerations, program maintenance or reorganization in response to inflation, and enrollment declines were picked by both groups of presidents. Additionally, the presidents of private institutions expressed concern about endowment and fund raising and facility development and improvement, while the presidents of public institutions mentioned faculty militance and unionism. All of these matters relate to finances. Following these in importance were concerns related to planning and program considerations and to faculty improvement and renewal. These college and university presidents also believe that fiscal problems head the list of serious challenges for higher education in the next ten years (19, pp. 586-587).

Because enrollments are intimately related to finances through tuition or legislative appropriations or both, limited enrollment growth means financial pressures on higher education institutions. This emphasizes the need for planning based on reliable data as well as on some degree of insight on the part of institutional leaders. Key state administrators and legislators will listen more carefully to a university president arguing for funds for the next biennium if he has demonstrated that his enrollment predictions are sound.

Economic pressures will be felt throughout all sectors of higher education, but planning will be especially challenging for one highly troubled group, those former teachers' colleges which began to develop into comprehensive universities in the 1960s (9, pp. 4-5). These regional universities have been stranded in a state of semi-development, and they need to develop very clear and distinct missions if they are not to suffer enrollment losses in the 1980s (59, p. 9). One of the institutions in this study fits that category exactly; the other was a state college, although not a teachers' college. Both institutions examined in this study receive funding based on enrollment-driven formulas. There are problems in periods of reduced growth when a university's revenue is tied to formula funding (29, p. 4; 47, p. 543).

As enrollments decline, formulas generate proportionately less funds. Such reductions prevent the development of new programs and ignore the needs of existing programs because they focus on meeting current fiscal needs with little regard for the future (47, p. 553). These formulas have an adverse effect on state appropriations for higher education in periods of stability or declining enrollments. Because required courses and key electives must not be discontinued even though fewer students enroll, because a certain minimum staff must be maintained to run the institution, and because the maintenance of specializations within academic areas prevents the reduction of faculty in proportion to the decline in enrollment, linear formula relationships work to the detriment of institutions with declining enrollments. Also, when reductions are made in the instructional staff, the lowest paid people are terminated as a result of tenure policies. This means that the reductions in costs do not match reductions in funding (29, p. 4). Enrollment-driven formulas are incapable of objectively measuring the level of an institution's instructional activities (47, pp. 549-550). The severity of the funding problem is compounded in periods of inflation because of the increased costs of equipment, supplies, maintenance of facilities, and energy as well as wages and salaries for staff and faculty.

Alternatives to enrollment-driven funding are being investigated in some states (35, p. 46). Formula funding is under study in committees of the Coordinating Board of the Texas College and University System. Three formula advisory committees have met several times in an effort to make substantial formula revisions and sound recommendations. Two new committees are to be activated, one on enrollment changes to study how sharp changes in enrollment affect university funding and one on funding for quality to consider what incentives for excellence are available within formula funding (58, p. 12). The Texas Legislature and its leadership want to preserve formula funding in a healthy condition since it is seen as the only logical and practical way to budget for large numbers of similar entities (59, pp. 125-126). As long as formula funding is the procedure to use, the emphasis must be placed on the need for better planning.

Even if a procedure other than formula funding were developed, it is unlikely that the procedure would ignore enrollments. Students are essential for institutional viability, and data about this important aspect will always have an impact on administrative decision making in higher education (15, p. 91).

The expected increase in the average age of the general population could cause a shift in public support from youth-oriented programs to support for services for older segments of the population. Higher education will then be in a less favorable position to compete with other services for scarce public funds (35, pp. 44-45). Public policy decisions such as those dealing with financial aid to students, appropriations in support of basic research, and allocation of funds to various service agencies supported by taxation affect higher education institutions. For example, certain policy changes or proposed changes would be favorable to national defense, big business, and the petroleum industry and be detrimental to environmental protection, development of alternate energy sources, education, and minorities, women, elderly, and handicapped.

There is no model for predicting or understanding the response of higher education to the decline in graduate enrollment and reduced federal funding. The labor market for new doctoral graduates has sharply declined; there have been changes in research funding and a decline in federal support for graduate students. Higher education, which has historically provided employment for new doctoral degree holders, does not continue to do so because of declining undergraduate enrollment (10, pp. 77-84).

Not only has federal support for graduate education declined, but privately funded fellowships have almost disappeared. The combination of poor job prospects and accelerating costs is certain to have a major impact on students who might go to graduate school. From a long-term perspective, the quality of teaching and research could diminish without the replenishment by talented students of new perspectives and new ideas (7).

There will likely be continuing difficulties in financing graduate education and many academic departments will probably face a shortage of graduate students (9, p. 4). Graduate enrollment in science and engineering is more sensitive to the labor market than graduate enrollment in the humanities and the social sciences (10, p. 84). The demand for scientists and engineers is specifically affected by the amount of emphasis on national defense and on space exploration.

Many political, social, and economic factors affect both graduate and undergraduate enrollments in higher education. The decrease in the traditional college age population is a reality. Further growth must come from attracting new categories of students (44, p. 164). Alternative plans can be considered when the data and enrollment projections indicate slowed growth or shifts in the composition of the student body. Some of the expected decline in the eighteen to twenty-four year olds can be offset with an increase in nontraditional students: women, older students, minorities, and immigrants. Jack Magarrell suggests twelve ways this might be done (42, p. 11). Carol Frances mentions essentially the same twelve strategies for offsetting the expected decline in traditional college age students by attracting additional sources of students (22, pp. 42-43).

Some shifts in enrollment patterns have already begun. In the 1977-1978 academic year the number of college women surpassed the number of college men in the United States. This was due to the upsurge in female enrollments and the decline in the percentage of white males attending college (27, p. 64). With increased life expectancy, increased attention to the idea of learning as a lifetime activity, and the need to update one's credentials for certain occupations have come increases in the numbers of older students enrolled in colleges and universities. Recent years have seen increased opportunities for minorities and international students.

Community colleges have experienced shifts in curriculum, with the number of students in transfer programs declining while well over half of the students enroll in occupational programs. These institutions also have experienced a shift of emphasis to nontraditional students (14, pp. 24-25).

The sources of revenue for colleges and universities, as well as costs to these institutions, have been seriously affected by inflationary trends. In adjusting to economic realities institutions encounter the possibility of causing a decline in the quality of education offered and of research undertaken (8). There is a danger that institutions will relax standards and ease requirements in order to attract students. Attempts to economize using such techniques as deferred maintenance of facilities, limited equipment and material acquisitions, and reductions in faculty and staff can damage program quality. Hard times can inhibit innovation (19, pp. 587-588). Depressed conditions in higher education cause decay of faculty morale which undermines creative teaching and research. In a declining state animosity and mutual suspicion between faculty and administration is likely to intensify (44, p. 168). Poor faculty morale produces an atmosphere which is scholastically counterproductive, and innovation is discouraged at a time when it is badly needed (65, p. 49). Comprehensive and creative planning is needed in this area to insure the quality of higher education in the future (11, p. 21). Faculty development, broadly conceived, should be an integral part of academic planning and curricular development (25, p. 5).

Academic effectiveness also can be seriously weakened by spreading resources too thin (35, p. 46). In order to make the very best use of resources planning is essential. The administrative decision process must be oriented to resource planning if it is to be useful (52, p. 31).

A study of trends and effects of declining enrollments in public schools showed that electives were the first elements to be cut in a time of financial hardship. Courses with low enrollments were cut, without regard to whether this was educationally sound. This action tended to reduce the options available to students and restrict the ability to accommodate individual differences and offer high quality educational opportunities (26, p. 656).

To counteract the ill effects of such reductions innovation in the form of individual instruction, cooperative efforts among schools, and use of video tapes was recommended to give curricular diversity. Imagination, foresight, and courage developed through participatory planning would allow educators to anticipate rather than react to enrollment declines. Thus corrective programs could be developed before a crisis occurs. It has been suggested that a more systematic approach to the planning of resource allocations and curriculum modifications is needed (26, pp. 566-567). Adherence to an institution's mission and goals, attention to the quality of academic programs offered, and efforts to maintain faculty vitality in times of financial constraints can minimize the effects of limited growth in enrollments and of spiraling inflation.

Need for Analytical Procedures and Data Collection

The planning and budgeting process does not dictate decisions, rather it provides a rational basis on which managers can make decisions (55). Sound, formal planning relies on statistical and analytical procedures. Although these are essential, the planning process does not end there. If planning is to contribute to the vigor of an institution, the information obtained through analytical procedures will be utilized in formulating the policies and strategies for the future (55).

Planning relies on data collection and analysis. There must be a data base which contains the needed information, and this information should be easy to obtain and to use.

The analysis of the data and the forecasting models ought to be as comprehensive as possible, consistent with the costs involved. The benefits accrued from appropriate analyses and projections are evident in administrative decisions which contribute to the ultimate vitality of the institution.

A method for projecting enrollment that approaches the ideal would use readily available data and adequate mathematical techniques that are easy to apply. Elaborate, complex models have tended to be cast aside after a brief period. In order for a model to be used it must provide concise, relevant information for the decision maker (1, p. B148; 53, p. 903). Mathematical approaches have been most successful when applied to small segments of a system which administrators understand and with which they feel comfortable (46, p. 133). A well-known and relatively simple technique such as linear regression is likely to be used by administrators because it is a familiar as well as an appropriate technique. Cost, accuracy, and availability of data are also important considerations when choosing a suitable model for the data to be analyzed and for the appropriate time span for which the forecast is to be made (62, pp. 8-10).

Mathematical models have been accepted as having a place in educational planning. They have been used to explain and to predict both on a classroom or institutional level and on a system level (12, p. 177). Educators need at least a general knowledge of modeling and systems analysis; otherwise they are at a disadvantage and find themselves professionally limited. Because of the proliferation of computer-based techniques and other quantitative analyses, today's college president needs to learn how these instruments can be used to provide objective bases for effective leadership (18, p. 38). Managers often feel threatened by mathematical and technical models (31, p. B149), but leaders must deal with numbers (16, p. 24). Increased complexities of life have increased the need for analytical methods (32, p. 7). The significance of the analytical approach to education is that it forces the individual manager to define the problem precisely, note the alternatives available and their total costs, and choose the most efficient alternative according to its performance criteria (6, p. 211).

Top level decisions are based on information provided by other personnel (30, p. 57). If this information is to be used it must be communicated to the manager in understandable, non-technical language (13, pp. 191-192). It has been suggested that mathematical models be used to produce some output variable with which administrators feel comfortable, without being overly concerned with validity or cause and effect. The data should be useful in a broad sense, and the model can be improved later through interaction between the analyst and the decision maker (46, pp. 133-134).

Estimation or projection and decision making are logically different activities (37, p. 93n). Quantitative analysis is not a substitute for judgment, but it sharpens intuition and judgment (40, p. 220). Predictions and forecasts can be quantitative or intuitive, but quantitative models outperform judgmental forecasts (33, p. 126). Neither procedure is sufficient alone. Subjective judgment is a useful complement to other forecasting procedures (63, p. 223). Human intuition and judgment are essential since a model cannot account for all aspects of planning (38, p. 193).

Mathematical models are limited in several ways. In projection it must be assumed that the current patterns will extend into the future. Models serve the predictive function well only when the future is similar to the past (60, p. 135). The range of error in projections increases as the projection period is lengthened (41, p. 5). Simple models are sometimes used for complex situations, for a realistic model may be prohibitively intricate (38, p. 192). It has been found that simple forecasting models are often at least as accurate as sophisticated ones. Added complexity does not tend to increase the accuracy of prediction (33, pp. 126, 130).

Institutions must develop their own projections, using their best assessment of the context within which they are operating (21, p. 411). Projections made by national and state agencies are not uniformly applicable since population trends and migration patterns affect different regions and institutions in various ways. Besides having greater reliability the institution's own forecast can serve as a catalyst for worthwhile changes (12, p. 51).

An adequate data base and a good information system are essential to planning (56, p. 42). As the need for planning continues, pressures for improved data and projections will continue (21, p. 411). One of the problems that institutions encounter in the development of a planning system is inadequate information (24, p. 45).

Short-term projections of enrollment which are used and revised rather than believed as prophecy contribute to the effective management of higher education institutions. They serve as instruments for detecting changes and improving estimations of enrollment and revenues. Administrators can use this information to plan and to make adjustments that enhance the institution's effectiveness and efficiency in serving the students and the community.

Importance of Enrollment Projections

Planning can make difficult times less traumatic and can help preserve the best instead of allowing inferior programs and policies to prosper. Problems can be considered and strategies for solution planned before they emerge (36, p. 31).

Enrollment projections can contribute importantly to the survival of some institutions and to the evenness in the quality of programs in all institutions whether threatened with extinction or not. The prediction of a downturn in enrollment signals the need to set lower limits in the funding of programs which have achieved high quality and to choose carefully where the paring needed to support these lower limits should be carried out. Key faculty can be retained and program momentum sustained until the next enrollment increase. In fact, the prediction of a downturn might well lessen its severity if it is possible to redistribute budget allocations to effect greater activity in recruiting students.

On the other hand, a prediction of increased enrollment and the steepness of that increase can be used to plan judicious expansion of faculty, staff, and programs. Enrollment projection of good quality adds to the stock of reliable information needed for sound decisions, whether they relate to expansion or contraction. Poor enrollment projections could, of course, have grave consequences leading to diminution of quality of programs, faculty, staff, and services and to gross operational inefficiencies.

Careful consideration should be given to the kind of information that is required for planning. Projections are a part of the needed information. For example, Haas suggests that an enrollment forecast be included when a planning council presents to the various units of the university its request for planning documents (55). Reliable forecasts are critical to the planning process (3, p. 95). Enrollment forecasts are useful to the units involved in planning because they indicate the number of students the institution can expect and, closely related to enrollment, the resources which will be available.

Any planning process must include data and information upon which to base decisions (55). The need for planning created a need for reliable information upon which plans could be based and decisions could be made. Because there are many facets of planning many problems surfaced as institutional planning developed. According to Freeman, one of the problems associated with institutional planning is the difficulty of obtaining reliable projections of enrollments and revenues (24, p. 45). Enrollment predictions, because of their bearing on administrative decisions, have never been more critical (43, p. 1; 57, p. 40). Information on future enrollments becomes more important every year. As enrollments level off the consequences of missed enrollment projections and bad planning are much more serious than in periods of rapid growth (21, p. 405).

Enrollment is but one component of a complex set of factors affecting colleges and universities. It is, however, an important factor to consider because an institution's resources are usually very closely related to enrollments. Those who plan for the future of higher education institutions must be acutely aware of enrollment since information about this important factor affects planning of faculty assignments, development of adequate funding, course scheduling, utilization of facilities, recruitment and admissions activities, and overall institutional programs (15, p. 91). Student enrollments are monitored and projected so that academic planning can be effective (57, p. 21). These enrollment data form a basis for decisions to withhold or dispense temporary funding or permanent support so that flexibility is maintained and resources are conserved for important projects (61, p. 655).

Useful enrollment projections yield information related to financial resources that an institution can expect to have available in the short term. This information can be used to facilitate short-range planning of faculty, staff, and program requirements (43, p. 40).

Projected enrollments are needed when policy decisions are formulated and alternatives are considered. For example, if a decline in enrollment is projected, administrators might decide to institute a program of recruitment aimed at non-traditional students or decide to strengthen a promising academic program in order to attract high quality students.

If an institution does have enrollment projections for a period of perhaps three years in advance, there is time enough to explore various options and plan changes if they are needed (61, p. 653). Many colleges do not review alternatives and do not plan far enough in advance (52, p. 31).

Some Enrollment Projection Models

Many researchers have focused on trend models for projecting higher education enrollments. A study by the National Center for Higher Education Management Systems showed that twenty-three projects surveyed focused on long-term trend projections (64). The projections by the National Center for Education Statistics are to be regarded as indicators of broad trends (23, p. 8). While these models are often uncomplicated and relatively easy to understand, they have not produced projections so accurate as are needed for good planning, especially in the short term. Administrators at individual institutions need more specific information.

Long-term and short-term projections have different uses and different strengths. Long-term projections are aimed toward planning for alternative futures and new directions for an institution or a system. These plans are wide ranging and deal with classes of events. Even so, the long-term perspective is linked to the short-term and the present. Short-term projections are more specific, contain greater detail, and generally merit more confidence in their precision (43, p. 34). The purposes for which projections are intended and the conditions under which they are to be made and used influence the choice of forecasting method.

Some trend models, however, are quite sophisticated. The Ohio statewide enrollment projection method is a rather complex one which uses a number of demographic factors and requires a detailed data base. This detailed and comprehensive data base has been developed over a period of fifteen years using a pool of data which is classified consistently throughout the state. Few states have data with the degree of accuracy and consistency necessary for good enrollment predictions. The forecasting model used by the state of Ohio has been subject to years of refinement and a variety of counterchecks (41, pp. 4, 8).

The staff of the Coordinating Board of the Texas College and University System, Southwest Econometrics of Austin, and a demographer from the University of Texas at Austin's Population Research Center have prepared projections of enrollment for the higher education institutions of the state of Texas (59, p. 97). A 1977 projection was revised early in 1980 and used to forecast enrollment for the next decade for each of the thirty-seven public senior colleges in Texas and for other elements of postsecondary education by broad category, i.e., independent senior colleges, public and independent junior colleges, and the technical institutes. These headcount enrollment forecasts were based on an analysis of college attendance patterns for the 254 counties in Texas and on population projections by age for the counties in Texas (4).

Both of these are statewide forecasting models. The Ohio model is elaborate and costly but probably the most advanced statewide model (41, p. 8). The Texas model is less sophisticated but provides some useful information. This model is mostly based on historical trends (59, p. 111). Both the 1977 and the 1980 predictions by the Texas model were consistently high for one university and consistently low for the other university analyzed in this study (4). Any forecasting system has limitations because of the numerous and complex factors influencing higher education.

There are various types of forecasting models used by individual institutions. Besides trend models dealing with historical enrollment data, there are models such as the cohort survival projection technique which uses the persistence rates of cohorts (groups) of students who enter the university as new students at the same class level in the same academic term. This rather complex model requires a student data bank of detailed student records which is costly to construct and which must be developed over a period of several years (57, pp. 25-40).

Louisiana State University has made enrollment projections based on the number of test scores submitted by prospective students and the number of those prospective students who actually enrolled, along with telephone surveys to project the expected rates of attendance from specific areas of the state (61, pp. 653-655).

Enrollment projection methods are numerous and diverse. They vary from administrative intuition to elaborate mathematical models.

Factors Affecting Higher Education Enrollments

Enrollments in higher education institutions are more difficult to project accurately than are enrollments in elementary and secondary schools where attendance is mandatory. Numerous factors affect enrollment in postsecondary units (23, p. 7). Even forecasting of enrollment in public schools is not easy because enrollments are affected by factors ranging from demography to politics. These influence the reliability of projections. Most school districts make projections based on historical data concerning the number of students progressing to the next grade level, a simple form of the cohort-survival technique. King-Stoops and Slaby found that enrollment projections could be improved by considering such variables as housing patterns, family sizes, family mobility, ethnic composition of neighborhood, local birthrates, and private school enrollments in the analysis (39, pp. 658-659).

A different set of factors influence higher education enrollments, and many of these are not measurable (57, p. 20). Variables such as the value of a degree in terms of status and the value of increased education for personal enrichment are impossible to quantify (23, p. 7). Domestic or international crises or changes in government policies, either federal or state, can make predictions about given institutions uncertain (16, p. 22). The social and political climates of the nation have influence on higher education, both on the funds available for the support of higher education and the attitudes of potential students. The economic climate affects the ability of students to pursue higher education and the ability of institutions to provide services to the students and the community.

It is difficult to determine the complex relationships between societal conditions and enrollments in higher education. This area holds potential for research by social scientists. There is evidence that educational aspirations vary among different age groups and different levels of socioeconomic status (43, pp. 37-38). However, good historical data are lacking on social factors influencing higher education participation. Because these factors are difficult to quantify and because information about them is scarce, their usefulness in a mathematical model is severely limited.

Statisticians cannot foresee and incorporate into mathematical models such factors as political changes and technological breakthroughs that can alter the picture. But adequate and useful models can be constructed which contribute to the body of information considered in making administrative decisions.

Shifting demographic and economic trends affect higher education (34, p. 2). Economic and demographic data have been monitored and understood for many years. These have been accumulated by various agencies as historical records and as bases for analysis and prediction. Economic factors are predictable (43, p. 35). They have been quantified, and, consequently, they lend themselves to mathematical applications.

At least five speakers at the Texas Postsecondary Education Outlook: 1980-1985 in Austin, Texas, December 9-10, 1979, (59) commented that higher education enrollment is countercyclical to, but lags, the national economy, and one speaker stated that the economy has a more important effect on higher education enrollments than does demography. Kraetsch (41, p. 6) notes that unemployment rates and particicipation in higher education are related. One study by Witkowski (65, p. 49) hypothesized that cyclical variation in employment affects enrollment in institutions of higher education. However, no statistical measures dealing with the relationship between employment and enrollment were discussed.

Thus, it is clear that economic events affect enrollment. Short-term factors such as unemployment and inflation and long-term factors such as changes in the market for college graduates influence enrollments in higher education (65, p. 49). The return from the investment in a college education has declined as costs have increased (65, p. 53).

Institutions as well as individuals are affected by economic factors. Economic growth by higher education has slowed in the past decade (45, p. 19). Even with stable enrollments inflation is devastating to colleges and universities. Higher education can do little to remove the impact of fluctuations in economic activity (65, p. 56). Enrollment driven funding formulas fail to react quickly to economic cycles, and this causes serious problems in periods of inflation (47, p. 558). Inflation and unemployment also affect the revenues of state and federal governments which ultimately affect institutions of higher education.

Reduced government expenditures aimed at slowing inflation coupled with higher interest rates result in fewer loans and scholarships available to students, less money for buildings and equipment, and reductions in research grants. These activities have both direct and indirect effects on enrollments in institutions of higher education because they reduce the funds available to students in the form of financial aid and the funds available to institutions to maintain or improve programs and facilities (65, p. 51). For state institutions declining enrollments mean a decrease in tuition revenue and state appropriations (21, p. 412). Enrollment is one of the seven key indicators of the economic climate of higher education (45, p. 20).

Students are subject to fluctuations in employment, both with respect to their own jobs and with respect to parental income (65, p. 50). Researchers have begun to study the relationship between unemployment and participation in higher education. Indications are that a depressed economy tends to encourage high school graduates to attend college immediately after high school as a means of improving their employment prospects. Individuals who are laid off their jobs may enroll in postsecondary programs to gain new skills and better education to enhance employment possibilities. Because job opportunities are appealing in a booming economy, some high school graduates choose to work instead of continuing their education. Urban schools are especially susceptible to fluctuations in the economy, and certain age groups tend to be more vulnerable to fluctuations in employment (41, p. 6).

Enrollment estimates should be based on the best information available and derived from a model designed to reflect as nearly as possible what is likely to happen (16, p. 24). The selection of a forecasting method depends on for whom the predictions are intended, what data are available, and at what level the projections are being conducted. Whatever the quantitative method, it should be complemented with subjective judgment (41, p. 7). It is essential that the forecasting model be sensible from the point of view of the setting in which it is used as well as from a statistical point of view (37, p. 91).

A Specific Forecasting Model

Salley, at Georgia State University, used traditional time series analysis and linear regression techniques for short-term enrollment projections (49, 50, 51). His linear model provided a very good fit to the data and an effective tool for short-term projections. He developed a multiple linear regression equation for projecting enrollment which incorporated a seasonal term, a trend term, and a cyclical term. The seasonal and linear trend components were obtained in the traditional manner using seasonal indices to adjust the enrollment data for seasonal variation and then fitting the least squares trend line to the deseasonalized data. The cyclical term was one which was derived from a national economic cycle that was found to have a high negative correlation with the enrollment cycle. This model, then, includes a component which is related to the economy. The projection equation makes use of a quantifiable factor which has been linked to university enrollments.

The study presented here uses a similar analysis to build projection equations for student semester credit hour enrollments at two universities in the north central Texas area. This technique is an appropriate one from the standpoint of cost, intended use, availability of data, type of data studied, period of projection, and continuation of the relationship from the past into the future (28, pp. 179-183; 41, p. 1; 62, pp. 204-213).

This study differs from Salley's in several respects. His study dealt with one university's enrollment; this study deals with two. Projection equations were developed here for undergraduate and graduate enrollments as well as for total enrollment; Salley presented a projection equation for total enrollment. Georgia State University uses the quarter system; the two universities of this study use the semester system. Different economic indicators were used in the projection equations developed in the two studies. The highly correlated economic cycle in Salley's study had a different period of lag from the ones used here. Additionally, only this study includes a detailed analysis of the residuals of the equations and the discovery of a pattern in those residuals, as well as in the residuals from Salley's equation.

Summary

The slowed growth in higher education in terms of enrollments, financial resources, and public support has created a need for careful planning. Financial constraints have caused administrators to be concerned with the problems of maintaining quality programs and viable institutions in the face of limited revenues. Efficient management based on goal-centered planning and adequate data enhances the likelihood of institutional survival and success.

Planning which is directed toward causing beneficial change in an institution must be based on adequate and reliable information. An important part of this information consists of data about projected student enrollment since enrollments are closely tied to revenues. Because national, or even regional, aggregate data do not give reliable projections for individual institutions, it is important for each to develop its own forecasts of enrollment.

Various models for predicting enrollments have been developed. Some models are more effective than others, yet each has advantages and disadvantages; each serves a purpose and is appropriate under certain conditions. A simple, easily understood method of projection which uses readily available data, which is inexpensive to execute, and which gives adequate results is ideal.

Since higher education enrollments are linked to the economy, a method for enrollment projection which incorporates an economic component makes use of a quantifiable factor which is related to the predicted variable. In this study multiple linear regression equations which contain a trend term, a seasonal term, and a cyclical term that is related to the economy were developed to project enrollments for two universities. The economic cycles used in the projection equations had high correlations with enrollment cycles that had been identified by the technique of traditional time series analysis.

The methods and procedures used to develop the explanatory or projection equations for this study are detailed in the following chapter. The equations are also presented along with the statistical measures to be used in assessing them.

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CHAPTER III

METHODS, PROCEDURES, AND PRESENTATION OF DATA

Methods and Procedures

The procedure followed and the rationale used in the establishment of the explanatory equations are given in detail in this section. The basic procedure was the same for each of the projection equations obtained in the study.

It was assumed that student semester credit hour enrollments contain seasonal fluctuations, long-term trend effects, short-term cyclical variations, and a small irregular error component. Based on these assumptions traditional time series analysis was used to remove the seasonal and trend components from the data leaving the cyclical variations along with the error term which cannot be removed. By correlating the remaining cycle with an appropriate economic cycle, information was obtained which was used in establishing a multiple linear regression equation for projecting student semester credit hour enrollments.

As stated earlier, the first purpose of the study was to identify the cyclical component of deseasonalized enrollment data. This purpose was accomplished using traditional time series analysis.

The student semester credit hour enrollment data for the two universities were obtained from records maintained by the registrars' offices of the universities. The total student semester credit hours, the undergraduate student semester credit hours, and the graduate student semester credit hours for each institution were used in the analyses, and a prediction equation in each of these categories for each institution was developed using long-term trend, seasonal fluctuation, and short-term cyclical variation.

For purposes of the analysis the student semester credit hour data for the fall and spring semesters were used, and the total summer enrollment was the figure used for the summer term. One university has two distinct five-week summer sessions, and the other has two five-week sessions and an eleven-week session. For purposes of this study each term--fall, spring, or summer--is called a semester.

The period of time originally examined in the study began with the 1959-1960 academic year, which was the first year that both universities were four-year institutions. Preliminary examination of the student semester credit hour data indicated that the appropriate interval to be considered as a basis for projection was approximately the most recent eight to twelve years since the enrollment trend at both universities showed a definite change at about the beginning of that time period. The 1978-1979 academic year was chosen as the termination point for purposes of the study so that projections based on the equation which was developed could be compared with the actual enrollment figures for each semester of the 1979-1980 academic year.

The student semester credit hour data showned an observable seasonal pattern. These data are given in Table XIII and Table XIV in the Appendix. For most of the data which were analyzed the enrollment was highest in the fall semester, slightly lower in the spring semester, and considerably lower in the summer semester. The notable exception to this pattern was the graduate enrollment at the institution which offers an extensive program in teacher education. This emphasis was reflected in a high graduate enrollment in the summer during the earlier years of the study. However, during the period covered in the analysis the pattern changed gradually to the more typical pattern mentioned above. Since 1968 this university has instituted new graduate level programs in ten different departments. These additions changed the enrollment pattern from that of a traditionally teacher education oriented institution to that of a comprehensive university (5).

The effect of seasonal variation in the student semester credit hour enrollment data was the first component to be removed. This was accomplished by using seasonal indices, numbers which represent the relative amount of enrollment in each semester (season) of the year. A complete seasonal cycle for these data consists of three semesters: fall, spring, and summer.

The seasonal indices were calculated by first computing a three-period moving average of student semester credit hour enrollment, centered at the middle of the three semesters used to compute the average. This average was divided into the corresponding student semester credit hour figure to obtain a raw seasonal ratio for each semester. These ratios form the basis for the seasonal indices. Instead of computing a single seasonal index for a particular set of data under study, a three-period moving average of raw seasonals was obtained which provided a series of seasonal indices to be used in deseasonalizing the enrollment data. This method was necessary for adjusting the graduate student semester credit hour enrollment figures in which the seasonal pattern gradually and definitely shifted. It was also more effective than single seasonal indices in removing the seasonal variation from the sets of data which did not have such an obvious change in pattern over the time interval encompassed by the study.

The enrollment data were deseasonalized, or seasonally adjusted, by dividing each actual student semester credit hour figure by the corresponding seasonal index. The values thus obtained have had the seasonal component removed from the data, leaving the long-term trend, short-term cycle, and irregular variations.

Trend lines were fitted to the seasonally adjusted data using linear regression. Preliminary examination of the data indicated that a change in the trend occurred in the late 1960s or in the early 1970s in the total student semester credit hour enrollments at both universities. Seven trend lines were examined for each institution starting with each fall semester of the years 1967 through 1973. The line with the minimum standard error of the estimate was chosen as the best fitting trend line. The best fitting trend lines for the deseasonalized total enrollment values for both universities encompassed the interval from the fall of 1971 through the summer of 1979, the termination point for the period upon which the projection equations were based. Both linear models fit the data very well.

In order to remove the effect of trend from the data, the calculated trend values were subtracted from the corresponding seasonally adjusted enrollment values. This subtraction yielded residual values which contain the cyclical component and the irregular fluctuations in the data. The irregular variations, or error terms as they are sometimes called, are small relative to the other components of the data, and they cannot be removed mathematically from data. Therefore, values which remain when the seasonal and trend components are removed are considered to form the cyclical component of the data.

The second purpose of the study was to determine the cyclical economic indicator having a high correlation with the cyclical component of the enrollment data and to use this selected economic indicator in a multiple linear regression equation to make enrollment projections. Economic activity which is related to enrollments in institutions of higher education was used in a mathematical model to predict enrollment.

Six enrollment cycles--total student semester credit hours, undergraduate student semester credit hours, and graduate student semester credit hours for each of the two universities--were correlated with seven different economic cycles. Each enrollment cycle was paired with each of the seven economic cycles during the concurrent four-month period, and the Pearson correlation coefficients were computed. Additionally, enrollment was correlated with each of the economic cycles during the previous period, that is, spring enrollment was paired with economic cycles of the previous fall, summer enrollment with economic cycles of the previous spring, and fall enrollment with economic cycles of the previous summer. Also, correlations paired enrollment with economic cycles from two periods earlier and from three periods earlier. This technique, called lagging, was used to determine the highest correlations between enrollment and prior economic activity so that an economic cycle could be chosen to contribute to accurate short-term enrollment projections. When an economic cycle is lagged one period in this kind of calculation, the economic cycle in a given period is correlated with enrollment in the following period. In this way, the economic cycle leads the enrollment cycle. It was necessary to identify a cycle which led the cyclical variation in student semester credit hour enrollment by at least one term in order to be able to use the economic data in the explanatory, or projection, equation. Two national economic cycles, two state cycles, and three local cycles were chosen for consideration because of their likely relationship with enrollment. The cyclical economic indicator chosen to be used in the prediction equation was selected on the basis of its high correlation with the enrollment data.

The seven economic cycles that were used are the United States composite index of twelve leading indicators, the United States composite index of four roughly coincident indicators, per cent of civilian labor force unemployed in Texas, nonagricultural wage and salary jobs in Texas, per cent of civilian labor force unemployed in the Dallas-Fort Worth SMSA, nonagricultural wage and salary jobs in the Dallas-Fort Worth SMSA, and net labor turnover rates in manufacturing industries in the Dallas-Fort Worth SMSA. The economic cycles which were chosen for consideration represent the movement of the national economy as a whole and various aspects of employment in Texas and in the Dallas-Fort Worth Standard Metropolitan Statistical Area (SMSA). Because various authorities have found that enrollment in higher education is countercyclical to the economy in general and to employment in particular, these economic cycles are appropriate (6, 8, 9, 10, 12).

Business Conditions Digest (1), a monthly publication of the United States Department of Commerce, contains the composite index of leading indicators and the composite index of coincident indicators, both of which are economic time series that reflect the cyclical movement in national aggregate economic activity. Statistics on employment and unemployment in the state of Texas and in the Dallas-Fort Worth SMSA were obtained from the Texas Employment Commission (2, 11). Monthly employment and unemployment data are available for the state of Texas and for the Dallas-Fort Worth SMSA, which includes eleven counties: Collin, Dallas, Denton, Ellis, Hood, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise. Both of the universities in the study are located in this area.

Because the academic calendar divides the year into three roughly equal segments, the economic data were also divided into three periods per year so that they might be related to the enrollment figures. For the purpose of relating economic activity to enrollment in this study the months of the year were grouped as follows: January, February, March, and April to correspond to the spring semester; May, June, July, and August to correspond to the summer semester; September, October, November, and December to correspond to the fall semester.

The geometric mean of the unemployment rates for each four-month interval was computed. These means, then, formed a cycle which was correlated with the cyclical component of the enrollment data. There were two such cycles of unemployment rates, one for the state of Texas and one for the Dallas-Fort Worth SMSA. Each unemployment cycle was correlated with the enrollment cycles of each university in the concurrent period. Also, each economic cycle was lagged one period, two periods, and three periods and correlated with the enrollment cycles of each institution. As indicated above, the lead-lag relationship is important in the projection process.

The net labor turnover rates in manufacturing industries for the Dallas-Fort Worth SMSA were calculated on a monthly basis by subtracting separation rates from accession rates. These monthly net turnover rates were averaged using the geometric mean of four-month items to obtain a cycle which could be correlated with university enrollments. The same correlations were computed as for unemployment cycles and enrollment cycles.

The number of nonagricultural jobs in Texas and in the Dallas - Fort Worth SMSA are available as monthly data. Both of these data sets were dominated by a definite long-term upward trend. The effects of these trends were mathematically removed from the data after the arithmetic means of the numbers of nonagricultural jobs for each four-month period were computed. The least squares trend lines were fitted to the figures represented by the three data points per year, and the computed trend values were subtracted from the corresponding average number of nonagricultural jobs per period to obtain a cycle. These cycles, one for the number of nonagricultural jobs in the state of Texas and one for the number of nonagricultural jobs in the Dallas-Fort Worth SMSA, were correlated with the enrollment cycles of both universities in the same manner as the other economic cycles.

In a similar manner the two national economic cycles, the composite index of leading indicators and the composite index of coincident indicators, were correlated with the student semester credit hour enrollments of the two universities. The monthly data which were reported for these economic indicators were grouped and averaged to obtain the cycles used in the correlations.

All of the economic data are readily available. The national cycles have been computed since 1948, and these particular indices are summarized yearly in the July issue of the _Business Conditions Digest_ with a monthly update in this publication from the Department of Commerce. These cycles tend to lead or to coincide with broad movements in national aggregate economic activity (1, p. 1). Historically they have proved to be reliable indicators of expansion and contraction in the business cycle. They are especially useful for comparison because they are current and because they are usable without any further calculation except the four-item means. They are useful, too, because the Texas economy tends to parallel the fluctuations in the national economy. Also, the Dallas-Fort Worth economy closely parallels the national economy, although it outperforms the nation (12, pp. 29, 33-34).

The labor turnover rates in manufacturing industries in the Dallas-Fort Worth SMSA have been available since 1972. These data are updated monthly in the *Dallas-Fort Worth Labor Market Review*, a publication of the Texas Employment Commission (2). This publication also contains the number of wage and salary jobs in nonagricultural industries in the Dallas-Fort Worth SMSA each month, as well as the unemployment rates. The area unemployment rates have been available since 1974. Because the Dallas-Fort Worth SMSA has had its current definition since 1972, the number of nonagricultural jobs has been recorded for the area and since that year, with values for 1970 and 1971 constructed by reference to county data.

The unemployment rates and the number of wage and salary jobs in nonagricultural industries in the state of Texas are published monthly in the *Texas Labor Market Review*, another publication of the Texas Employment Commission (11). These data were obtained from 1970 onward.

The unemployment rates for the state and for the local area are especially easy to use because of their prompt availability and because the only calculations required are the four-item means. Because of the dominance of the long-term trend in the nonagricultural employment data, these figures require some preliminary analysis to remove the effects of the trend before cycles can be obtained to use in the correlations.

In every case except one undergraduate enrollment cycle, the highest correlations occurred when the economic cycles were lagged one period. The exception had the highest correlation in the concurrent period. To be useful for prediction the economic cycle must lead the enrollment cycle by at least one period. Thus, the second highest correlation was chosen in the exceptional case so that the economic cycle could be used in an explanatory or prediction equation. The best correlations for economic cycles lagged two periods were also selected because their inclusion in an explanatory equation would allow projection of enrollments two periods in advance. Table V in the Appendix gives the correlations between each of the three enrollment cycles for each university and the particular economic cycle having the highest correlation with each enrollment cycle when the economic cycle was lagged one period. Table VI in the Appendix gives the correlations between each of the three enrollment cycles for each university and the economic cycle having the highest correlation with each enrollment cycle when the economic cycle was lagged two periods. The values in Table V are given for comparison. The economic cycles in Table VI were used in the projection or explanatory equations because they are more useful from a practical standpoint.

The explanatory equations were developed for the total enrollment, the undergraduate enrollment, and the graduate enrollment for each university using multiple linear regression. Each of the equations has the form:

$$y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + e.$$

The student semester credit hour enrollment, y, is expressed as a function of a constant, b_0, a trend term, b_1x_1, a seasonal term, b_2x_2, a cyclical term, b_3x_3, and e, an error term that represents erratic fluctuations. Therefore, the dependent variable, student semester credit hour enrollment, was explained by or predicted from the independent variables--long-term trend, seasonal variation, and cyclical fluctuation. When the regression equation is fitted to the data, the error term, which is assumed to be random, is absorbed in the numerical coefficients and does not appear as a term of the explanatory equation.

The coefficient of determination adjusted for degrees of freedom, adj R^2, and the Durbin-Watson statistic, d, were calculated for each equation. The number of data points used in each equation is n. The coefficient of determination represents the proportion of variance in enrollment which is determined by the independent variables in the equation (7, p. 102). The Durbin-Watson statistic is used to test for serial correlation, or autocorrelation, in the data (4), that is, it is used to test whether the error term is dependent on previous error terms. This is important because one of the original assumptions of the regression model is that error terms are random (13, p. 124).

Presentation of Data

Each explanatory or projection equation is given along with its values of n, adj R^2, and d. The explanatory equation for University I total student semester credit hour enrollment is

$$y = 67336.1 + 80.2x_1 + 122938.2x_2(\text{fall}) - 4719.3x_3 \quad [1]$$
$$+ 108060.8x_2(\text{spring})$$
$$+ \quad 0 \quad (\text{summer})$$

adj $R^2 = 0.99701$ $\quad$ $d = 1.85230$ $\quad$ $n = 20$

The explanatory equation for University I undergraduate student semester credit hour enrollment is

$$y = 58039.6 - 212.8x_1 + 119538.6x_2(\text{fall}) + 133.4x_3 \quad [2]$$
$$+ 105221.5x_2(\text{spring})$$
$$+ \quad 0 \quad (\text{summer})$$

adj $R^2 = 0.99782$ $\quad$ $d = 2.21148$ $\quad$ $n = 15$

The explanatory equation for University I graduate student semester credit hour enrollment is

$$y = 10425.7 + 151.5x_1 + 3156.7x_2(\text{fall}) + 1187.6x_3$$
$$+ 1917.4x_2(\text{spring}) \quad [3]$$
$$+ \quad 0 \quad (\text{summer})$$

adj $R^2 = 0.67103$ $\quad$ $d = 1.67209$ $\quad$ $n = 15$

The explanatory equation for University II total student semester credit hour enrollment is

$$y = 4741.0 + 1521.0x_1 + 126427.7x_2(\text{fall}) - 143.6x_3 + 109450.1x_2(\text{spring}) + 0\ (\text{summer}) \qquad [4]$$

adj $R^2 = 0.99063$ $\qquad d = 2.55633$ $\qquad n = 24$

The explanatory equation for University II undergraduate student semester credit hour enrollment is

$$y = 20114.3 + 1021.2x_1 + 118513.2x_2(\text{fall}) - 120.4x_3 + 102265.1x_2(\text{spring}) + 0\ (\text{summer}) \qquad [5]$$

adj $R^2 = 0.99267$ $\qquad d = 2.48225$ $\qquad n = 24$

The explanatory equation for University II graduate student semester credit hour enrollment is

$$y = -16707.7 + 466.7x_1 + 7706.2x_2(\text{fall}) - 4.6x_3 + 7164.4x_2(\text{spring}) + 0\ (\text{summer}) \qquad [6]$$

adj $R^2 = 0.94335$ $\qquad d = 2.48992$ $\qquad n = 24$

In each equation the trend variable, x_1, takes the values of an arithmetic series such as 37, 38, 39, . . . 60, where thirty-seven represents the fall of 1971, thirty-eight represents the spring of 1972, and sixty represents the summer of 1979. Each number in the series represents a particular four-month period covered by the equation. The number of periods required is dependent on the economic cycle used because data were not available for all the economic cycles from the fall of 1970. As indicated previously, the unemployment rates for the Dallas-Fort Worth SMSA were available from the spring of 1974, and the net labor turnover rates for the Dallas-Fort Worth SMSA were available from the spring of 1972. All other economic cycles were available at least as early as the fall of 1970, the earliest period for which correlations were calculated. The same span of time must be used for all independent variables in a particular regression equation.

The seasonal variable, x_2, has the value zero or one. This is a dummy variable, or categorical variable, and there are actually two seasonal coefficients, b_2. Only one is used in the equation at any particular time. When the enrollment value is computed for the fall semester, the b_2 represents the fall semester and the corresponding value of x_2 is one. The other x_2 values are zero. When enrollment is computed for the spring semester, the b_2 represents the spring semester, and the other x_2 values are zero. When enrollment is computed for the summer semester, all x_2 values are zero. A categorical variable with m categories is represented by m-1 dummy variables (13, p. 105).

The cyclical variable, x_3, takes the values of the highly correlated economic cycle lagged two periods. Thus economic activity is related to university enrollments in an equation that is used to predict these enrollments.

The coefficient of determination represents the fraction of variation in enrollment that is explained or determined by the regression equation (3, p. 26). The Durbin-Watson statistic is computed to look for significant serial correlation. When the values of the Durbin-Watson statistic are near two and lie within certain upper and lower bounds which depend on the number of independent variables in the regression equation, they indicate no significant serial correlation in the data (4).

A value of 0.99701 for adj R^2 in equation [1] indicates that approximately 99.7 per cent of the variation in total enrollment for University I is determined by the explanatory equation. A value of 1.85230 for the Durbin-Watson statistic indicates no significant autocorrelation in the data.

A value of 0.99782 for adj R^2 in equation [2] indicates that approximately 99.8 per cent of the variation in undergraduate enrollment for University I is determined by the explanatory equation. A value of 2.21148 for the Durbin-Watson statistic indicates no significant autocorrelation in the data.

A value of 0.67103 for adj R^2 in equation [3] indicates that approximately 67.1 per cent of the variation in graduate enrollment for University I is determined by the explanatory equation. A value of 1.67209 for the Durbin-Watson statistic indicates that the test for autocorrelation in the data is inconclusive.

A value of 0.99063 for adj R^2 in equation [4] indicates that approximately 99.1 per cent of the variation in total enrollment for University II is determined by the explanatory equation. A value of 2.55633 for the Durbin-Watson statistic indicates no significant autocorrelation in the data.

A value of 0.99267 for adj R^2 in equation [5] indicates that approximately 99.3 per cent of the variation in undergraduate enrollment for University II is determined by the explanatory equation. A value of 2.48225 for the Durbin-Watson statistic indicates no significant autocorrelation in the data.

A value of 0.94335 for adj R^2 in equation [6] indicates that approximately 94.3 per cent of the variation in graduate enrollment for University II is determined by the explanatory equation. A value of 2.48992 for the Durbin-Watson statistic indicates no significant autocorrelation in the data.

Summary

Explanatory or projection equations were developed for three sets of enrollment data for two universities. First the seasonal variation was removed from the raw student semester credit hour enrollment figures using seasonal indices. Next a trend line was fitted to the seasonally adjusted data. The effects of trend were then removed by subtracting the trend values from the deseasonalized enrollment figures. The values which remained formed the cyclical component of the enrollment data.

Because higher education enrollments are related to economic activity, seven different economic cycles were correlated with each of the six enrollment cycles to determine which economic cycles had high correlations with the various enrollment cycles when the economic cycles were appropriately lagged. Correlation coefficients were calculated for lags of zero, one, two, and three periods (semesters) for each comparison. National, state, and regional economic cycles were considered. Thus an economic cycle was chosen for its high correlation with a cycle of enrollment so that it could be used in a multiple linear regression equation, the projection equation, which could predict that enrollment.

The projection or explanatory equations which were developed had a trend component, b_1x_1, a seasonal component, b_2x_2, and a cyclical component, b_3x_3. These components represent influences on higher education enrollments. To help assess how well the equations explained mathematically the relationships among these components and enrollment, certain statistical measures were computed--the coefficient of determination, adj R^2, and the Durbin-Watson statistic, d. The results are

University I total student semester credit hour enrollment (adj R^2 = 0.99701, d = 1.85230)

$$\begin{aligned} y = 67336.1 + 80.2x_1 &+ 122938.2x_2(\text{fall}) - 4719.3x_3 \\ &+ 108060.8x_2(\text{spring}) \\ &+ \quad 0 \quad (\text{summer}) \end{aligned}$$

University I undergraduate student semester credit hour enrollment (adj R^2 = 0.99782, d = 2.21148)

$$y = 58039.6 - 212.8x_1 + 119538.6x_2(\text{fall}) + 133.4x_3 + 105221.5x_2(\text{spring}) + 0\ (\text{summer})$$

University I graduate student semester credit hour enrollment (adj R^2 = 0.67103, d = 1.67209)

$$y = 10425.7 + 151.5x_1 + 3156.7x_2(\text{fall}) + 1187.6x_3 + 1917.4x_2(\text{spring}) + 0\ (\text{summer})$$

University II total student semester credit hour enrollment (adj R^2 = 0.99063, d = 2.55633)

$$y = 4741.0 + 1521.0x_1 + 126427.7x_2(\text{fall}) - 143.6x_3 + 109450.1x_2(\text{spring}) + 0\ (\text{summer})$$

University II undergraduate student semester credit hour enrollment (adj R^2 = 0.99267, d = 2.48225)

$$y = 20114.3 + 1021.2x_1 + 118513.2x_2(\text{fall}) - 120.4x_3 + 102265.1x_2(\text{spring}) + 0\ (\text{summer})$$

University II graduate student semester credit hour enrollment (adj R^2 = 0.94335, d = 2.48992)

$$y = -16707.7 + 466.7x_1 + 7706.2x_2(\text{fall}) - 4.6x_3 + 7164.4x_2(\text{spring}) + 0\ (\text{summer})$$

In the next chapter the projected and actual enrollments are compared. The residuals from the explanatory or projection equations are analyzed, and statistical measures relating to each equation are examined.

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CHAPTER IV

ANALYSIS OF DATA AND RESULTS OF THE STUDY

Once the multiple linear regression equations (explanatory or projection equations) are developed they can be used to project enrollment on a short-term basis. Projections should routinely be compared with actual enrollments. Wing (25, p. 227) states that the comparison of forecasts with actual enrollments is the best way to evaluate a forecasting procedure. Because conditions may change, the equations should be examined periodically to determine whether or not they might be improved. Analysis of the residuals, the differences between the actual enrollments and the predicted enrollments, can provide insight into the effectiveness of the equations.

Comparison of Projected and Actual Enrollments

The third purpose of the study was to compare projected 1979-1980 academic enrollment figures obtained from the explanatory equations for each institution with actual enrollment. The projected enrollments were calculated by substituting suitable values of the independent variables in the appropriate regression equations.

The value used for x_1 was the number of the period for which the prediction was desired, determined by counting from summer, 1979, which was period number sixty. The value used for x_2 was zero or one as appropriate to the semester (season). The value used for x_3 was the value of the highly correlated cyclical variable, correctly lagged, corresponding to the desired projection period.

Because the economic data must be available for use in the projection equation, equations with one-period lags of economic cycles are impractical to use. The economic data are not available far enough in advance to make useful predictions of enrollment when the economic cycle leads the enrollment cycle by one period. Explanatory equations which contain economic cycles lagged two periods can be used to predict enrollment one period ahead of the period for which the latest economic data are available. For example, when the economic data are available for January through April, the cyclical value can be computed and enrollment can be projected for the following fall. The availability of economic data is a constraint on the range of projection of enrollment.

In a similar analysis Salley (9, p. 7; 20, p. 329) used an economic cycle that was lagged three quarters in the explanatory equation. This cycle was chosen for its high correlation with the total enrollment cycle at Georgia State University, an urban institution which uses the quarter system. Because the highest correlation occurred (with another economic cycle) during the concurrent period, that cycle could not be used for projection. The explanatory or projection equation and the enrollment data presented in Salley's analysis dealt with total enrollment.

Student semester credit hour (SSCH) enrollments were projected in this study for the two universities for the 1979-1980 and the 1980-1981 academic years using each regression equation which was developed. The projections were made for total enrollment, undergraduate enrollment, and graduate enrollment for each institution. Table I gives these projections along with actual enrollment figures for comparison. The per cent deviations of projected enrollments from actual enrollments are also given. It can be noted that although there are ups and downs in the actual enrollment data the predictions were typically in the right direction. For example, the equation predicted a decline in total enrollment for University I in the fall of 1980 from the fall of 1979, and a decline actually occurred. Further analyses of the results are made below in conjunction with detailed examinations of the six explanatory equations.

Forecasts or projections are based on the assumption that present patterns continue into the future and that the derived equation fits the conditions under which the projections are to be made. If the actual enrollment values show an unusual deviation from the predicted values an explanation

TABLE I

ACTUAL AND PROJECTED ENROLLMENTS FOR TWO UNIVERSITIES, FALL, 1979-SUMMER, 1981

Category	Semester	University I			University II		
		Actual Enrollment SSCH	Projected Enrolmt. SSCH	PDAE*	Actual Enrollment SSCH	Projected Enrolmt. SSCH	PDAE
Total	Fall, 1979	194,118	192,807	- 0.6	215,834	203,544	- 5.7
	Spring, 1980	177,403	180,369	+ 1.7	197,542	188,231	- 4.7
	Summer, 1980	63,968	71,445	+11.7	70,683	79,426	+12.4
	Fall, 1980	192,998	193,519	+ 0.3	228,151	209,644	- 8.1
	Spring, 1981	177,283	181,554	+ 2.4	206,123	194,934	- 5.4
	Summer, 1981	66,478	72,629	+ 9.3	71,960	85,554	+18.9
Undergraduate	Fall, 1979	167,782	165,051	- 1.6	195,900	183,812	- 6.2
	Spring, 1980	151,999	150,588	- 0.9	178,575	168,705	- 5.5
	Summer, 1980	42,365	45,073	+ 6.4	60,896	66,727	+ 9.6
	Fall, 1980	165,466	164,519	- 0.6	208,654	188,164	- 9.8
	Spring, 1981	151,194	150,083	- 0.7	187,212	173,563	- 7.3
	Summer, 1981	45,067	44,542	- 1.2	62,769	71,103	+13.3
Graduate	Fall, 1979	26,336	26,862	+ 2.0	19,934	18,945	- 5.0
	Spring, 1980	25,404	26,368	+ 3.8	18,967	18,585	- 2.0
	Summer, 1980	21,603	23,889	+10.6	9,742	11,735	+20.5
	Fall, 1980	27,532	28,266	+ 2.7	19,497	20,116	+ 3.2
	Spring, 1981	26,089	28,010	+ 7.4	18,911	19,896	+ 5.2
	Summer, 1981	21,411	25,294	+18.1	9,191	12,917	+40.5

*Percentage deviation from actual enrollment.

should be sought. A significant program change or an unusual event could account for the deviation. It is possible that the explanatory equation itself needs reexamination.

The projection equations were found to be most useful for predicting the enrollments in semesters other than the summers. Closer predictions were obtained for the fall and spring semesters. Various forces could account for this. Different economic factors may affect summer enrollments than those affecting the other semesters. The same economic factors may affect summer enrollments differently. Factors other than economic ones may have strong influence on summer enrollments. Because students may have different attitudes about summer school than about the regular sessions, a mathematical model used for predicting enrollment for all semesters may give inferior results for the summer term.

There are indications that students exhibit various responses to the same economic conditions, especially during the summer. Magarrell (13) states that in the summer of 1981 some students enrolled in summer school to graduate before tuition increases take effect and because they could not find summer jobs, others took jobs to help meet the rising expenses of the regular academic year. He also finds that summer enrollment trends are mixed but that the general decline in summer enrollment in the last few years is related to tight money and higher tuition. Higher gasoline prices have influenced enrollments as have reductions in financial aid for students.

Although Salley (19, p. 10) explained his large summer quarter error in prediction by stating that there had been a major program change, close examination of the residuals from the equation shows that larger residuals generally correspond to summer quarters. Including the four predicted quarters his explanatory equation dealt with twenty-eight quarters, seven of which were summer quarters. When the magnitudes of the residuals were examined, six of the ten largest discrepancies were found to occur in summer quarters. Thus, only one summer residual was among the small ones. The summer enrollment at Georgia State University, for which Salley's predictions were made, is typically approximately 70 per cent of the fall enrollment. This means that the per cent deviations of the projected enrollments from the actual enrollments for the summer quarters loomed even larger.

The per cent deviations of the projected enrollments from the actual enrollments were generally greater in the summer semesters for the two institutions examined in this study. Although the magnitudes of enrollment residuals for the equations developed for the two universities were not unusually high for the summer semesters, the lower summer enrollments caused the per cent deviations from actual enrollments to be elevated. The total summer enrollment at University I is typically approximately 37 per cent of the total fall enrollment, and the total summer enrollment at University II is typically approximately 33 per cent of the total fall enrollment.

Comparison of Explanatory Equations and of Projections

The fourth purpose of the study was to compare the explanatory equations developed for the two institutions and the projections of student semester credit hour enrollments they yielded. The equations differ because the effects of trend, seasonal, and cyclical influences vary for each institution and each level of enrollment--total, undergraduate, and graduate. The equations differ, also, in how well they fit the data.

Each explanatory equation developed in this study had, in addition to a trend term and a seasonal term, a cyclical term which used an economic cycle having a high correlation with the cycle of enrollment. These equations were used to project enrollment for the second four-month period following the economic activity.

The economic cycle used in the equation to predict the first university's total enrollment was the cycle of net labor turnover rates in manufacturing industries in the Dallas-Fort Worth SMSA. The economic cycle used in the equations to predict both the undergraduate and graduate enrollment for the first university was the per cent of the civilian labor force unemployed in the Dallas-Fort Worth SMSA.

The economic cycle used in the equations to predict the total enrollment and the undergraduate enrollment for the second university was the United States composite index of twelve leading indicators. The economic cycle used in the equation to predict the second university's graduate enrollment was the cycle of nonagricultural wage and salary jobs in Texas.

Of the various factors which are related to university enrollments economic cycles were chosen to be included in the explanatory or projection equations in part because they are readily available and they are quantifiable. Social and political factors are not easy to quantify, so they are not so useful in a mathematical model. Demographic factors, of course, relate to enrollments, but Michael Abbot (23, p. 108) stated that economics has more effect than demography on higher education enrollments.

As stated earlier, several have found that higher education enrollments are countercyclical to economic activity (12; 18; 19; 23, pp. 14, 40, 72, 85, 107), that is, enrollments tend to be high in times of economic recession. This phenomenon was evident for the enrollments analyzed in this study with one exception. The undergraduate enrollment cycle for one institution had its highest correlation, a negative correlation, with the area unemployment rate cycle lagged one period. This same enrollment cycle showed a negative correlation with the area unemployment rate cycle lagged two periods, and this was its highest correlation with an enrollment cycle that was lagged two periods. This university's graduate enrollment cycle showed its highest, but positive, correlations with the same area unemployment rate cycle with the corresponding lags. This means that the undergraduate enrollment at this university is down when area unemployment is high and up when area unemployment is low, while the graduate enrollment cycle follows the pattern most analysts expect, high enrollment in times of high unemployment. The total enrollment cycle at this institution was countercyclical to the economy as evidenced by having its highest (positive) correlation with the state unemployment rate cycle lagged one period. Its highest correlation with an economic cycle lagged two periods was a negative correlation with the area labor turnover rate cycle.

All of the other university's enrollment cycles were countercyclical to the economy. The total enrollment and the undergraduate enrollment had highest (positive) correlations with the state unemployment rate cycle lagged one period. The highest correlations for these enrollment cycles with economic cycles lagged two periods occurred with the national cycle of leading indicators, and these correlations were negative. The graduate enrollment cycle for this institution had its highest (negative) correlation with the cycle of nonagricultural jobs in the area. Its highest correlation with an economic cycle lagged two periods occurred with the state nonagricultural employment cycle, and it was also negative.

Each explanatory equation which was developed has a high value for its coefficient of determination, indicating that a large percentage of the variance in the enrollment is explained by the equation, and no value of the Durbin-Watson statistic for an equation indicates that there exists significant autocorrelation in the data. However, there are discrepancies between the predicted enrollments and the actual enrollments. Discrepancies occur because it is impossible to include all factors affecting higher education enrollments in an explanatory or projection equation.

A study of these discrepancies, or residuals, over the period of the explanatory equation can help uncover hidden structures in the data (4, p. 10). This information can lead to a better understanding of the mathematical model and the data upon which it is based.

The examination of residuals is an important part of regression analysis. By inspecting these differences between actual and predicted values an investigator hopes to spot anomalies in the data or patterns in the residuals that would provide information about the prediction equation or the data itself (10, pp. 220-221).

An outlier is a residual that is unusually large in absolute value. It is a peculiarity which indicates a datum that is not typical of the rest of the data. Outliers are residuals which lie three or four standard deviations from the mean of the residuals. They indicate that further investigation should be made of the data to determine the cause of the unusual value (6, pp. 94-95).

For all six equations of this study the standardized residuals were computed. They are included in Tables VII-XII in the Appendix. These were found by dividing each residual by the standard error of the estimate for the particular equation. The standardized residuals for the periods over which each equation was written had values between two and negative two, except for one value of 2.1. This indicates that all but one of the residuals were within two standard errors of the estimate on either side of the mean of the residuals and that there were no outliers.

For the prediction period the standardized residual for the summer of 1980 for the total enrollment of University I was -2.4. Other standardized residuals which lay outside the range of two standard errors of the estimate on either side of the mean during the prediction period were for the fall semesters of 1979 and 1980 for the total enrollment of University II. They were 2.2 and 3.3, respectively. Also, the standardized residual for the undergraduate enrollment of University II for the fall of 1979 was 2.6, for the spring of 1980 was 2.2, for the fall of 1980 was 4.5, and for the spring of 1981 was 3.0. The appearance of large standardized residuals could indicate that past patterns may not hold. Reactions to economic conditions could be changing.

The explanatory or projection equations tend to give closer predictions for University I than for University II as is seen from the per cent deviations of projected enrollments from actual enrollments during the explanatory and the prediction periods. In fact 80 per cent of the predictions for University I were closer to the actual enrollments than were those for University II. One factor which helps to account for this is University I's nearly horizontal trend in enrollment since approximately 1971. There have been relatively small deviations from this trend as can be seen by comparing the enrollments in consecutive fall, consecutive spring, and consecutive summer semesters.

In contrast, the direction of prediction from one fall to the next, one spring to the next, and one summer to the next was better for the enrollment at University II than for University I for the time covering the explanatory and prediction periods. For University II the direction of prediction was correct over 79 per cent of the time, while the direction of prediction for University I was correct approximately 52 per cent of the time. This can be understood in part by comparing the trends in enrollment at the two universities--unswervingly upward for University II, irresolute for University I.

It is likely that the degree programs offered at the two universities have effects on enrollment patterns, in combination with the state of the economy. Enrollments in Texas colleges and universities during the ten years from 1970 through 1979 have shown the greatest percentage increases in fields where the job prospects are good. Specifically, the highest percentage increases have been in nursing, engineering, and business (23, p. 89). University II has degree programs in both nursing and engineering, but University I does not. Both universities offer degrees in business. The smallest percentage increases in enrollments have occurred in education, liberal arts, and home economics (23, p. 90). University I offers degrees in home economics and in education, but University II does not. Both universities offer degrees in liberal arts. The higher than predicted enrollments at University II in the fall and spring semesters could be related to degree offerings and anticipated employment opportunities. This suggests that enrollments might be analyzed by academic college or division and the results aggregated to obtain closer predictions.

Another effect of degree programs could be the lowered graduate enrollment in recent semesters at University II. Breneman (3, p. 84) states that graduate enrollment in science and engineering is more sensitive to the labor market than graduate enrollment in humanities or the social sciences. University II has an extensive graduate program in engineering, and the decrease in graduate enrollment at this university could be due in part to the excellent employment opportunities for engineers. Another possible contributing factor to this decrease is the tightening of criteria for the awarding of teaching assistantships to international students.

Plots of the residuals for both of the universities for the regular academic year (fall and spring semesters) versus time are roughly linear with a positive slope. This is true for the entire time span covered in the study, that is for the period of the explanatory equations and the prediction periods. Corresponding plots for the summer terms have a negative slope. These overlapping and opposing patterns in the residuals are not obvious upon initial inspection of the residuals for the explanatory equations. On the contrary, the residuals appear to be randomly distributed. Not only is this true for the data analyzed in this study, but it was found that Salley's data showed the same pattern. Discovery of such patterns gives important insight into the data.

An example surfaces when one recalls that the sum of the residuals of an equation for the period over which the equation was developed is zero. The fact that the summer residuals and the regular academic year residuals have opposing patterns assures that a given explanatory equation will yield projections that are high for summer and low for the regular academic year. This would not occur if the summer residuals and the residuals for the regular academic year were separately truly random.

When an independent variable, such as the seasonal variable in this instance, is related to the residuals over time the problem is called contemporaneous correlation of the independent variable and the residual. However, if the purpose is to specify a forecasting model, the analyst may ignore entirely the problems associated with contemporaneous correlation, particularly if the dependency is expected to continue during the forecasting period. Test statistics for setting forecast intervals are not appropriate under these conditions, but simple numerical comparisons of actual and predicted values can be made (15, pp. 291-298). For the equations in this study the actual residuals, the standardized residuals, and the per cent deviations of the projected enrollments from actual enrollments were computed. These data are available in Tables VII through XII in the Appendix.

Salley did not present an analysis of the residuals from his data, but, when such an analysis was made, it was discovered that a similar pattern exists to that for the residuals of the two universities analyzed in this study, that is, the residuals for the summer quarters tended to decrease from large positive values to values that are large in magnitude but negative over the period encompassed by the explanatory equation and the period of prediction. This suggests that a refinement of the method would result if one could determine how to apply it separately to regular academic year and summer enrollments.

When a given equation is examined, one cannot compare the coefficients of the trend, seasonal, and cyclical terms and judge the relative importance of each term in the equation because the independent variables are not measured in the same units. Even the standardized regression coefficients cannot be used, for their magnitudes are dependent upon the variability of the independent variables from which the equation is developed since these standardized coefficients are obtained after dividing each variable by its standard deviation before developing the regression equation (24, pp. 59-60). No method for comparing the relative importance of the terms exists. It is impossible, also, to make a meaningful comparison of one equation with another.

Examination of Statistics Related to Explanatory Equations

A large value for the coefficient of determination, adj R^2, does not guarantee accurate prediction from a regression equation, but it should be considered because it gives an indication of the fit of the mathematical model (10, p. 83). A low value for adj R^2 may be due to little variation in Y values (24, p. 61).

The adj R^2 values for the equations developed in this study are listed below in Table II.

TABLE II

COEFFICIENTS OF DETERMINATION FOR EXPLANATORY EQUATIONS

Category	University I, adj R^2	University II, adj R^2
Total	0.99701	0.99063
Undergraduate	0.99782	0.99267
Graduate	0.67103	0.94335

All of the adj R^2 values for the explanatory equations are large. The only one which does not indicate that at least 94 per cent of the variation in the enrollment data is explained by the equation is the adj R^2 for the graduate student semester credit hour enrollment for University I. This adj R^2 of 0.67103 indicates that over two-thirds of the variation in graduate enrollment at University I is explained by its equation.

Various factors may have contributed to a relatively low adj R^2 for this equation. The number of data points which were used to establish the regression equation was limited by the availability of economic data. The highly correlated economic cycle used in the equation was the Dallas-Fort Worth SMSA unemployment cycle for which data are available since 1974. The Y values for this data set had little variability. The graduate enrollment at University I is relatively constant throughout the year. Additionally, the pattern of graduate enrollment for this university is in a state of transition. Because University I has instituted graduate programs in ten different departments since 1968, the emphasis has shifted from heavy concentration in teacher education programs toward the more diverse curriculum of a comprehensive university (8). Along with this shift has come a change in the seasonal pattern of enrollment. The higher summer enrollment in graduate student semester credit hours typical of institutions specializing in teacher education programs has changed over recent years to the pattern found at most comprehensive universities of highest graduate enrollment in the fall semester, slightly lower enrollment in the spring semester, and the lowest enrollment in the summer semester. This transition has affected both the seasonal term, because there has been a changing pattern, and the values of the dependent variable, because during the transition there have been sequences of semesters with nearly equal enrollments. The per cent deviations from actual enrollments and the standardized residuals, however, are comparable to those for the other equations.

Closely related to the coefficient of determination is the value of F for each equation. This statistic can be used to test the null hypothesis that all the coefficients in a regression equation are zero against the alternative hypothesis that not all the regression coefficients are zero. If F has a value greater than a critical value, related to the number of data points used to develop the equation and the number of independent variables in the equation as well as the level of significance chosen, the null hypothesis can be rejected. One thereby rejects the notion that the regression coefficients differ from zero by chance (24, pp. 40-41).

The values of F are given in Table III for each equation. Along with these are the critical values of F at the 1 per cent level of significance for the appropriate degrees of freedom (17, pp. 460-461).

TABLE III

F VALUES FOR EXPLANATORY EQUATIONS

Category	University I			University II		
	F	df	CV*	F	df	CV
Total	1585.83	4,15	4.89	608.79	4,19	4.50
Undergraduate	1604.84	4,10	5.99	779.82	4,19	4.50
Graduate	8.14	4,10	5.99	96.75	4,19	4.50

*Critical values, 1 per cent level.

The values of F for each equation are such that the null hypothesis that all of the regression coefficients of the equation are zero can be rejected at the 1 per cent level of significance. All but one of the F values are many times greater than the critical value for the particular equation.

The Durbin-Watson statistic, d, was computed for each equation. It is used to test for autocorrelation in the data.

If autocorrelation is indicated, the equation could be refitted to the data after suitable transformation of the variables. If appropriate, additional variables can be added to the equation or a method other than multiple linear regression can be used to analyze the data (2; 4, p. 128).

The data upon which the six equations developed in this study are based were tested for positive autocorrelation. Negative autocorrelation is unlikely to occur (4, p. 127). The critical values for each level of significance of the Durbin-Watson statistic are based on the number of data points from which the equation was developed and the number of independent variables in the equation. No single critical value can be obtained, but upper and lower bounds, d_U and d_L, to the critical values can be calculated. If the observed value, d, is less than d_L positive autocorrelation is indicated at the chosen level of significance. If d is greater than d_U, one concludes that there is no positive autocorrelation at the chosen significance level. For values of d between d_L and d_U the test is inconclusive (7, p. 161).

Table IV gives the value of d for each equation. Additionally, the values of d_L and d_U at the 1 per cent level of significance are given for each equation (7, p. 175). Each equation had four independent variables, for each dummy (seasonal) variable is counted separately for this purpose (24, p. 103).

TABLE IV

DURBIN-WATSON STATISTICS FOR EXPLANATORY EQUATIONS

Category	d	Number of Data Points	Bounds on Critical Values, 1% Level	
			d_L	d_U
University I				
Total	1.85	20	0.68	1.57
Undergraduate	2.21	15	0.49	1.70
Graduate	1.67	15	0.49	1.70
University II				
Total	2.56	24	0.80	1.53
Undergraduate	2.48	24	0.80	1.53
Graduate	2.49	24	0.80	1.53

In no case is there definite evidence of autocorrelation. No value of d is less than the lower bound to the critical values. In every instance except one, the value for the graduate enrollment for University I, d is greater than the upper bound to the critical values. This indicates that there is no positive autocorrelation at the 1 per cent level of significance. For the graduate enrollment at University I the value of d is very close to d_U but is, nevertheless, in the interval for which the test in inconclusive.

When the value of the Durbin-Watson statistic is in the inconclusive region, additional analysis of the equation is optional (4, p. 127). Further analysis is not performed here because it is not feasible to add another variable to the equation and it is impossible to use the same highly correlated economic cycle and increase the number of data points due to the limited availability of the economic data. Another study could be performed in which the variables were transformed and a new equation developed, or another method such as the Box-Jenkins method (2) could be used to analyze the data.

Enrollment Projections and Planning

The fifth purpose of the study was to discuss enrollment projections for each institution and the uses of enrollment projections in planning. Planning for the use of all the resources of a university--physical, monetary, human, temporal--is related to student enrollment. For this reason estimates of enrollment are needed when administrators schedule classes, plan the use of equipment and facilities, determine staff and faculty requirements, and deal with budgets.

Enrollment projections have various uses in planning. Long-range planning requires general forecasts of trends. This type of projection of enrollment makes extensive use of demographic data such as birth rates, number of high school graduates, and college attendance rates from various subpopulations. Short-range projections of enrollment that deal with one fiscal year provide information that is useful in budget planning. These projections, along with other information, allow decision makers to plan service activities and the use of personnel, equipment, space, and supplies.

Periods of limited growth or of decline in enrollments make accurate enrollment predictions more critical than periods of rapid growth (9, p. 408), and enrollment predictions are needed because they have a significant bearing on administrative decisions (22, p. 40). Because budgets and revenue allocation are vital to a university, information which relates to these is important. Enrollment projections which give accurate information allow better planning, increased efficiency of operation, and generally wiser use of resources, all of which are especially important in these times of heightened emphasis on accountability. Erroneous forecasts can kill the best of plans, and accurate predictions can be offset by poor planning (11, p. 116). However, accurate information and communication are vital for those involved in making the difficult decisions facing higher education if they are to do their jobs well. Communication is a key to any successful planning endeavor whether for reduction, expansion, or maintenance (21).

The ramifications of inadequate enrollment projections are serious. Some of the inadequacies of projections result from extrapolations of past trends (5, p. 27). By incorporating factors which are related to higher education enrollments in the forecasting model the quality of the projections can be improved. Economic indicators are important. They are related to the amount of public support that is available for higher education and to the capability of students to finance their education (14, p. 31). The inclusion of economic factors in a mathematical model used to project enrollments gives a more nearly accurate prediction than a model based solely on historical trend.

Some of the problems that colleges and universities are experiencing at the present time are the result of unplanned growth. To deal with these problems and to minimize the likelihood of careless, expedient decisions, administrators need to plan for the short-term and for the long-range future using the best data available. Adequate enrollment projections are necessarily a part of these data.

In this study short-term enrollment projections for two universities were developed. The extent to which enrollment projections are actually used in planning at the two universities examined in this study, or at any university, depends upon the commitment of the institution's administration to planning. One university examined in this study has instituted a formal planning process; the other has not. Both could use information on projected enrollments.

As important as the actual projections obtained is the process for obtaining the projections. The mathematical models are available for use and for revision and improvement.

In order to have enrollment projections available for use in planning at any institution an initial effort must be made to provide such forecasts of enrollment. From any original model revisions and refinements can be developed to improve the model. The desired accuracy and precision of prediction must be weighed against the costs of additional or more elaborate models. Any quantitative prediction should be tempered with subjective judgment and blended with other available information. For example, consideration should be given to the fact that the projections for summers have tended to be high during the most recent years. Knowing this an analyst could develop another model, perhaps a model for summers separate from the regular academic year, or an administrator could revise the projection based on past experience and other current information.

As mentioned earlier, the higher than predicted enrollments for University II during recent fall and spring semesters may be related to degree offerings and the corresponding anticipated employment opportunities. It is likely that analysis of the enrollment data by college or division could sharpen projections. The findings of this study indicate that the development of separate explanatory equations for broad curriculum categories such as engineering, liberal arts, education, etc., could be beneficial. The discrepancies in the projections produced in this study and in those produced by the Coordinating Board of the Texas

College and University System (1) tend to be in the direction of underestimating the enrollment for University II and overestimating the enrollment for University I. Since both universities are state institutions and located in the same metropolitan area, it is a reasonable assumption that enrollment is related to the programs available at the two universities.

Enrollment projections serve a useful purpose in the planning process even when they need to be altered because of changing conditions. An original prediction may be the impetus for a change in programs which causes a shift in enrollments that makes the earlier projection obsolete (12, p. 7). Comparison of enrollment estimates and actual enrollments can be used to assess the impact of changes in policy or environment (25, p. 217).

Planning involves many factors and many activities. Forecasting is not planning, but it is useful to the individuals who are doing the planning; it is one part of the planning process (16, p. 115). Enrollment is but one of the conditions which must be predicted for higher education institutions. It is, however, an important element because it is the reason a university exists, and it is closely tied to funding.

Enrollment projections are essential for planning processes which deal with different time intervals. The emphasis of this study is on projections for short-term planning. Because the national, regional, and local economy influence university enrollments, economic indicators were incorporated into prediction equations from which projections were calculated.

Economic factors have an immediate effect on enrollments; therefore, they are useful for short-range projections. Such information is useful in formulating plans for allocating salary monies for part-time personnel, for planning expenditures of operating funds, and for refining course or class section offerings. The information could also serve as an impetus for improving recruiting activities or developing marketing strategies if a decrease is predicted. A predicted increase may signal a need for recruiting temporary faculty, scheduling additional classes, or planning alternative use of facilities.

Summary

Projections of total, undergraduate, and graduate student semester credit hours for both universities were computed using the six explanatory or projection equations. The projections were made for the 1979-1980 and the 1980-1981 academic years.

Each equation has a trend term, a seasonal term, and a cyclical term which was related to the economy. The enrollment projections were calculated by substituting the appropriate variables in the projection equations. These variables consisted of the ordinal number of the trend period, zero or one for the appropriate season, and the value of the highly correlated economic cycle lagged two periods. The timeliness of the availability of economic data and the magnitude of its correlation with enrollment data determined the period of prediction. The equations gave closer predictions for fall and spring semesters than for summers.

Residuals, the differences between actual and projected enrollments, were examined to gain information about the equations and the data from which the equations were developed. The residuals for the periods encompassed by the explanatory equations were not unusual. During the prediction period, however, there were some larger residuals. These deviations may be related to the degree offerings at the two institutions.

Close examination of the residuals over time revealed that summer residuals and regular academic year residuals had opposite trends. The same pattern was discovered by this analyst in Salley's data. Indications are that summer enrollments and regular academic year enrollments can be analyzed separately with improved precision.

In addition to residuals and the closely related per cent deviations of projected from actual enrollments, three statistical measures related to each equation were examined. All of the coefficients of determination for the explanatory equations were greater than 0.94 except one which was approximately 0.67. These values indicate that very large fractions of the variance in enrollment were explained by the equations. The F values for each equation were found to be greater, and usually many times greater, than the critical value of F at the 1 per cent level of significance. This fact indicates that the null hypothesis that all of the regression coefficients were zero should be firmly rejected. Finally, no value for the Durbin-Watson statistic indicated positive autocorrelation in the data.

Enrollment projections are used by administrators when plans are made for the use of institutional resources, both on a long-range and on a short-term basis. This study develops short-term enrollment projections which can be used in various aspects of planning. The projections can be used, along with other information and subjective judgment, by administrators of the two universities. The equations can be used as they are to project enrollments; they can be reexamined and revised using the method presented here; or they can be the impetus for developing new equations which deal with summers and long semesters separately, which are written for individual colleges or divisions, or which are used to analyze enrollment data in some other way.

Following a brief overview, the next chapter contains the conclusions that were drawn. Two major recommendations emerge from the work, and other suggestions for further research are given.

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CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Overview of Study

Enrollment projections are an important part of planning for institutions of higher education. They are related to budgets, programs, policies, and personnel. Planning becomes more difficult and more crucial in times of limited growth, and good enrollment projections become more critical.

It has been found that higher education enrollments are related to economic activity (4, 6, 7). Using this fact appropriately in an equation to project enrollments improves the accuracy of the forecast over that of an equation which uses trend alone.

The purpose of this study was to make short-term projections of student semester credit hour enrollments, at each of two state universities of comparable size, based on traditional time series analysis. This was accomplished by developing a multiple linear regression equation for each category of enrollment that was to be predicted. Each explanatory or projection equation contained a trend term, a seasonal term, and a cyclical term which was related to the economy.

The explanatory or projection equations for the total student semester credit hour enrollment, the undergraduate student semester credit hour enrollment, and the graduate student semester credit hour enrollment for each of the two universities were developed by using decomposition of time series followed by multiple linear regression. The equations were then used to project enrollments for 1979-1980 and 1980-1981. The projections were compared with actual enrollments, and the equations were analyzed to uncover information about their behavior, the enrollments considered in this study, and directions for further research.

Results

The first purpose of the study was to identify the cyclical component of deseasonalized enrollment data. This was accomplished by mathematically removing from the enrollment data the effects of trend and of seasonal variation, leaving the cyclical component of the data.

The second purpose was to determine the cyclical economic indicator having a high correlation with the cyclical component of the enrollment data. The Pearson correlation coefficients were computed for the six enrollment cycles paired with each of seven different economic cycles, each of which was lagged zero, one, two, and three periods. The economic cycle which was most highly correlated when lagged two periods was chosen for each enrollment category and was used to establish the multiple linear regression equation for projecting that enrollment.

The third purpose was to compare projected 1979-1980 academic year enrollment figures obtained from explanatory equations for each institution with actual enrollment figures. This was accomplished by examining the actual and projected enrollments and the per cent deviations of the projected enrollments from the actual enrollments. The per cent deviations were generally small for the fall and spring semesters. The per cent deviations were higher in summer because summer enrollments are typically the smallest of the year.

The fourth purpose was to compare explanatory equations developed for the two institutions and the projections of student semester credit hour enrollments they yielded. This was accomplished by examining the coefficients of determination, the Durbin-Watson statistics, and the residuals for each equation. All six of the explanatory equations fit the data well as is shown by the coefficients of determination. Five of the six adj R^2 values were greater than 0.94, and the sixth value was approximately 0.67. No value of the Durbin-Watson statistic for an equation indicated autocorrelation in the data. Analysis of the residuals from the equations indicates that summer enrollments should be projected separately. Separation of summer data from that of the regular academic year is indicated for Salley's data also (6).

The fifth purpose was to discuss enrollment projections for each institution and the uses of enrollment projections in planning. These short-term projections were discussed with respect to their usefulness in the decision-making process and their contribution to the planning of budgets, personnel assignments, schedules, facilities use, and service activities. The method of analysis used here provides a good basis for planning and a technique that can be used in future years by the institutions studied as well as by other institutions.

Discussion and Conclusions

Enrollment projections are data that can be incorporated into the total body of information used in the decision-making process. For the university that has a formal planning process enrollment projections are an integral part of that process. For the university which has no such formal procedure enrollment projections yield information that can be used by the administrators who do the informal planning for the institution.

The projecting of enrollments needs to be an ongoing process. The factors that influence enrollments and enrollment projections are dynamic. They require periodic review and analysis (4, p. 7). Wing (8, p. 217) states that the underlying trends and relationships which now exist in higher education are unlikely to continue unchanged into the future but that projections can provide information about trends and patterns. Kraetsch (4, p. 6) also comments that it is not known whether employment rates and college participation rates of the past will reflect the trends of the next decade because of unpredictable shifts in the economy at national, state, and local levels. Inflation promises to be a tough problem. The 1980s are expected to have a slowly growing economy with continued high inflation and unemployment (2, p. 3). This could be a mixed blessing to higher education since in the past enrollment has tended to be up in periods of unemployment (4, 7). On the other hand, inflation continues to put severe pressures on institutions of higher education (2, p. 5).

Regardless of the difficulties involved, enrollment forecasts are essential. Long-range and short-term projections are needed. Forecasts are useful from a statewide level to an individual department in a single institution. They are used in formal and informal planning by decision makers at all levels of responsibility.

Sound enrollment forecasts require effort, expertise, effective data systems, and computer support (8, p. 219). Any initial effort at enrollment projection can be improved and refined. The development of an adequate projection model takes time (8, p. 223). Established priorities and constraints of time and cost determine what elaborations or revisions are to be applied to a model.

Subjective judgment is needed during enrollment projection. Models can be improved by interaction and communication between the analyst and the decision maker (5, p. 134). Intuition is coupled with quantitative results to develop realistic and logical projections. Even the selection of a forecasting method is usually based on some subjective decision (4, p. 2).

Multiple linear regression was chosen as the method of analysis for this study because economic factors which have been shown to be related to higher education enrollments can be incorporated through this method in an equation to predict enrollments. Regression is appropriate to use in short-term projections, and it is a relatively inexpensive, uncomplicated, and effective method to use with enrollment data.

Application of the method has led to some interesting observations in this study. The fact that the regular academic year enrollments (fall and spring) have tended to be lower than predicted at University I and higher than predicted at University II during recent years indicates that consideration should be given to analysis by academic college or division. The degree offerings at the two institutions located in the same metropolitan area could well be a factor in enrollments. The prospective job opportunities in nursing, engineering, and business attract students (7, p. 89). University II offers degrees in nursing and in engineering while University I does not. Both offer degrees in business. The curriculum areas of least growth are home economics, education, and liberal arts (7, p. 90). University I offers degrees in home economics and in education while University II does not. Both offer degrees in liberal arts. These differences in offerings may also account for the fact that University I has had a nearly horizontal trend in enrollment during the past ten years while University II has experienced moderate increases in enrollment. It is possible that closer projections could be obtained if enrollments were analyzed by college or division and aggregated.

The pattern of the graduate enrollment at University I has been changing over recent years from that of a teacher education oriented institution to that of a comprehensive university. University II first offered graduate work in 1966, and, because of this late beginning, the graduate program is still developing. As stated previously, Breneman (3, p. 84) notes that graduate enrollment in science and engineering is more sensitive to the labor market than graduate enrollment in the humanities or the social sciences. University II has an extensive graduate program in engineering, and the recent decrease in graduate enrollment at this institution could be caused in part by the very favorable employment opportunities for engineers with baccalaureate degrees coupled with the tightening of standards for the awarding of teaching assistantships to international students. Perhaps it is partly for these reasons that the forecasts of graduate enrollments were sometimes inferior to the other forecasts. Furthermore, the graduate enrollments at both institutions examined in this study comprise a small subset of the total student semester credit hours generated at each institution. Undergraduate enrollment dominates the picture. Projections tended to be better for undergraduate and for total enrollment than for graduate enrollment.

There are many forecasting techniques available for projecting enrollments. Each has advantages and disadvantages, and various methods are appropriate under different conditions. No method gives perfect results.

Many quantitative techniques have been used to project enrollments. Curve-fitting techniques have employed simple averages, moving averages, exponential smoothing, polynomial models, exponential models, and spectral analysis. Also, there are causal models or pattern techniques such as cohort-survival models, ratio methods, Markov transition models, multiple correlation and regression methods, path analytical models, and systems of equations (4, p. 2; 8, p. 222). It is likely that a mixed strategy involving several techniques is most appropriate for forecasting enrollments (8, p. 221). Such a mixed strategy could be effected in a professional setting in which an analyst is charged with developing enrollment projections, and this person has the staff and the computer support to accomplish the task.

Always there are factors affecting university enrollments which are qualitative and normative and virtually impossible to deal with in a forecasting model (8, p. 233). Among these factors are regional migration, student attitudes, increases in minority populations, the labor market for graduates, and a changing political climate (7, pp. 6-8) Enrollments may be influenced by revisions in academic or admission requirements of neighboring institutions, by the availability of parking or dormitory space, or by changes in financial aid laws or fuel costs.

The procedure used in this study to project enrollments could be used by any higher education institution. The method has broad applicability. Projections could be made at a system level or a statewide level. Individual institutions could develop equations for various subsets of enrollments as well as for total enrollments. In this study, besides total enrollment, projections were made for undergraduate and graduate enrollments. Enrollment could be divided into Caucasian and minority subgroups, male and female, students under twenty-three years of age and students twenty-three and over, for example. Analyses could be of headcount data rather than of credit hours. Projections could be made for full-time and for part-time enrollment. Kraetsch (4, p. 8) has found part-time enrollment more difficult to predict than full-time enrollment. Enrollments could be predicted by academic department or major budgetary unit. Needs and interests determine which projections should be developed.

Planning is of vital importance especially in difficult times. Good information is essential for good planning, and enrollment projections are a part of the information needed by planners. Adequate enrollment projections are an important contribution to the planning process.

Recommendations

Two major recommendations for further research emerge from the analysis of the explanatory or projection equations. First, summer enrollments should be analyzed separately from regular academic year (fall and spring) enrollments. This recommendation results from the discovery that the pattern of residuals for recent years has not been truly random. The summer residuals have exhibited a trend that is opposite to the trend of residuals for the regular terms. This was found to be true for Salley's data (6) as well as for the six sets of data analyzed in this study. The second recommendation is that, in addition to institutional totals, enrollments should be analyzed by academic college or division. This recommendation comes from the observation that enrollment projections have tended to be too high for University I and too low for University II, both when the projection equations developed in this study are used and in the case of the Coordinating Board's forecasts (1). The degree offerings at the two institutions appear to influence enrollments appreciably because of their relationships to prospective employment opportunities, with the greatest increases in enrollment in the fields where the job market is good.

Other suggestions for enrollment forecasting and further research include the study and elaboration of other quantitative techniques chosen according to the cost of implementation, required precision, appropriateness of technique, adequacy of data base, and availability of computer support. A mixed strategy using several techniques could be employed.

Additionally, higher education enrollments could be analyzed by age, sex, minority status, or hours enrolled. The requirements of an institution or planning group or the needs and interests of a researcher would determine what analyses and projections are to be made.

Enrollment projections are but a part of the complex process of planning for an institution of higher education. As such they are to be incorporated with other data in a body of information to be used by a planner or decision maker whose subjective judgment is a vital part of the planning process. In the practical situation wherein the analyst and decision maker can interact, enrollment projections can be improved by revising projection equations or by using additional techniques that are appropriate to the data and the conditions that exist.

Summary

Enrollment projections are necessary, and they require periodic review and revision. Forecasts of enrollment are useful to decision makers from the statewide level to the level of an individual department in a single institution.

Sound enrollment projections take time, effort, and computer support.

From this study, which produced six explanatory or projection equations for enrollments that fit the data well, two major recommendations emerge. First, summer enrollments should be analyzed separately from regular academic year (fall and spring) enrollments. This is indicated because the pattern of residuals for summers in recent years has had a trend that is opposite to the trend of residuals for the regular terms. Second, enrollments should be analyzed by academic college or division since degree offerings which are related to prospective job opportunities appear to influence enrollments appreciably.

Other suggestions for further research include analyses of higher education enrollments by quantitative methods that fit constraints, restrictions, or conditions that are commonly encountered or by means of a mixed strategy involving several techniques. Analyses of enrollments by categories of age, sex, minority status, or hours enrolled await development and evaluation. Needs and interests of the researcher would dictate the projections to be made.

Any enrollment projection should be blended with other information and subjective judgment by a planner or decision maker. These projections are a contribution to the complex process of planning for an institution of higher education.

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APPENDICES

TABLE V

CORRELATIONS BETWEEN ENROLLMENT CYCLES AND ECONOMIC CYCLES LAGGED ONE PERIOD

Enrollment Cycle	Economic Cycle	Correlation Coefficient, R	Probability of More Extreme R
		University I	
Total SSCH[a]	TX unempl[b]	0.5777	$p < 0.005$ (22df)
Undergraduate SSCH	DFW unempl[c]	-0.5327	$p < 0.025$ (12df)
Graduate SSCH	DFW unempl[c]	0.9016	$p < 0.005$ (12df)
		University II	
Total SSCH	TX unempl[b]	0.4221	$p < 0.025$ (22df)
Undergraduate SSCH	TX unempl[b]	0.3616	$p < 0.05$ (22df)
Graduate SSCH	DFW nonag[d]	-0.3633	$p < 0.05$ (22df)

[a]Student semester credit hours.

[b]Per cent of civilian labor force unemployed in Texas.

[c]Per cent of civilian labor force unemployed in Dallas-Fort Worth SMSA.

[d]Nonagricultural wage and salary jobs in Dallas-Fort Worth SMSA x 1,000 (deviations from trend).

TABLE VI

CORRELATIONS BETWEEN ENROLLMENT CYCLES AND ECONOMIC CYCLES LAGGED TWO PERIODS

Enrollment Cycle	Economic Cycle	Correlation Coefficient, R	Probability of More Extreme R
University I			
Total SSCH[a]	DFW net labor[b]	-0.5302	$p<0.01$ (18df)
Undergraduate SSCH	DFW unempl[c]	-0.4790	$p<0.05$ (12df)
Graduate SSCH	DFW unempl[c]	0.6675	$p<0.005$ (12df)
University II			
Total SSCH	US leading[d]	-0.3658	$p<0.05$ (22df)
Undergraduate SSCH	US leading[d]	-0.3181	$p<0.10$ (22df)
Graduate SSCH	TX nonag[e]	-0.3355	$p<0.10$ (22df)

[a]Student semester credit hours.

[b]Net labor turnover rates in manufacturing industries in Dallas-Fort Worth SMSA.

[c]Per cent of civilian labor force unemployed in Dallas-Fort Worth SMSA.

[d]United States composite index of twelve leading indicators.

[e]Nonagricultural wage and salary jobs in Texas x 1,000 (deviations from trend).

TABLE VII

ENROLLMENTS AND RESIDUALS FROM EXPLANATORY EQUATION FOR UNIVERSITY I TOTAL STUDENT SEMESTER CREDIT HOURS

Period	Actual SSCH	Predicted SSCH	Residual	Standardized Residual	Per Cent DPFA*** SSCH
41	180353	178683	1670	0.5	-0.9
42	74454	70231	4223	1.4	-5.7
43	189853	191833	-1980	-0.6	1.0
44	171743	175620	-3877	-1.3	2.3
45	72422	71415	1007	0.3	-1.4
46	188127	192545	-4418	-1.4	2.3
47	177186	178692	-1506	-0.5	0.9
48	78300	77319	981	0.3	-1.3
49	194547	197505	-2958	-1.0	1.5
50	177987	177045	942	0.3	-0.5
51	71942	70008	1934	0.6	-2.7
52	195405	191611	3794	1.2	-1.9
53	178663	177757	906	0.3	-0.5
54	69885	70720	- 835	-0.3	1.2
55	194981	192795	2186	0.7	-1.1
56	179571	177998	1573	0.5	-0.9
57	67909	70489	-2580	-0.8	3.8
58	194996	191620	3376	1.1	-1.7
59	179002	178710	292	0.1	-0.2
60*	64853	69314	-4731	-1.5	7.3
61**	194118	192807	1131	0.4	-0.6
62	177403	180369	-2966	-1.0	1.7
63	63968	71445	-7477	-2.4	11.7
64	192998	193519	- 512	-0.2	0.3
65	177283	181554	-4271	-1.4	2.4
66	66478	72629	-6151	-2.0	9.3

*Period through which explanatory equation was developed.

**Projection periods, 61-66.

***Deviation of predicted from actual.

TABLE VIII

ENROLLMENTS AND RESIDUALS FROM EXPLANATORY EQUATION FOR UNIVERSITY I UNDERGRADUATE STUDENT SEMESTER CREDIT HOURS

Period	Actual SSCH	Predicted SSCH	Residual	Standardized Residual	Per Cent DPFA*** SSCH
46	165942	168284	-2342	-0.9	1.4
47	152526	153808	-1282	-0.5	0.8
48	53785	48427	5358	2.1	-10.0
49	167075	167913	- 838	-0.3	0.5
50	151680	153463	-1783	-0.7	1.2
51	48669	47962	707	0.3	- 1.5
52	167851	167274	577	0.2	- 0.3
53	152377	152771	- 394	-0.2	0.3
54	46170	47177	-1007	-0.4	2.2
55	167063	166543	520	0.2	- 0.3
56	153497	151946	1551	0.6	- 1.0
57	44881	46499	-1618	-0.6	3.6
58	167841	165758	2083	0.8	- 1.2
59	153149	151241	1908	0.7	- 1.2
60*	42326	45767	-3441	-1.3	8.1
61**	167782	165051	2731	1.1	- 1.6
62	151999	150588	1411	0.5	- 0.9
63	42365	45073	-2708	-1.0	6.4
64	165466	164519	947	0.4	- 0.6
65	151194	150083	1111	0.4	- 0.7
66	45067	44542	525	0.2	- 1.2

*Period through which explanatory equation was developed.

**Projection periods, 61-66.

***Deviation of predicted from actual.

TABLE IX

ENROLLMENTS AND RESIDUALS FROM EXPLANATORY EQUATION
FOR UNIVERSITY I GRADUATE STUDENT
SEMESTER CREDIT HOURS

Period	Actual SSCH	Predicted SSCH	Residual	Standardized Residual	Per Cent DPFA*** SSCH
46	22185	24115	-1930	-1.7	8.7
47	24660	24214	446	0.4	- 1.8
48	24515	22449	2066	1.8	- 8.4
49	27472	26944	528	0.5	- 1.9
50	26307	27044	- 737	-0.7	2.8
51	23273	24091	- 818	-0.7	3.5
52	27554	27399	155	0.1	- 0.6
53	26286	26311	- 25	0.0	0.1
54	23715	23358	357	0.3	- 1.5
55	27918	27853	65	0.1	- 0.2
56	26074	25578	496	0.4	- 1.9
57	23028	23812	- 784	-0.7	3.4
58	27115	25933	1182	1.0	- 4.4
59	25853	26033	- 180	-0.2	0.7
60*	22257	23079	- 822	-0.7	3.7
61**	26336	26862	- 562	-0.5	2.1
62	25404	26368	- 964	-0.9	3.8
63	21603	23889	-2286	-2.0	10.6
64	27532	28266	- 734	-0.6	2.7
65	26089	28010	-1921	-1.7	7.4
66	21411	25294	-3833	-3.4	18.1

*Period through which explanatory equation was developed.

**Projection periods, 61-66.

***Deviation of predicted from actual.

TABLE X

ENROLLMENTS AND RESIDUALS FROM EXPLANATORY EQUATION FOR UNIVERSITY II TOTAL STUDENT SEMESTER CREDIT HOURS

Period	Actual SSCH	Predicted SSCH	Residual	Standardized Residual	Per Cent DPFA*** SSCH
37	168199	171419	- 3220	-0.6	1.9
38	150405	155632	- 5227	-0.9	3.5
39	58115	47444	10670	1.9	-18.4
40	172467	174632	- 2165	-0.4	1.3
41	157739	158744	- 1005	-0.2	0.6
42	56923	49997	6926	1.2	-12.2
43	177584	177500	84	0.0	0.0
44	157453	162159	- 4706	-0.8	3.0
45	56117	54431	1686	0.3	- 3.0
46	178448	182523	- 4075	-0.7	2.3
47	165103	167885	- 2782	-0.5	1.7
48	65163	61536	3627	0.7	- 5.6
49	186679	190260	- 3581	-0.6	1.9
50	176115	173554	2561	0.5	- 1.5
51	64000	64964	- 964	-0.2	1.5
52	194704	192209	2495	0.5	- 1.3
53	177783	176207	1576	0.3	- 0.9
54	62615	68048	- 5433	-1.0	8.7
55	198156	195566	2590	0.5	- 1.3
56	182943	179822	3121	0.6	- 1.7
57	63910	71448	- 7538	-1.4	11.8
58	207111	199239	7872	1.4	- 3.8
59	190015	183552	6463	1.2	- 3.4
60*	66476	75451	- 8975	-1.6	13.5
61**	215834	203544	12290	2.2	- 5.7
62	197542	188231	9311	1.7	- 4.7
63	70683	79426	- 8743	-1.6	12.4
64	228151	209644	18507	3.3	- 8.1
65	206123	194934	11189	2.0	- 5.4
66	71960	85554	-13594	-2.5	18.9

*Period through which explanatory equation was developed.

**Projection periods, 61-66.

***Deviation of predicted from actual.

TABLE XI

ENROLLMENTS AND RESIDUALS FROM EXPLANATORY EQUATION FOR UNIVERSITY II UNDERGRADUATE STUDENT SEMESTER CREDIT HOURS

Period	Actual SSCH	Predicted SSCH	Residual	Standardized Residual	Per Cent DPFA*** SSCH
37	160425	162973	- 2548	-0.6	1.6
38	142850	147469	- 4619	-1.0	3.2
39	54850	46009	8841	1.9	-16.1
40	164433	164905	- 472	-0.1	0.3
41	149226	149317	- 91	0.0	0.1
42	52962	47386	5576	1.2	-10.5
43	166953	166547	406	0.1	- 0.2
44	146912	151417	- 4505	-1.0	3.1
45	50708	50342	366	0.1	- 0.7
46	166246	169996	- 3750	-0.8	2.3
47	152602	155456	- 2854	-0.6	1.9
48	58680	55537	3143	0.7	- 5.4
49	172354	175722	- 3368	-0.7	2.0
50	161994	159447	2547	0.6	- 1.6
51	56808	57649	- 841	-0.2	1.5
52	178627	176594	2033	0.4	- 1.1
53	162142	160909	1233	0.3	- 0.8
54	55450	59472	- 4022	-0.9	7.3
55	180058	178646	1412	0.3	- 0.8
56	165531	163178	2353	0.5	- 1.4
57	55000	61561	- 6561	-1.4	11.9
58	187249	180963	6286	1.4	- 3.4
59	171478	165543	5935	1.3	- 3.5
60*	57652	64155	- 6503	-1.4	11.3
61**	195900	183812	12088	2.6	- 6.2
62	178575	168705	9870	2.2	- 5.5
63	60896	66727	- 5831	-1.3	9.6
64	208654	188164	20490	4.5	- 9.8
65	187212	173563	13649	3.0	- 7.3
66	62769	71103	- 8334	-1.8	13.3

*Period through which explanatory equation was developed.

**Projection periods, 61-66.

***Deviation of predicted from actual.

TABLE XII

ENROLLMENTS AND RESIDUALS FROM EXPLANATORY EQUATION FOR UNIVERSITY II GRADUATE STUDENT SEMESTER CREDIT HOURS

Period	Actual SSCH	Predicted SSCH	Residual	Standardized Residual	Per Cent DPFA*** SSCH
37	7774	8137	- 363	-0.3	4.7
38	7555	8081	- 526	-0.5	7.0
39	3265	1504	1761	1.5	-53.9
40	8034	9809	-1745	-1.5	22.1
41	8513	9584	-1071	-0.9	12.6
42	3961	2809	1152	1.0	-29.1
43	10631	11089	- 458	-0.4	4.3
44	10541	10777	- 236	-0.2	2.2
45	5409	4036	1373	1.2	-25.4
46	12202	12385	- 183	-0.2	1.5
47	12501	12089	412	0.4	- 3.3
48	6483	5664	819	0.7	-12.6
49	14325	14368	- 43	0.0	0.3
50	14121	14183	- 62	-0.1	0.4
51	7192	7424	- 232	-0.2	3.2
52	16077	15765	312	0.3	- 1.9
53	15641	15502	139	0.1	- 0.9
54	7165	8911	-1746	-1.5	24.4
55	18098	17261	837	0.7	- 4.6
56	17412	16983	429	0.4	- 2.5
57	8910	10106	-1196	-1.0	13.4
58	19862	18189	1673	1.5	- 8.4
59	18537	17623	914	0.8	- 4.9
60*	8824	10755	-1931	-1.7	21.9
61**	19934	18945	989	0.9	- 5.0
62	18967	18585	382	0.3	- 2.0
63	9742	11735	-1993	-1.7	20.5
64	19497	20116	- 619	-0.5	3.2
65	18911	19896	- 985	-0.9	5.2
66	9191	12917	-3726	-3.2	40.5

*Period through which explanatory equation was developed.

**Projection periods, 61-66.

***Deviation of predicted from actual.

TABLE XIII

UNIVERSITY I STUDENT SEMESTER CREDIT HOUR ENROLLMENT, FALL, 1959, THROUGH SUMMER, 1981

Semester	Period	Undergraduate	Graduate	Total
Fall, 1959	1	98486	2954	101340
Spring, 1960	2	87588	3028	90616
Summer, 1960	3	29930	7889	37819
Fall, 1960	4	102471	3497	105968
Spring, 1961	5	94136	3448	97584
Summer, 1961	6	34180	8335	42515
Fall, 1961	7	120835	3947	124782
Spring, 1962	8	108018	4050	112068
Summer, 1962	9	36397	9419	45816
Fall, 1962	10	134719	4197	138916
Spring, 1963	11	122950	4397	127347
Summer, 1963	12	41713	10170	51883
Fall, 1963	13	141159	5304	146463
Spring, 1964	14	127514	5690	133204
Summer, 1964	15	44146	12118	56264
Fall, 1964	16	152538	6074	158612
Spring, 1965	17	135120	6223	141343
Summer, 1965	18	49678	14532	64210
Fall, 1965	19	168797	7485	176282
Spring, 1966	20	151254	7971	159195
Summer, 1966	21	49834	16273	66107
Fall, 1966	22	174527	9217	183744
Spring, 1967	23	153963	9469	163432
Summer, 1967	24	52332	16734	69066
Fall, 1967	25	178029	11253	189282
Spring, 1968	26	158897	11771	170668
Summer, 1968	27	53351	17529	70880
Fall, 1968	28	179650	12353	191903
Spring, 1969	29	163780	13249	177029
Summer, 1969	30	52562	18100	70662
Fall, 1969	31	178778	14852	193630
Spring, 1970	32	160517	15650	176167
Summer, 1970	33	54761	19076	73837
Fall, 1970	34	173282	17126	190408
Spring, 1971	35	159873	17429	177302
Summer, 1971	36	59257	20640	79897
Fall, 1971	37	175649	19433	195082
Spring, 1972	38	160573	18721	179294
Summer, 1972	39	57545	20880	78425

TABLE XIII--*Continued*

Semester	Period	Undergraduate	Graduate	Total
Fall, 1972	40	175268	20329	195597
Spring, 1973	41	159780	20573	180353
Summer, 1973	42	53307	21147	74454
Fall, 1973	43	168356	21497	189853
Spring, 1974	44	151461	20282	171743
Summer, 1974	45	50816	21606	72422
Fall, 1974	46	165942	22185	188127
Spring, 1975	47	152526	24660	177186
Summer, 1975	48	53785	24515	78300
Fall, 1975	49	167075	27472	194547
Spring, 1976	50	151680	26307	177987
Summer, 1976	51	48669	23273	71942
Fall, 1976	52	167851	27554	195405
Spring, 1977	53	152377	26286	178663
Summer, 1977	54	46170	23715	69885
Fall, 1977	55	167063	27918	194981
Spring, 1978	56	153497	26074	179571
Summer, 1978	57	44881	23028	67909
Fall, 1978	58	167841	27115	194996
Spring, 1979	59	153149	25853	179002
Summer, 1979	60	42326	22257	64583
Fall, 1979	61	167782	26336	194118
Spring, 1980	62	151999	25404	177403
Summer, 1980	63	42365	21603	63968
Fall, 1980	64	165466	27532	192998
Spring, 1981	65	151194	26089	177283
Summer, 1981	66	45067	21411	66478

TABLE XIV

UNIVERSITY II STUDENT SEMESTER CREDIT HOUR ENROLLMENT, FALL, 1959, THROUGH SUMMER, 1981

Semester	Period	Undergraduate	Graduate	Total
Fall, 1959	1	75244	. . .	75244
Spring, 1960	2	63542	. . .	63542
Summer, 1960	3	19881	. . .	19881
Fall, 1960	4	87598	. . .	87598
Spring, 1961	5	75741	. . .	75741
Summer, 1961	6	27082	. . .	27082
Fall, 1961	7	95902	. . .	95902
Spring, 1962	8	80851	. . .	80851
Summer, 1962	9	29648	. . .	29648
Fall, 1962	10	103677	. . .	103677
Spring, 1963	11	90235	. . .	90235
Summer, 1963	12	33262	. . .	33262
Fall, 1963	13	109787	. . .	109787
Spring, 1964	14	94832	. . .	94832
Summer, 1964	15	36745	. . .	36745
Fall, 1964	16	126126	. . .	126126
Spring, 1965	17	111782	. . .	111782
Summer, 1965	18	43530	. . .	43530
Fall, 1965	19	138074	. . .	138074
Spring, 1966	20	116652	. . .	116652
Summer, 1966	21	43376	. . .	43376
Fall, 1966	22	135612	446	136058
Spring, 1967	23	116772	433	117210
Summer, 1967	24	44197	315	44512
Fall, 1967	25	139514	828	140342
Spring, 1968	26	122375	932	123307
Summer, 1968	27	45524	395	45919
Fall, 1968	28	148054	2088	150142
Spring, 1969	29	131142	2337	133479
Summer, 1969	30	48031	1292	49323
Fall, 1969	31	162040	3908	165948
Spring, 1970	32	143147	4000	147147
Summer, 1970	33	51220	1808	53028
Fall, 1970	34	166983	5840	172823
Spring, 1971	35	147232	6237	153469
Summer, 1971	36	54088	2611	56699
Fall, 1971	37	160425	7774	168199
Spring, 1972	38	142850	7555	150405
Summer, 1972	39	54850	3265	58115

TABLE XIV--Continued

Semester	Period	Undergraduate	Graduate	Total
Fall, 1972	40	164433	8034	172467
Spring, 1973	41	149226	8513	157739
Summer, 1973	42	52962	3961	56923
Fall, 1973	43	166953	10631	177584
Spring, 1974	44	146912	10541	157453
Summer, 1974	45	50708	5409	56117
Fall, 1974	46	166246	12202	178448
Spring, 1975	47	152602	12501	165103
Summer, 1975	48	58680	6483	65163
Fall, 1975	49	172354	14325	186679
Spring, 1976	50	161994	14121	176115
Summer, 1976	51	56808	7192	64000
Fall, 1976	52	178627	16077	194704
Spring, 1977	53	162142	15641	177783
Summer, 1977	54	55450	7165	62615
Fall, 1977	55	180058	18098	198156
Spring, 1978	56	165531	17412	182943
Summer, 1978	57	55000	8910	63910
Fall, 1978	58	187249	19862	207111
Spring, 1979	59	171478	18537	190015
Summer, 1979	60	57652	8824	66476
Fall, 1979	61	195900	19934	215834
Spring, 1980	62	178575	18967	197542
Summer, 1980	63	60896	9742	70683
Fall, 1980	64	208654	19497	228151
Spring, 1981	65	187212	18911	206123
Summer, 1981	66	62769	9191	71960

TABLE XV

FOUR-MONTH AVERAGES OF SEVEN ECONOMIC CYCLES

Period	U.S. Leading[a]	U.S. Coincident[b]	TX Unemploy[c]	TX Nonag[d]	DFW Unemploy[e]	DFW Nonag[f]	DFW Net Labor[g]
34[h]	104.4	107.0	4.7	109.25	. . .	39.90	. . .
35	111.6	108.5	5.2	28.04	. . .	6.71	. . .
36	113.9	109.3	5.1	23.74	. . .	1.55	. . .
37	115.7	110.6	4.6	- 2.46	. . .	0.69	. . .
38	121.0	115.0	4.6	- 31.07	. . .	-12.10	0.3
39	124.0	117.5	4.6	1.53	. . .	2.48	0.0
40	129.7	121.8	4.2	18.32	. . .	10.22	0.1
41	132.8	126.1	4.0	- 5.08	. . .	9.78	0.4
42	132.0	127.3	4.3	46.42	. . .	28.47	0.7
43	130.6	128.9	3.3	55.91	. . .	35.48	- 0.1
44	129.6	127.1	3.9	17.61	3.7	16.01	0.3
45	123.9	126.8	4.3	65.60	4.1	24.18	0.1
46	112.9	122.1	4.5	6.40	4.5	3.04	- 1.3
47	107.5	113.5	5.4	-109.00	5.7	-38.53	- 0.7
48	116.2	114.9	5.8	- 85.11	6.3	-48.79	0.5
49	120.8	118.2	5.4	- 71.91	5.8	-42.85	0.3
50	125.7	121.9	5.7	-108.42	5.7	-73.02	0.6
51	129.5	123.8	6.2	- 67.52	5.9	-36.33	0.4
52	131.1	125.3	5.3	- 90.82	4.7	-36.17	0.2
53	134.1	128.4	5.8	-129.33	5.0	-43.53	0.4
54	136.1	131.4	5.1	- 85.13	4.5	-20.15	0.4
55	139.2	134.2	5.1	- 46.23	4.4	- 8.36	0.3
56	140.3	136.3	4.8	- 26.74	3.9	- 7.17	0.7
57	141.9	140.4	4.9	80.06	4.0	26.61	0.3

TABLE XV--Continued

Period	U.S. Leading[a]	U.S. Coincident[b]	TX Unemploy[c]	TX Nonag[d]	DFW Unemploy[e]	DFW Nonag[f]	DFW Net Labor[g]
58	143.1	143.6	4.4	116.95	3.7	47.37	0.6
59	142.1	145.1	4.1	113.45	3.4	46.51	0.5
60[i]	141.1	145.3	4.5	175.55	3.9	69.40	0.0

[a]United States composite index of twelve leading indicators.

[b]United States composite index of four roughly coincident indicators.

[c]Per cent of civilian labor force unemployed in Texas.

[d]Nonagricultural wage and salary jobs in Texas x 1,000 (deviations from trend).

[e]Per cent of civilian labor force unemployed in Dallas-Fort Worth SMSA.

[f]Nonagricultural wage and salary jobs in Dallas-Fort Worth SMSA x 1,000 (deviations from trend).

[g]Net labor turnover rates in manufacturing industries in Dallas-Fort Worth SMSA.

[h]Fall, 1970.

[i]Summer, 1979.

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