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Economic base model : alternative methods of analysis and their application to rural areas using covered wages and salaries

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The Economic Base Model: Alternative Methods of Analysis and Their Application to Rural Areas Using Covered Wages and Salaries

by

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This study will investigate an alternative method for estimating the parameters of the economic base model and will evaluate its forecasting performance in rural areas using covered wages and salaries. The economic base model is frequently used to analyze small economic regions. It postulates that the derivative or local sector is a function of an export or basic sector.

Regression analysis has traditionally been used to quantify the relationship between the basic and derivative sectors, and will provide the benchmark against which the alternative will be evaluated.

Transfer functions provide an alternative to traditional regression analysis for quantifying the relationship between basic and derivative sectors. A transfer function formulation of the economic base model postulates that the derivative sector is a function of the basic sector and past trends in the derivative sector; parameter values are derived using an autoregressive-integrated-moving-average (ARIMA) method.

A diverse group of Montana counties will be analyzed to investigate the application of a transfer function version of the economic base model in a variety of economic situations. The study areas are include Flathead, Butte-Silver Bow and Anaconda-Deer Lodge, Rosebud and Valley counties. These study areas have experienced various patterns of economic development as well as have different economic structures and population bases.

The alternative specifications will be estimated using quarterly data for wages and salaries from the Montana Department of Labor and Industry. This information is available beginning in 1961 and includes persons covered by Montana Unemployment Insurance.

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CHAPTER I: THE ECONOMIC BASE MODEL

The main advantage of the economic base model is that it is very simple to use (Tiebout [1962]) and can be modeled using data that are generally available. Economic base analysis has historically been used to quantify the short-term impact of an economic event. The heavy reliance on the economic base model by planners has polarized the discussion of impact models. The following discussion briefly describes the economic base model and identifies some of the concerns expressed by critics.

Derivation of the Economic Base Model

The economic base model hypothesizes that all regional growth is dependent on outside forces. Those sectors of the economy dependent on outside markets are called basic and serve as building blocks for the rest of the economy called derivative. Other terms used to describe the basic sector are export, exogenous, and primary. The derivative sector is often called the service, endogenous, tertiary, or secondary sector. The first mention of derivative growth because of basic activity in regional context was by Aurousseau [1921]:

> "The more primary citizens there are, the more secondary in a relation something like compound interest."

Other early economists and geographers recognizing this relationship were Adams [1929], Jefferson [1931], and Hartshorne [1936]. The first attempts at measuring the economic base used ratios (Wiemer and Hoyt [1939]). The first application with data was a study of British cities by Daly [1940] using employment data from the 1920 and 1930 British censuses. Daly's estimates of a multiplier were very close to more recent estimates using sophisticated models and detailed data.

More recently, regression methods have been used for modeling the economic base. The economic base model estimated by regression can be portrayed in a Keynsian framework as a mathmatical relationship of income:

$$Y = D + E \qquad (1)$$

where Y (total wages and salaries), D (derivative wages and salaries), and E (export wages and salaries). Derivative income (D) is specified as a linear relationship with income (Y):

$$D = a + bY \qquad (2)$$

$$Y = (D - a)/b \qquad (3)$$

A multiplier is derived by combining (1) and (3):

$$(D - a)/b = D + E \qquad (4)$$

$$D = [1/(1-b)](a+bE) \qquad (5)$$

or

$$Y = a/(1-b) + 1/(1-b)E \qquad (6)$$

1/(1-b) is the traditional multiplier. "b" is related to the propensity to spend locally.

Estimating the Basic and Derivative Sectors

The main problem with using the economic base model is deriving reliable measures of the basic and derivative sectors. Four main methods are generally used to assign industries to either the basic or derivative sectors: location quotients (Mattila and Thompson [1955], minimum requirements (Ullman and Dacey [1960]), special situations (Andrews [1954 #3]), Greenhut [1959]), and direct assignment (Andrews [1954 #3]). Each method has its advantages and disadvantages as will be summarized below.

Location quotients are the most widely used method to bifurcate a regional economy. Location quotients compare the structure of the regional economy with that of a benchmark economy (i.e., the nation, the state). Usually industries are considered candidates for the basic sector if they are relatively more important in the subject economy. The most cited criticism of the location quotient method is that it fails to take into account regional differences in household income, production practices and industrial mix. This method generally underestimates the basic sector.

Minimum requirements assumes a region allocates a minimum amount of resources to produce each good used by local residents. Minimum needs are usually based on population (i.e., per capita). The excess portion is assigned to the basic sector. This method may be best used for measuring the economic base where true exports do not exist (i.e., amenity based income flows such as retirement payments and part-time residents).

Special situations are the presence of unusual activities such as universities, tourism, commuter activity, import substitution, and agglomeration effects. These are generally discussed as parts of the economic base, however, criticism may occur in the actual measurement of the base. Greenhut [1959] discusses the potential effects of import substitution on increased derivative activities. He suggests in many cases expansion of local service activities may have more long-term growth potential than the opening of a new factory paying low wages.

Direct assignment incorporates a knowledge of the local conditions. Industries are assigned as basic or nonbasic depending on their primary market (i.e., those selling outside the area are assigned to the basic sector and those serving the local area are classified as derivative). This method will be used in this study to classify industries as basic or nonbasic. The small size of the study areas means that broad industry categories may, in fact, consist of only a few firms, thus simplifying the bifurcation decision. The main weakness of this approach is that some firms may have a basic component and be classified as derivative or vice versa.

Criticisms

The economic base model is not without its critics. These criticisms fall into three major classes: bifurcation of the economy into basic and nonbasic sectors, long-run vs. a short-run model, and the economic base approach ignores the position of a region in the regional hierarchy.

Gerking and Isserman [1981] point out that the method used to classify industries is the most important determinant of how the economic base model performs. Richardson [1985], a long-time critic of the economic base model, points out many critcisms in how the economic base is bifurcated. In his survey articles on multipliers he criticizes and describes the various methods of delineating the economic base. These methods and some problems associated with them were discussed earlier.

The question of whether the economic base model is a short or long-term explanation of economic growth has not been resolved. North [1955] argued that the economic base model is a short-term impact model. On the other hand Tiebout [1956] suggests that the model is more relevant for the long-term. Isard [1960] points out that although much of the multiplier effect derived from the economic base model is short-run, the effects may be felt over a long period of time.

Isard [1960] also pointed out that the focus of the economic base model is a single region. One area, however, is usually part of a hierarchy of regions with significant linkages among them. Ignoring these linkages may cause biases when modeling a regional economy with the economic base model because the bifurcation of the economy into basic and derivative sectors may be flawed. This bias may be especially severe in trade centers or amenity regions with large tourist related sectors.

Even with these criticisms, the economic base model is used for impact analysis. The purpose of this study is to compare the performance of an alternative methodology, the transfer function, with the traditional parameter estimation technique of regression. Further discussion of the bifurcation and other criticisms is contained in following sections.

CHAPTER II: ARIMA MODELS AND THE TRANSFER FUNCTION

Autoregressive-integrated-moving-average (ARIMA) models are a family of models that forecast movement of a time series by inspecting past values of the time series. A time series is explained by past values and a weighted sum of random disturbances affecting the time series. Transfer functions expand the ARIMA model by investigating the effect of independent variables on the weighted sum of random disturbances estimated by the simple ARIMA model. Transfer functions are similar to regression, but some causality may be inferred in that current changes are influenced by past values of the independent variable.

The Terminology

Several terms and their corresponding symbols are generally used when discussing auto-regressive-integrated-moving-average (ARIMA) models. Since ARIMA models are primarily interested in the lag structure of a time series, a simplified notation is necessary. The conventional term describing the lag structure is called the back-shift operator it is shown mathematically in equation (1):

$$Bz_t = z_{t-1} \qquad (1)$$

Also important is the backward difference operator presented in equation (2).

$$\nabla^1 z_t = z_t - z_{t-1} = (1 - B)z_t \qquad (2)$$

A simplified notation for an estimated ARIMA model is often used. For example, a seasonal model with both an autoregressive component and seasonal autoregressive component, first and seasonal differencing is represented by $(1,1,0)(1,1,0)_4$. The subscript delineates the seasonal pattern, the first number in each parentheses defines the number of autoregressive terms, the second number the level of differencing, and the third number the number of moving-average parameters. The models estimated in this study will use this notation.

The Background

ARIMA and transfer function models are generally attributed to Box and Jenkins [1976], however, the basic foundations were formulated by others. Yule [1921, 1926, 1927] pointed out the problems associated with interpreting correlations between time series without knowing the correlations among individual values (autocorrelations) of the separate series. Quenouille [1957] outlined the structures of ARIMA models as well as developed methods of identification and estimation of the defined models. He also outlined the schematic identification and estimation components of the "Box-Jenkins method".

Box and Jenkins [1976] extended the concepts developed by Quenoulle. They state three basic assumptions concerning the form of the time series: stationarity, the number of parameters (parsimony) and bounds on the parameter values (invertiblity). Each of these assumptions will be described.

Stationarity means that the time series has a constant mean and constant variance. Stationarity of the data is obtained through transformations. Differencing, both simple and seasonal, is usually adequate however more complicated transformations such as the logarithmic transformation maybe necessary to achieve stationarity.

Parsimony requires the fewest number of parameters possible to derive a functionable model. Parsimony provides for model stability.

Invertibility means the parameter values are between negative 1 and positive 1. Parameters within these bounds insure the effect past values of the time series have on the model will eventually fade to zero.

The Modeling Process

Box and Jenkins also formalized a modelling process of identification, estimation, diagnostic checking and forecasting. Within the modeling process, they suggest several criteria to use when identifying and estimating ARIMA models. Each of these steps and the corresponding criteria will be described.

The identification process uses the assumption of stationarity and the theoretical underpinnings of ARIMA models to hypothesize a preliminary model. Once stationarity is achieved by the appropriate transformation(s), the autocorrelation function (ACF), and partial autocorrelation function (PACF) are inspected. The autocorrelation function is the plot of the autocorrelation coefficient against lags. The autocorrelation at lag k is:

$$p_k = \text{cov}[z_t, z_{t+k}]/\sigma^{2z}$$

The PACF is the autocorrelation coefficient controlling for the effect of intervening lags. It is not easily represented by a formula as it is the solution of a system of Yule-Walker equations (Box and Jenkins [1976]). It can be shown that the PACF is a series of equations using the ACF of the previous lags (McCleary and Hay [1980]). Each type of ARIMA model has a distinctive form of ACF and PACF (Box and Jenkins [1976]). The identification process makes use of the theoretical ACF and PACF. Seasonality also can be identified using the characteristic forms. These distinctive functions are diagrammed in Exhibit 1 for several processes common to economic time series.

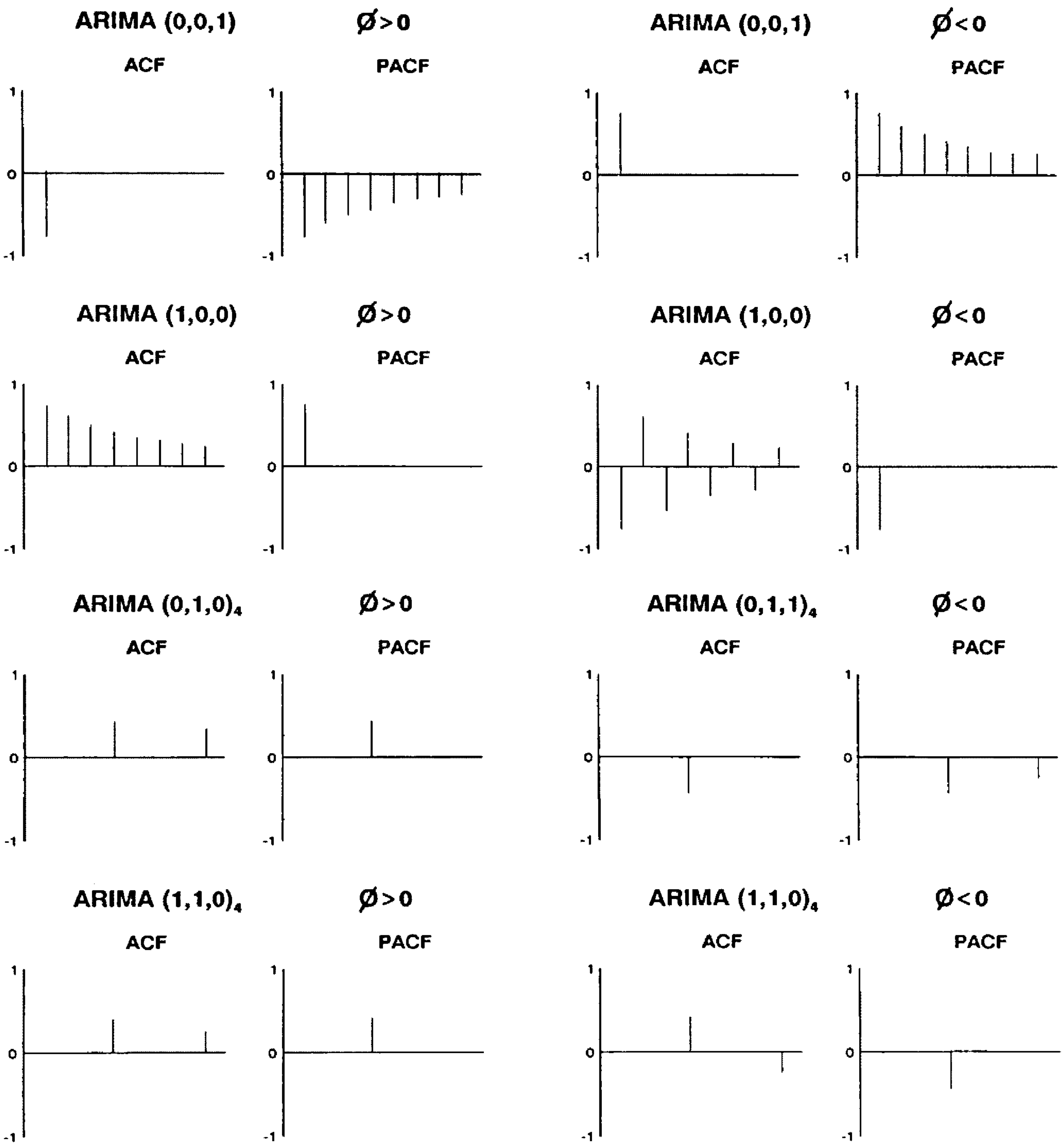
Once a preliminary model, following the notion of parsimony, has been identified, the second step in the modeling process, estimation of parameters, is carried out using maximum likelihood methods. Discussion of maximum likelihood estimation algorithms is beyond the scope of this study.

The third step of the "Box-Jenkins method" is diagnostic checking. The individual parameters must be inspected. The invertibility assumption is paramount in diagnostic checking. The significance level of the individual parameters is also important. This is usually measured by the T-statistic. Parameters that are not significant at a relatively high level should be eliminated in further estimation processes as they violate the parsimony principle and may lead to instability in the model.

The overall fit of the model is also important. Comparison of the actual and the fitted series is a generally recognized statistic. The Q-statistic (Ljung and Box [1978]) is now the most often used goodness of fit measure. Box and Jenkins [1976] also suggest

EXHIBIT 1

Characteristic ACF and PACF Common ARIMA Models



inspection of the residuals. The ACF of the residuals is inspected for outlyers. If no outlyers are apparent, the model is probably adequate and further diagnostics may be unnecessary.

If the model is deemed inadequate through the various suggested diagnostics, the estimation process is repeated with a slightly different model until an adequate model is estimated. Once a model is estimated, the series is forecasted.

The previous discussion has been concerned with univariate ARIMA model identification and estimation. The identification of transfer functions follow much the same process. The effect of the independent variable(s) on the residuals from the derived ARIMA model is then estimated. The resulting model is the transfer function. The same diagnostic testing used for the ARIMA model is applied to the transfer function model.

CHAPTER III:

THE TRANSFER FUNCTION AND THE ECONOMIC BASE MODEL

Transfer function models were originally used to model manufacturing and chemical process. Bennett [1974] introduced transfer functions to regional science when he modeled the North-West England area. His results were encouraging. Cook [1979] used a transfer function model for estimating the economic base relationship for two counties in Washington. His results were also encouraging.

Buonigirno et al. [1988] derive a dynamic multiplier of an multivariate autoregressive model by using the recursive structure of the autoregressive model and the requirement that the absolute value of the coefficients be less than one. Expansion of the model creates an infinite series in two variables. Since the absolute value of the coefficients is less than one (invertibility), the series converges. By generalizing this series to a unit change in the independent variable, a multiplier is derived. Chow [1981] explains a similar scenario for macroeconomic variables.

The transfer function as an estimation technique for the economic base model has some advantages over traditional regression methods. One of the criticisms of the economic base model is that it fails to take into account the resident population as a self-sustaining economic entity with is own growth potential. This resident population may have sources of income that are derived from non-participation in the labor force (i.e., retirement or property income). These sources of income are outside the traditional economic base. The transfer function incorporates these sources of income into the model though past values of derivative.

The question of whether economic base multipliers are long- or short-run is also addressed by the transfer function. The coefficient of the independent variable in the transfer function is an impulse function indicating the incremental change of an increase in the independent variable basic. Expansion of the transfer function model results in a distributed lag model incorporating both the derivative and basic sectors. The coefficients of the unexpanded model produce a short-term impact multiplier while the expanded form generates a long-term multiplier.

CHAPTER IV: THE DATA

Units of Measure

The choice of the units of measure and the data used has a large affect on measurement of the economic base. Employment has often been used in economic base studies (Tiebout [1956], [1962]) because of the general availability of data. Relationships developed with employment data do not account for differences in earnings in different industries. More recent work (Polzin [1977], Polzin et al. [1988]) use wage and salary data.

Hoover [1948] points out that employment and income alone may not adequately explain the importance of an industry to the economic base. Such an industry (i.e., university) may have relatively low employment but be responsible for substantial local purchases. Because of such industries, Andrews [1954] in his comprehensive study of economic base analysis suggests that the flexibility in the units of measure used to identify the economic base be retained.

Description of the Data

The specifications in this study will be estimated using ES-202 quarterly data for wages and salaries compiled by the Montana Department of Labor and Industry. This information is available beginning in 1961 and includes jobs covered by Montana

Unemployment Insurance. These detailed data are available at the county level. Data are compiled at 3-digit SIC codes pre-1973; 4-digit SIC codes post-1973. These data are collected at the firm level and represent actual wages paid.

There are several advantages for using ES-202 data. It is the only source of wages and salaries available at a detailed industry level for counties. This detail allows for more precise bifurcation of the industries. In small economies such as those in this study, an analyst is generally working with very few firms, thus, the identification of the economic base using 3 or 4 digit SIC codes approaches a firm by firm classification. Data are available for 1961-1987 period and are collected on a quarterly basis. Over one hundred observations are available for the time series of wages and salaries. Sophisticated modelling techniques require a large number of observations. In addition, the quarterly frequency enables seasonal patterns to be quickly identified.

ES-202 data do have limitations. Only workers covered under state UI laws are included. The ES-202 data do not include earnings of the self-employed. One major sector of the economy, railroads, is not covered. The railroad industry has a separate reporting program. In addition, most workers in agriculture are self-employed or exempt from unemployment insurance. Only about 7 percent of agricultural employment is covered. Covered wages and salaries account for about 45 percent of total personal income and 70 percent of labor income.

Various industries have been added to the reporting requirements over time, so discontinuities in the data occur. No attempt has been made to make estimates for uncovered industries or to correct for discontinuities in the data, to investigate the robustness of the transfer function as a forecasting tool.

CHAPTER V: THE STUDY AREAS

Definition of Regions

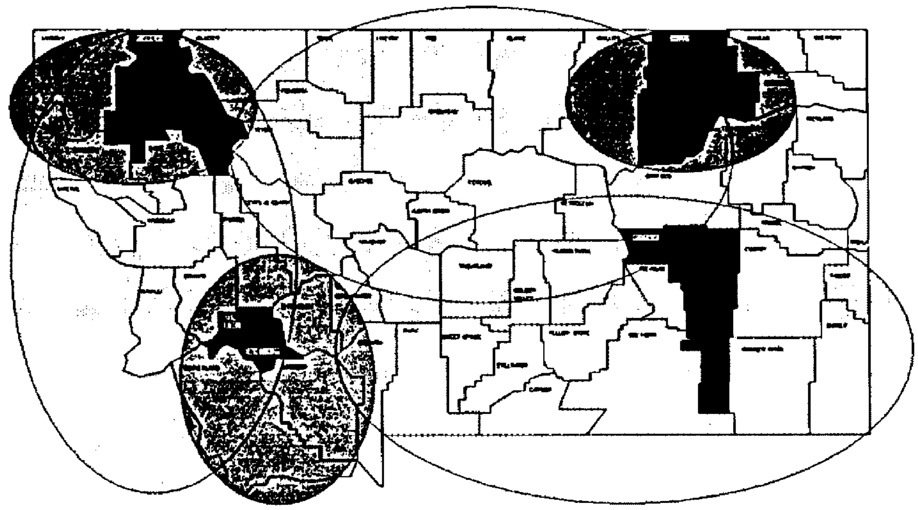
The definition of regional boundaries is a problem in defining the economic base. Andrews [1954] suggests two goals to remember when defining a region. First, the region be an economic and social entity with significant interdependencies between the productive and distributive parts of the economy. Second, the region be delineated in a way that comparisons with other regions or combinations of regions can be facilitated. The definition of the region is also dependent on the availability of data. Defining a region for which data are not available is an exercise in futility. The county is being used in this study because it is the smallest area for which data are available. These data are available for all counties, thus the second goal is accomplished.

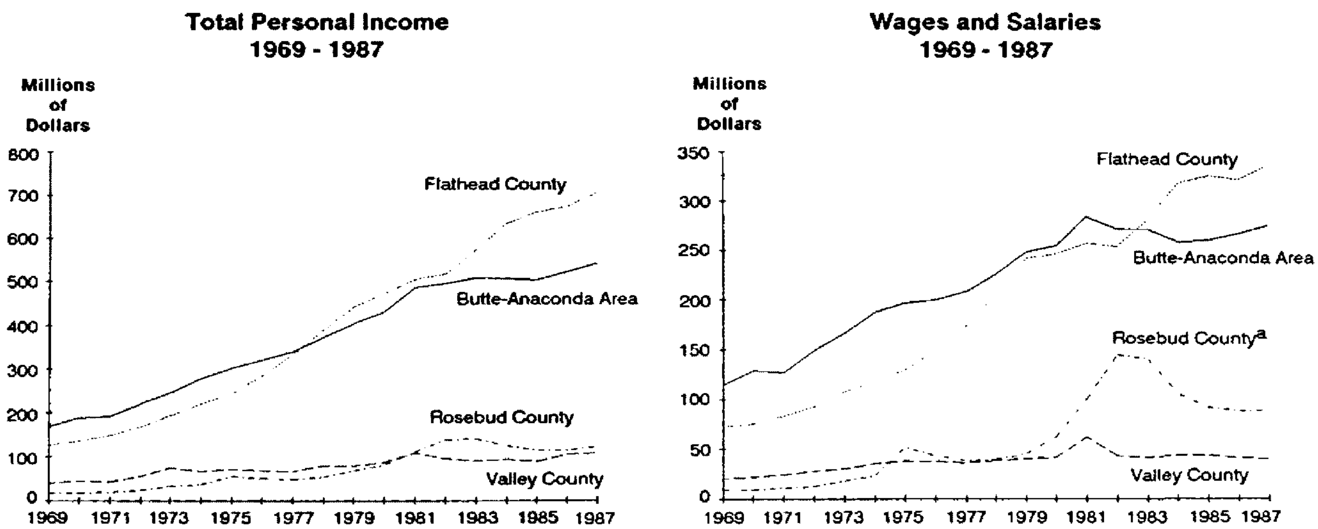
Characteristics of the Study Areas

The study regions (Flathead, Butte-Silver Bow and Anaconda-Deer Lodge, Valley, and Rosebud counties) have been chosen for several reasons: position in the regional hierarchy, different growth trends, different levels of coverage, and different economic bases. Each reason will be briefly discussed and differences among the study regions identified.

EXHIBIT 2

Description of the Study Areas





Source: U. S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System (April 1989).

[a]Includes wages and salaries of persons working in Rosebud County and living elsewhere.

A region's position within the hierarchy of regions is an important determinant of the multiplier. Thompson [1982, 1983] hypothesizes the multiplier will be higher for trade centers than for simple subsistence economies. Exhibit 2 maps the four study regions within the state of Montana. The Flathead and the Butte-Anaconda regions serve rural hinterlands, but are themselves served by a higher-order city, Missoula. Valley County serves a small agricultural hinterland but is itself served by Great Falls, a higher order city. Rosebud County is relatively close to the major trade center of Billings and has no hinterland.

The areas have also been chosen because they experienced different trends during the study period. Exhibit 2 also shows the fluctuations in total personal income and wage and salary labor income. These data are from the Bureau of Economic Analysis and include sectors of the economy not reported under the ES-202 program. Using data from the ES-202 data series may yield different trends because uncovered industries may perform differently than covered industries.

Flathead County experienced continuous growth as measured by these statistics. A slowdown in growth of total personal income occurred in 1981 and 1982. Wages and salaries experienced stagnation during 1979-1982 and again in 1984-1986. The Butte-Anaconda area had growth from 1969-1981 then stopped in 1981 with the closure of the Anaconda Copper Company mining and smelter operations. Some growth has occurred since 1985. Valley County has remained stable throughout the time period as measured by total personal income and wage and salary income. The only exception is the blip in

1981 with construction of the Bearpaw Pipeline. Farm income has also fluctuated throughout the time period but does not appear to affect these measures. The most dramatic boom and bust periods occurred in Rosebud County with the transformation from an agricultural economy to a more industrial economy. This boom period shows up in the graphical representations of the data. The data for Rosebud County include the wages and salaries of workers who worked in Rosebud County but lived elsewhere.

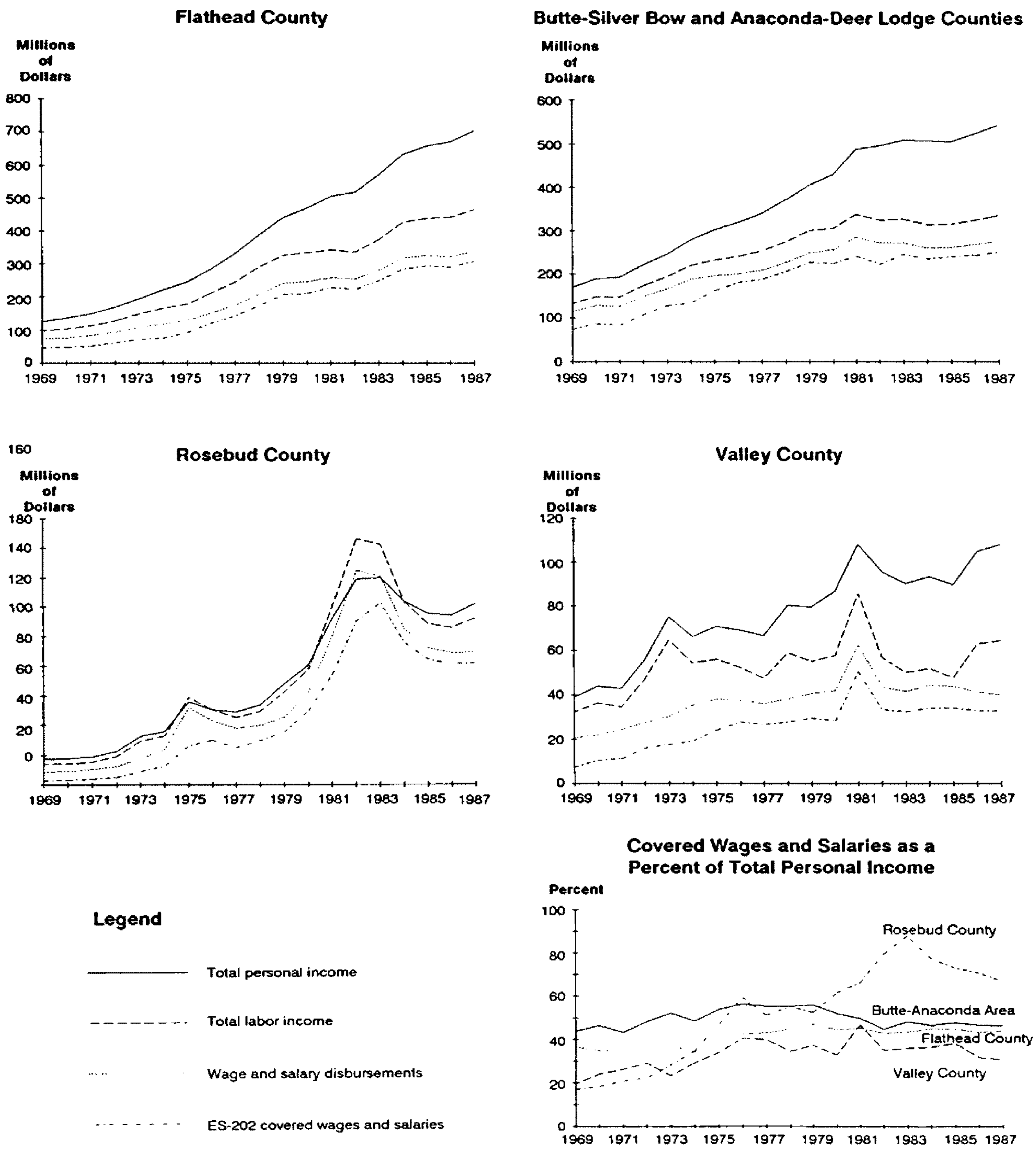
Coverage levels also vary among the study regions. The levels of coverage for each study area are illustrated in Exhibit 3. Four lines are graphed for each area: total personal income, total labor income, wage and salary disbursements, and ES-202 wages and salaries. Total personal income includes labor income, income not associated with labor force participation and a statistical adjustment for residence. Total labor income is the total of wages and salaries, including the farm sector, plus the earnings of the self-employed. Wage and salary disbursements exclude the income of the self-employed. A chart of covered wages and salaries as a percent of total income illustrates the coverage levels.

Two things are readily apparent, coverage levels have increased over time and they differ among the study counties. First, coverage levels have risen for all the study counties. The primary change is the expansion of UI coverage to include government and certain service industries, primarily hospitals. This change occurred during the 1972-1977 time period.

There are significant differences among the study counties in the levels of coverage. The intercounty differences in the level of coverage may be related to the

EXHIBIT 3

Coverage Levels of the Study Areas 1969-1987



Source: U. S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System (April 1989).

regional industrial composition. Regions where covered industries are relatively important have high coverage levels; agricultural counties display irregular patterns. The study regions were chosen to illustrate some of these factors.

The coverage levels in Flathead County are lower than the Butte-Anaconda area. This is partially due to the exclusion of railroad wages and salaries from the ES-202 data set. Nonfarm proprietors' income in Flathead County also make up a slightly larger portion of total labor income than other regions in the study as well as nonlabor income contributing a larger proportion of the local economy.

Rosebud County coverage levels were lower during the 1960s and early 1970s when the economy was dependent on agriculture. Coverage levels exploded when coal mining and electric power production became dominant factors in the late 1970s and 1980s. The dramatic increase in coverage may be attributable to two factors. First, ES-202 wages are often reported as the address of the parent firm. In Rosebud County's case, many of the firms involved in construction may be based in nearby Yellowstone County. Second, many small sub-contractors may be self-employed thus they are not covered.

The lines in Valley County range from narrow to wide due to the agricultural dependence of the region. The exception is caused by the dramatic increase in earnings caused by the construction of the Bearpaw pipeline.

Description of the Study Areas

Each study area has been carefully bifurcated into basic and derivative sectors. Appendix 1 lists each four-digit SIC code that has been included in the basic sector. Examples of individual companies in each basic category are given when there may be questions as to the character of the industry. The remaining industries are classified as derivative.

Flathead County has been extensively studied by Polzin and Schallau [1985, 1986, 1987] and provides a basis for comparison of the various methods and with previous studies. Flathead County is a regional trade center, relatively isolated with a diversified economy when compared to other counties in the study. The area is also perceived as an amenity area with a substantial retired and part-time resident population. A major basic industry (railroads) is not included in the ES-202 data. Analysis of secondary data suggests that Flathead County may be a retirement area. Retirement related transfer payments comprised about 12 percent of total personal income in 1987, compared with 11 percent for Montana. Retirement will not be included in basic sector, and the complications of this exclusion will be examined. Nonresident travel is also important to the Flathead economy. Measurement of wages and salaries related to tourism is very difficult; portions of this industry, especially retail trade, have been misclassified into the derivative sector.

The Butte and Anaconda areas will be analyzed together because of the interdependence between Silver Bow and Deer Lodge counties. There are extremely close linkages between the communities with significant commuting of workers between them. The region has undergone serious economic decline with mine and smelter closures. The local economy appears to have stabilized and may even be growing. Butte-Anaconda is a regional trade center with an economy that has historically been dominated by a single industry (mining) which has experienced significant declines.

Rosebud County experienced significant growth in coal mining along with short-run booms in 1976-1978 and 1979-1983 associated with the construction of electric power generating plants. Rosebud County does not contain a major city; it is part of the Billings trade area. Many of the service activities associated with the Rosebud County economy appear to occur in neighboring Yellowstone County.

Valley County has been chosen because of isolation and agriculture dependence. It is an isolated rural county that has experienced agricultural related problems as well as the closure of a major military installation at the beginning of the study period. The nearest trade center, Great Falls, is over 250 miles away.

CHAPTER VI:

MODEL IDENTIFICATION, ESTIMATION AND PERFORMANCE

The remainder of this study is patterned on the modelling process of identification, estimation, diagnostic checking and forecasting suggested by Box and Jenkins [1976]. Significant events and trends are identified in charts of basic and derivative wages and salaries. Estimation and diagnostic checking of the models is then discussed. Finally, forecasts of each model are performed and comparisons made.

Charts of Basic vs. Derivative

Charts of basic and derivative wage and salaries and the estimated models for each study region are shown in Exhibits 4-7. The charts of all four regions suggest that the growth in derivative wages and salaries generally parallels the long-run trend in basic wages and salaries. Valley County is the exception. Significant events also occurred in all the counties. These events impacted different sectors of the regional economies. Coverage change, national economic disruption, and local economic activity were the reasons for the disturbances in each sector.

Coverage changes affect both the basic and derivative sectors. Inclusion of government, especially federal, in the reporting system between 1973 and 1975 increased the basic sector. This increase was paralleled by changes in the derivative sector caused by the inclusion of most state and local governments in the derivative sector. Inclusion of other service industries, especially hospitals accelerated the change in derivative wages and salaries.

National economic disruptions are the second cause of dramatic changes in the charts. Three major recessions during the 1970-1987 period affect the data. These recessions had the greatest impact on the basic sectors of the study areas. The impacts on derivative industries were not as obvious. The first two recessions, graphically affecting only Flathead County, occurred in 1970-71 and 1974-1975. The third recession occurred between 1979-1982; its affects are visible in both the Flathead and Butte-Anaconda regions. There were periods of agricultural prosperity in the mid-1970s (i.e., Russian grain sales), but their impacts are not easily seen in the data.

The third cause of dramatic changes in the charts are specific events in local industries. For example, the 1981 decline in basic wages and salaries of Flathead County is a partially attributable to a decline in wood products wages and salaries. In addition, ownership changes at the Columbia Falls Aluminum Plant resulted in substantial wage and salary reductions. Strikes against the Anaconda Copper Company resulted in dramatic declines in the basic sector of the Butte-Anaconda area during 1967, 1971, and 1974. Thirdly, the spikes in Rosebud basic wages and salaries are directly attributable to construction of four major electric generating plants during the study period. Finally, two changes occurred in Valley County, an increase in the service industry, beginning in

1969 related to the closure of Glasgow Air Base and construction of the Bearpaw pipeline in 1981.

The Models

A transfer function model, an univariate ARIMA model, and a simple regression model, were estimated for each study area. The estimated parameters are shown in Exhibits 4-7. Stewart [1959] was concerned about change in parameters over time as structural changes occurred in the economic base. Two time periods were modelled; one was based on data from first quarter 1961 to fourth quarter 1980, while the second incorporated observations from first quarter 1961 to fourth quarter 1987. The first time period reserves observations for evaluation of out of sample forecasts and the second model uses the longer time period and takes into account the entire data set; it allows the evaluation of the models as explainers of change in the derivative sector. In addition, stability of the estimated parameters can be observed by comparing the parameters from both time periods, addressing the concerns of Stewart. Breaking the time periods into two more equal parts was not possible because the transfer function and ARIMA models require a large number of observations.

Each model was estimated using the procedures discussed earlier. The identification and diagnostic statistics for the transfer function and univariate models for each study area are shown in Appendix 2. The regression models are simple in that no attempt has been made to refine the initial estimated parameters.

The appropriate models estimated for each area and time period will be discussed. Transformations as they relate to a stationary time series will be addressed. The parameter values and significance levels will be evaluated and stability of the parameters monitored. Significant levels of the parameters will be measured by the T-statistic which is derived by dividing the parameter by its standard error. Only parameters with significance levels near 0.05 in one of the two time periods have been included. In addition, R-squared, Durbin-Watson and Q-statistic will be used to compare the overall performance of the models. In general, high R^2 indicates a better model, however, direct comparison of R^2 among the models is not appropriate because of problems caused by autocorrelation (Pierce [1977]). The Durbin-Watson statistic tests for autocorrelation. If no autocorrelation is present the Durbin-Watson should be near 2.00. This is generally true for the ARIMA and transfer function as these models are autoregressive. The regression models will vary. Finally, the Q-statistic will be evaluated. The Q-statistic measures lack of fit, therefore the higher the value the better the fit.

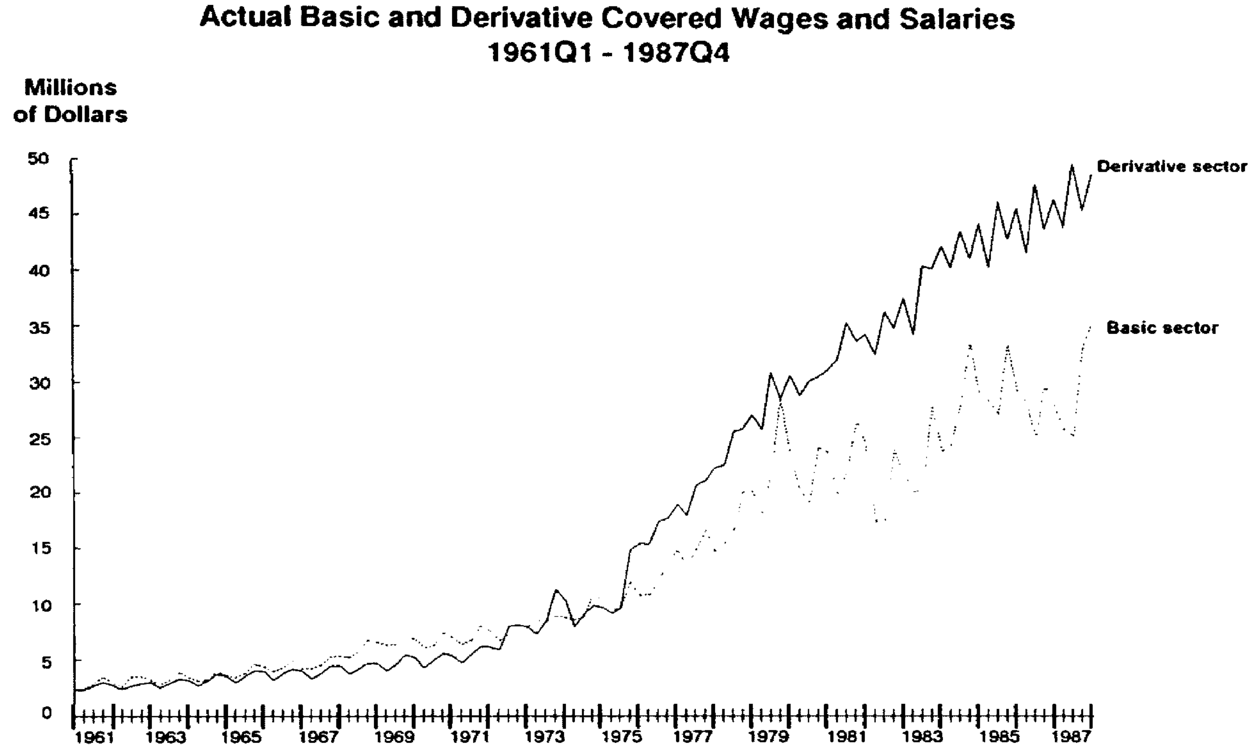
Stationarity for Flathead County was achieved with first differencing and one seasonal differencing. The univariate ARIMA model that gave the best fit was $(1,1,0)(1,1,0)_4$. A transfer function was then estimated using basic as an independent variable. Basic became significant when it led the derivative by one quarter. Parameter values and their significance level for all models during both time periods remained fairly constant indicating stability in the models. The incremental contribution of the transfer function model over the ARIMA model was an increase in R^2 from 0.38 to 0.41 for the short time period and 0.37 to 0.42 for the entire data set. The regression model was highly explanatory with an R^2 of 0.97. Durbin-Watson for the ARIMA and transfer function models was near 2.00 as expected; it dropped to about 1.25 for the regression models indicating some positive autocorrelation. The Q-statistic increased over both time periods when comparing the ARIMA and transfer function model. The transfer function fit the data better than the ARIMA model. The models are summarized in Exhibit 4.

Simple differencing provided a stationary time series for the Butte-Anaconda data. The best fit for an univariate ARIMA model was achieved with a seasonal autoregressive model of the form $(0,1,0)(1,0,0)_{4 \text{ as shown in Exhibit 5}}$. Inclusion of basic (t-1) as an independent variable in the transfer function resulted in a highly significant parameter values. The parameters of all models were similar for both time periods. The R^2 of the transfer function model was higher than the ARIMA model. The R^2 for the regression model was surprising low over both time periods. The Durbin-Watson for both the ARIMA and transfer function model was somewhat greater than 2.00 indicating some negative serial correlation and less than 1 for the regression model. The value of the Q-statistic improved slightly with the transfer function for the shorter period, but deteriorated for models using the entire data set.

The estimated models for Rosebud County are shown in Exhibit 6. Simple differencing resulted in a stationary time series. The univariate ARIMA model which best represented the derivative time series took the form of $(0,1,0)(1,0,0)_4$. Basic was a highly significant variable in the transfer function. The SAR (4) coefficients for both the ARIMA and transfer function models declined when all the data was considered indicating potential structural change, however, the basic coefficient did not change. The

EXHIBIT 4

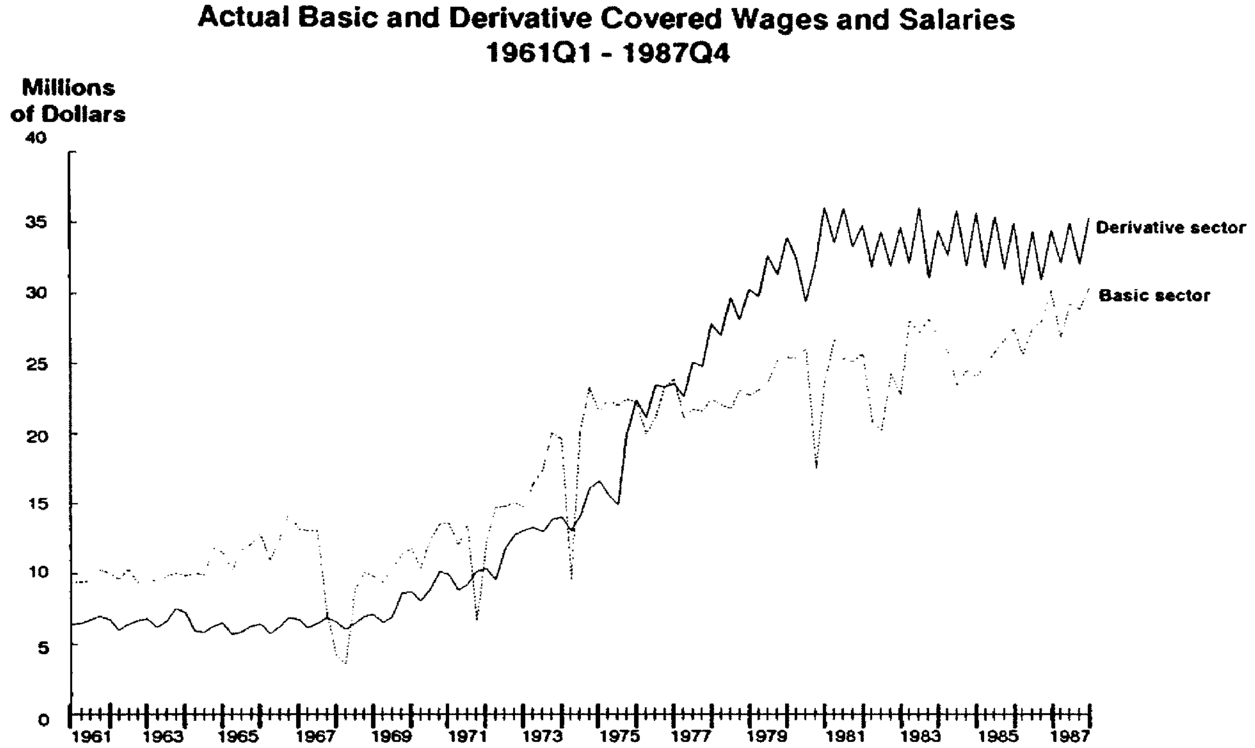
Flathead County



	Variable	Lag	Coefficient	T-Statistic		
Transfer Function Model (First Difference and One Seasonal Difference)						
1963Q3 - 1980Q4	Basic	-1	0.203	1.90	R^2	0.41
	AR	1	-0.234	-1.92	Durbin-Watson	1.96
	SAR	4	-0.615	-5.47	Q-Statistic	35.21
1963Q3 - 1987Q4	Basic	-1	0.236	2.82	R^2	0.42
	AR	1	-0.212	-1.90	Durbin-Watson	2.01
	SAR	4	-0.587	-5.87	Q-Statistic	48.03
Univariate ARIMA Model (First Difference and One Seasonal Difference)						
1963Q3 - 1980Q4	AR	1	-0.219	-1.83	R^2	0.38
	SAR	4	-0.628	-5.60	Durbin-Watson	1.96
					Q-Statistic	34.32
1963Q3 - 1987Q4	AR	1	-0.260	-2.63	R^2	0.37
	SAR	4	-0.565	-6.62	Durbin-Watson	1.96
					Q-Statistic	31.93
Regression Model						
1961Q1 - 1980Q4	Constant	0	-2,773,610	-6.71	R^2	0.95
	Basic	0	1.444	37.93	Durbin-Watson	1.25
					Q-Statistic	62.88
1961Q1 - 1987Q4	Constant	0	-3,650,612	-6.01	R^2	0.97
	Basic	0	1.611	34.31	Durbin-Watson	1.21
					Q-Statistic	81.35

EXHIBIT 5

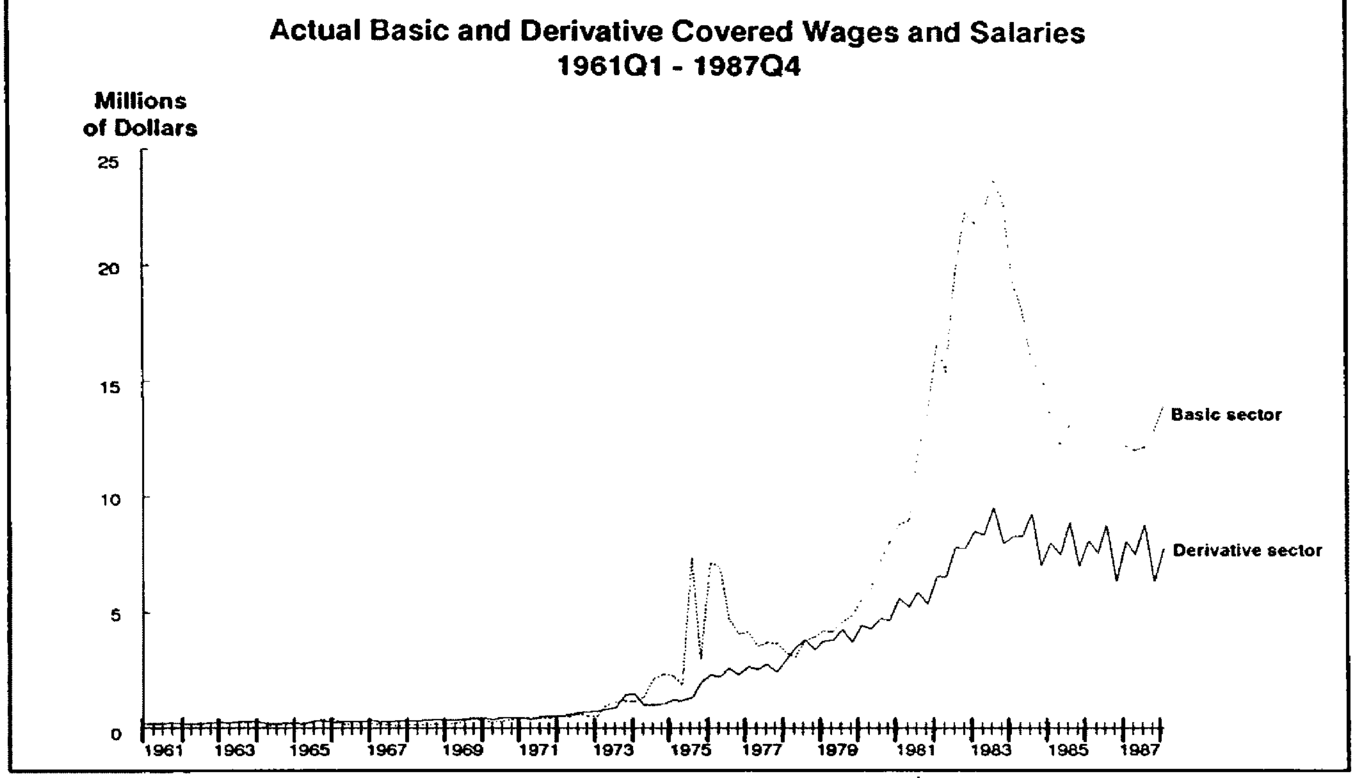
Butte - Silver Bow and Anaconda - Deer Lodge Counties



	Variable	Lag	Coefficient	T-Statistic		
Transfer Function Model (First Difference)						
1962Q3 - 1980Q4	Basic	-1	0.113	2.47	R^2	0.22
	SAR	4	0.569	-5.47	Durbin-Watson	2.26
					Q-Statistic	30.07
1962Q3 - 1987Q4	Basic	-1	0.138	3.39	R^2	0.56
	SAR	4	0.791	11.50	Durbin-Watson	2.65
					Q-Statistic	95.00
Univariate ARIMA Model (First Difference)						
1962Q3 - 1980Q4	SAR	4	0.535	4.58	R^2	0.16
					Durbin-Watson	2.19
					Q-Statistic	31.04
1962Q3 - 1987Q4	SAR	4	0.755	10.72	R^2	0.52
					Durbin-Watson	2.60
					Q-Statistic	87.75
Regression Model						
1961Q1 - 1980Q4	Constant	0	-6,893,148	-5.07	R^2	0.78
	Basic	0	1.366	16.44	Durbin-Watson	0.72
					Q-Statistic	134.90
1961Q1 - 1987Q4	Constant	0	-8,504,521	-7.02	R^2	0.85
	Basic	0	1.523	24.44	Durbin-Watson	0.87
					Q-Statistic	210.96

EXHIBIT 6

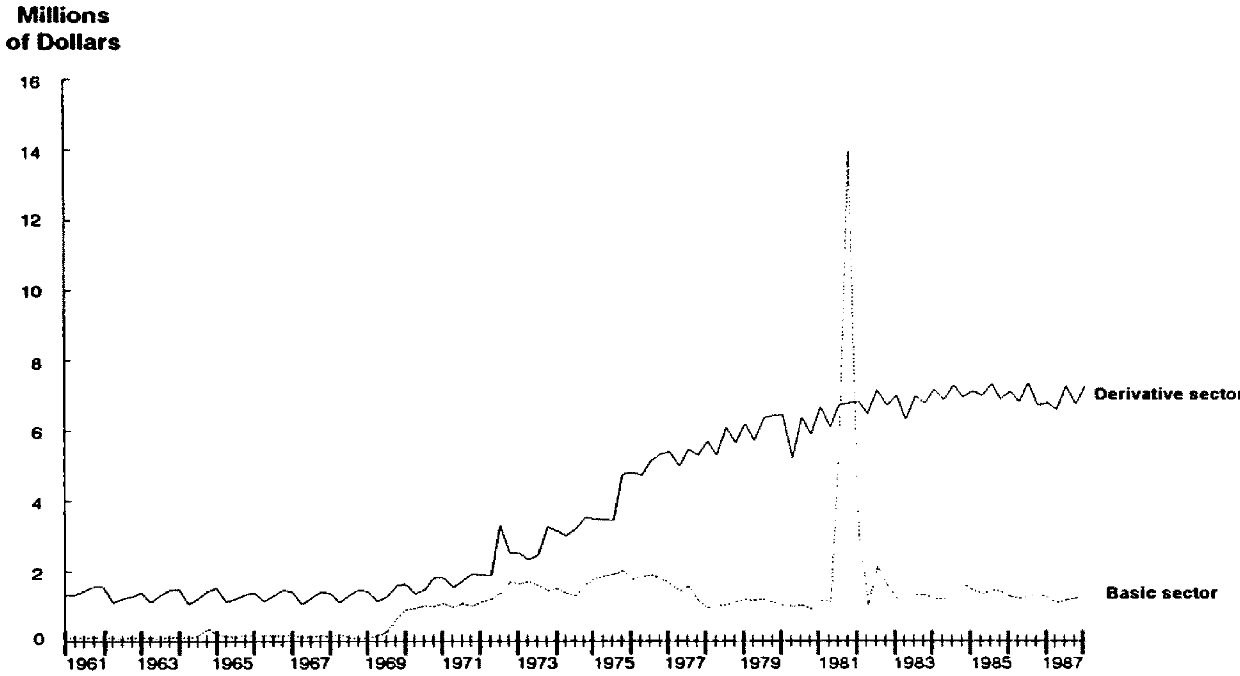
Rosebud County



	Variable	Lag	Coefficient	T-Statistic		
Transfer Function Model (First Difference)						
1962Q3 - 1980Q4	Basic	-1	0.056	3.08	R^2	0.36
	SAR	4	0.724	7.16	Durbin-Watson	1.79
					Q-Statistic	52.63
1962Q3 - 1987Q4	Basic	-1	0.042	2.21	R^2	0.80
	SAR	4	1.027	19.66	Durbin-Watson	2.08
					Q-Statistic	54.74
Univariate ARIMA Model (First Difference)						
1962Q3 - 1980Q4	SAR	4	0.657	6.08	R^2	0.28
					Durbin-Watson	1.93
					Q-Statistic	43.99
1962Q3 - 1987Q4	SAR	4	1.005	19.86	R^2	0.79
					Durbin-Watson	1.98
					Q-Statistic	63.14
Regression Model						
1961Q1 - 1980Q4	Constant	0	317,673	3.53	R^2	0.80
	Basic	0	0.551	17.89	Durbin-Watson	0.87
					Q-Statistic	166.27
1961Q1 - 1987Q4	Constant	0	605,457	4.80	R^2	0.89
	Basic	0	0.436	29.63	Durbin-Watson	0.65
					Q-Statistic	434.48

EXHIBIT 7

Valley County



	Variable	Lag	Coefficient	T-Statistic		
Transfer Function Model (First Difference)						
1962Q3 - 1980Q4	Basic	-4	0.070	0.29	R^2	0.34
	AR	1	-0.454	-4.13	Durbin-Watson	2.03
	SAR	4	0.501	4.29	Q-Statistic	27.83
1962Q3 - 1987Q4	Basic	-4	-0.036	-1.91	R^2	0.46
	AR	1	-0.432	-4.62	Durbin-Watson	2.09
	SAR	4	0.541	6.11	Q-Statistic	43.92
Univariate ARIMA Model (First Difference)						
1962Q3 - 1980Q4	AR	1	-0.452	-4.14	R^2	0.34
	SAR	4	0.508	4.40	Durbin-Watson	2.03
					Q-Statistic	26.84
1962Q3 - 1987Q4	AR	1	-0.460	-5.06	R^2	0.46
	SAR	4	0.499	5.62	Durbin-Watson	2.03
					Q-Statistic	44.08
Regression Model						
1961Q1 - 1980Q4	Constant	0	1,266,906	4.93	R^2	0.44
	Basic	0	1.929	7.81	Durbin-Watson	0.10
					Q-Statistic	471.58
1961Q1 - 1987Q4	Constant	0	3,113,075	11.65	R^2	0.18
	Basic	0	0.700	4.85	Durbin-Watson	0.23
					Q-Statistic	1,087.28

coefficients for the regression model were relatively consistent. The R^2 for the transfer function model was higher than the ARIMA model for the truncated time series. The R^2 for all models using the entire data set was very high. The Durbin-Watson for the transfer function model declined when the 1961-1980 time period was considered. The Q-statistic for the longer transfer function was better than the ARIMA model; the opposite for the short time series.

Exhibit 7 shows the results of estimating the models of Valley County. Stationarity was the result of simple differencing. The parameters estimated by an univariate ARIMA model of the form $(1,1,0)(1,0,0)_4$ were significant and consistent over both time periods. The transfer function models were erratic. Basic was significant, but negative for the longer series but insignificant for the short data set. The other coefficients were nearly identical. The regression model resulted in dramatically different coefficients for basic when estimated for the two time periods. The transfer function does not appear to be any improvement over the ARIMA model when measured by both the R^2 and Q-statistic which are very similar. The regression models are inconsistent.

The Forecasts

Derivative wages and salaries were forecasted for the period 1981Q1 to 1987Q4 using the equations estimated over the time period 1961Q1-1980Q4. Each equation was forecasted 28 periods. Each model was then evaluated as to out-of-sample accuracy.

Exhibits 8-11 chart the forecast and show several diagnostic statistics for each study area. Each statistic will be briefly described.

A correlation coefficient was calculated measuring the correlation between the actual and forecasted data. The root mean squared error (RMSE) and the mean error are also shown. These measure the direct differences between the actual and forecasted series. The RMSE is the numerator of Theil-U. The mean absolute percent error (MAPE) measures the relative deviation of the forecast from the actual data in absolute terms.

The Theil inequality coefficient (Pindynk and Rubenfeld [1976], Koutsoyiannis [1979]) and its decomposition was also calculated for each model. Mathematically, Theil's U ranges in value from 0 to positive infinity. Theil's U = 0 means a perfect forecast (i.e., predicted equals actual). If Theil's U = 1, predicted $_t$ equals actual $_{t-1}$. Theil's U > 1 means that the prediction is worse than the naive forecast where U = 1. Theil's U may also be decomposed into components measuring various characteristics of the forecasts. These components are bias, variance and covariance. Bias is the percentage of U due to differences in the average values of the actual and forecast series. It is an indication of systematic error. The variance component measures the percentage of U due to differences in the variation of the actual and projected series. A large variance percentage indicates the actual series has fluctuated more than the forecast series. Covariance is the percentage of U due to unsystematic error; a large covariance component suggests that further improvements to the forecasts cannot be made. Ideally, bias equals variance equals 0 and covariance equals 1.00.

The chart in Exhibit 8 shows the forecasts for Flathead County. Both the transfer function and the univariate ARIMA model track the actual closely. The transfer function begins to deviate from the actual in 1986. The univariate model underestimates derivative during the 1983-1984 period. The regression model bounces around during the entire period however it appears to underestimate during most periods. Examination of the forecast statistics is revealing. Mixed results are obtained depending on the statistic used. The transfer function model was the best forecaster of derivative wages and salaries as measured by the correlation coefficient. Evaluation of the RMSE suggests very similar forecasting performance with both the transfer function and univariate ARIMA model. The RMSE for the regression model is much larger than the other models. The MAPE for the transfer function model is lower than either of the other two models. The regression model MAPE is substantially higher than the univariate model MAPE. The mean error for the transfer function is slightly larger than the univariate model, however, both are much smaller than the regression model. Theil-U for both the transfer function model and univariate model are nearly identical and both are much closer to the ideal than the regression model. Decomposition of Theil-U suggests some differences between the transfer function and the univariate models. The bias component of the transfer function model is nearly 40 percent compared to about 21 percent for the univariate model, suggesting some improvement could be made in the transfer function. The variation component of the transfer function model is about 20 percent compared to 3 percent for the univariate model. The covariation component of the transfer function model is about 38 percent and the univariate model 75 percent,

EXHIBIT 8

Forecasting Performance of the Alternative Models
Flathead County
1981Q1 - 1987Q4

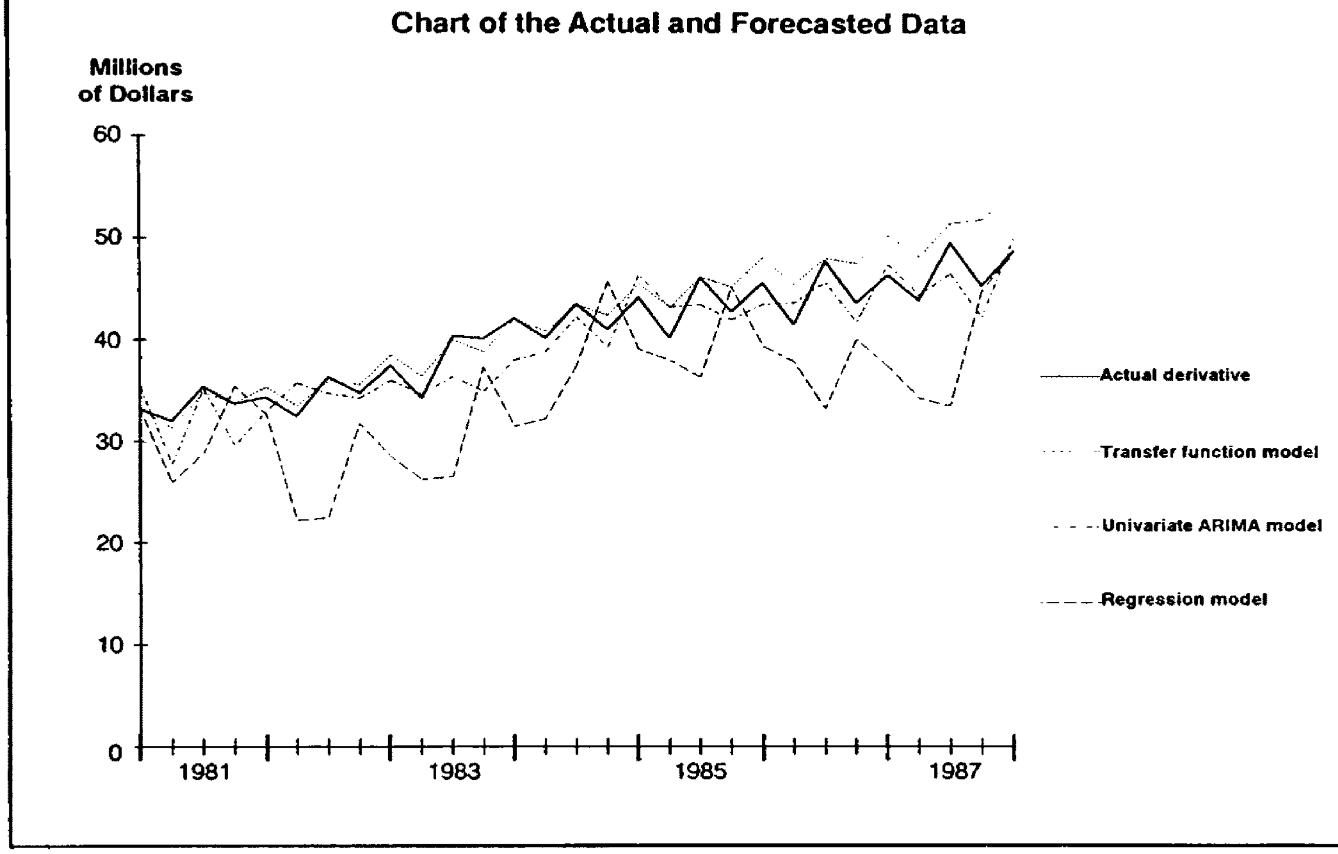


Table of Forecast Statistics

	Transfer Function Model	Univariate Model	Regression Model
Correlation coefficient	0.961	0.914	0.642
Root mean squared error	2,536,970	2,538,860	8,045,259
Mean absolute percent error	4.3	5.4	16.6
Mean error	-1,597350	1,176,020	6,111,710
Theil Inequality Coefficient (U)	0.030	0.031	0.105
Fraction of error due to:			
Bias	0.396	0.215	0.577
Variation	0.216	0.034	0.043
Covariation	0.387	0.752	0.380

suggesting that improvement in the transfer function model may be possible but not the univariate model. The bias and covariation components of the Theil-U for the regression model are large indicating the potential for improvement.

The forecasts are charted and the diagnostics for the Butte-Anaconda region are shown in Exhibit 9. None of the models appears to be a reliable forecaster. Graphic examination suggests that the regression model may be the better model over the long-term but the diagnostics suggest the transfer function and the univariate model may be the more consistent forecasters. The correlation coefficients for all three models are very low. The transfer function and univariate models exhibit slightly negative correlation while the regression model has no apparent correlation between the actual and predicted series. The RMSE for both the transfer function and univariate models are nearly the same and somewhat lower than the RMSE for the regression model. The MAPEs for the transfer function and univariate models are over 12 percent slightly lower than the regression model MAPE. The mean error for the transfer function and univariate models are nearly identical and almost mirror the mean error of the regression model. Theil-U for the transfer function and univariate model are identical and only slightly better than the regression model. Disaggregation of Theil-U show somewhat similar patterns among the three models; a high bias and covariation component and low variation component suggesting improvement in all the models may be possible.

Both the transfer function and regression versions of the economic base model appear to perform adequately over the long-term in Rosebud County as illustrated in Exhibit 10. The transfer function appears to be the best predictor when evaluated

EXHIBIT 9

Forecasting Performance of the Alternative Models
Butte - Silver Bow and Anaconda - Deer Lodge Counties
1981Q1 - 1987Q4

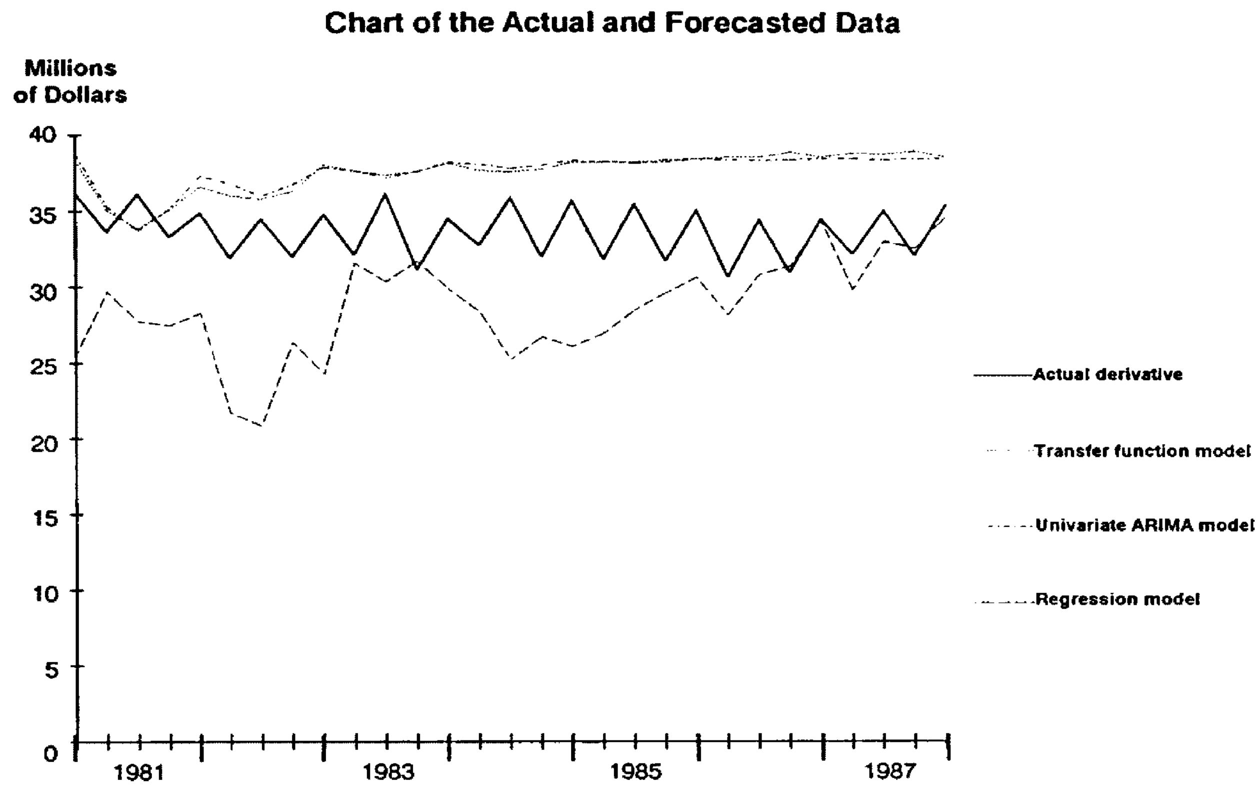


Table of Forecast Statistics

	Transfer Function Model	Univariate Model	Regression Model
Correlation coefficient	-0.158	-0.175	0.002
Root mean squared error	4,622,110	4,602,670	6,078,340
Mean absolute percent error	12.6	12.7	14.3
Mean error	-3,979,170	-3,998,120	4,789,220
Theil Inequality Coefficient (U)	0.065	0.065	0.097
Fraction of error due to:			
Bias	0.741	0.755	0.621
Variation	0.008	0.014	0.068
Covariation	0.251	0.232	0.312

EXHIBIT 10

Forecasting Performance of the Alternative Models
Rosebud County
1981Q1 - 1987Q4

Chart of the Actual and Forecasted Data

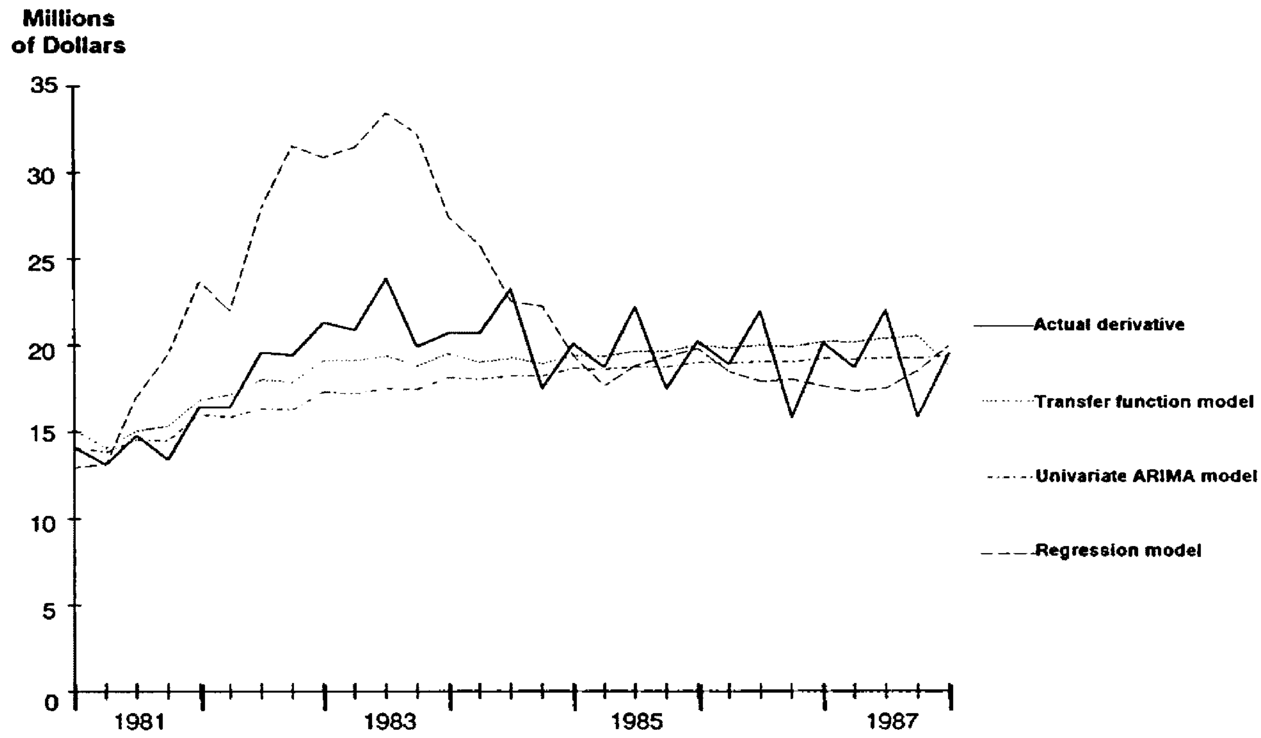


Table of Forecast Statistics

	Transfer Function Model	Univariate Model	Regression Model
Correlation coefficient	0.661	0.553	0.452
Root mean squared error	841,005	1,058,890	2,351,740
Mean absolute percent error	8.9	10.5	23.7
Mean error	103,207	518,024	1,270,570
Theil Inequality Coefficient (U)	0.055	0.071	0.097
Fraction of error due to:			
Bias	0.015	0.239	0.292
Variation	0.280	0.194	0.222
Covariation	0.705	0.566	0.486

graphically. The regression model overestimates derivative wages and salaries between 1981 and 1984, however, it appears to estimate the derivative sector very well during the later time periods. The correlation coefficient for the transfer function model is higher than the other two models. Both the univariate and regression models also exhibit high correlations between the actual and predicted time series. The RMSE is lowest for the transfer function model followed by the univariate model then the regression model. The transfer function MAPE is also the lowest among the three models. The univariate model MAPE is about half the MAPE for the regression model. The mean error follows the same pattern as the other diagnostic statistics with the transfer function being the best predictor. The Theil-U statistic for each model also follow the same pattern but the decomposition reveals differences. The bias component for the transfer function is close to the ideal of zero but the other models have bias components over 0.20. The variation component for the transfer function is 0.28 compared to about 0.20 for the univariate and regression models. The covariation component for the transfer function model is about 0.70 compared to about 0.50 for the other models.

The economic base model performance in Valley County is illustrated in Exhibit 11. Graphical examination suggests both the univariate and transfer function models forecasted better than the regression model. The differences between the transfer function and univariate models appear to be negligible. The regression model spikes in 1981 then underestimates actual derivative wages and salaries. The forecast diagnostics suggest the transfer function model performed the best in Valley County. The correlation coefficient for the transfer function model is slightly higher than the univariate model. There is no correlation between actual and predicted data for the regression model. The RMSE is also lowest for the transfer function model. The transfer function model MAPE is lower than the univariate model, both substantially lower than the regression model. The mean error follows the same pattern. Theil-U also suggests the transfer function is the best predictor of derivative wages and salaries. Decomposition of Theil-U for the transfer function indicates improvements in the forecast may be obtained by accounting for the variation in the series. Most of the error for the univariate model appears to be in the bias component. The regression model error is mostly found in the variance component.

EXHIBIT 11

Forecasting Performance of the Alternative Models
Valley County
1981Q1 - 1987Q4

Chart of the Actual and Forecasted Data

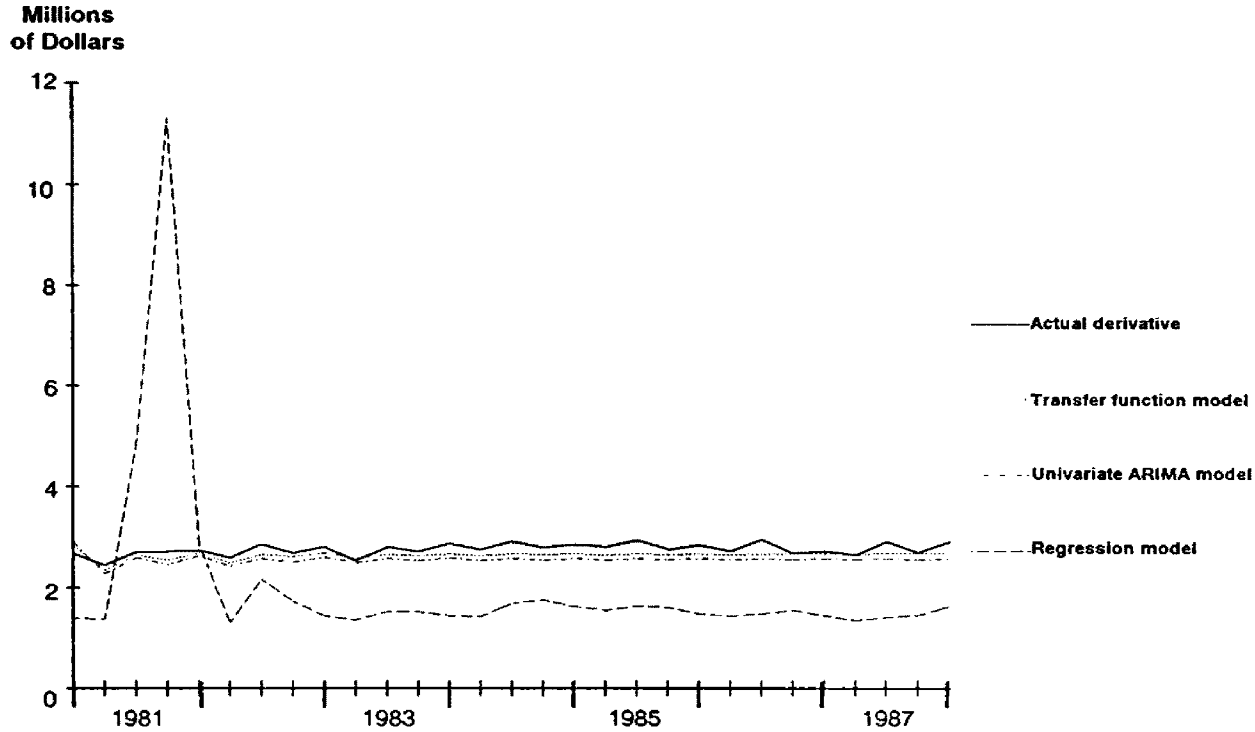


Table of Forecast Statistics

	Transfer Function Model	Univariate Model	Regression Model
Correlation coefficient	0.711	0.682	-0.082
Root mean squared error	382,251	591,980	5,114,460
Mean absolute percent error	4.7	7.8	53.9
Mean error	313,357	546,297	1,778,400
Theil Inequality Coefficient (U)	0.028	0.044	0.367
Fraction of error due to:			
Bias	0.672	0.852	0.121
Variation	0.114	0.057	0.759
Covariation	0.214	0.091	0.120

CHAPTER VII: SUMMARY OF FINDINGS

Three models were estimated and forecasted for each study area. The performance of each model was evaluated by examining five statistics. These statistics were ranked on a scale of one to three and then summed to derive a total score as shown in Exhibit 12. The model with the lowest score performed best among the three models. The transfer function model scored best for all the study regions except Flathead County. The univariate ARIMA model was the best forecaster for Flathead County. The regression model tallied the highest score, therefore performed worse than either of the other models, in all the study regions. The consistent performance of the transfer function and univariate models suggest that further study of the economic base model using auto-regressive methods be pursued with other regions and data sets.

Uncovered sectors of the economy may affect the overall performance of the economic base model. The decomposition of Theil-U reveals the bias found in forecasts made using the economic base model. Much of this bias may be caused by the data set. This problem may only be investigated if comprehensive estimates including uncovered sectors of the economy are developed. Further research into the effect the amount of coverage bifurcation process and nonlabor income have on the economic base model is warranted.

EXHIBIT 12

Ranking of the Forecast Statistics

	Flathead County			Butte-Silver Bow and Anaconda-Deer Lodge Counties		
	Transfer Function Model	Univariate Model	Regression Model	Transfer Function Model	Univariate	Regression Model
Correlation coefficient	1	2	3	2	1	3
Root mean squared error	1	2	3	2	1	3
Mean absolute percent error	1	2	3	1	2	3
Mean error	2	1	3	1	2	3
Theil Inequality Coefficient (U)	1	2	3	1	1	3
Fraction of error due to:						
Bias	2	1	3	2	3	1
Variation	3	1	2	1	2	3
Covariation	3	1	2	2	3	1
Total score	14	12	22	12	15	20

	Rosebud County			Valley County		
	Transfer Function Model	Univariate Model	Regression Model	Transfer Function Model	Univariate Model	Regression Model
Correlation coefficient	1	2	3	1	2	3
Root mean squared error	1	2	3	1	2	3
Mean absolute percent error	1	2	3	1	2	3
Mean error	1	2	3	1	2	3
Theil Inequality Coefficient (U)	1	2	3	1	2	3
Fraction of error due to:						
Bias	1	2	3	2	3	1
Variation	3	1	2	2	1	3
Covariation	1	2	3	1	3	
Total score	10	15	23	10	17	21

The composition of a local economy may have an effect on the performance of the economic base approach to modeling economic growth. The economic base model was weakest in Flathead county which has a more diversified economy with a larger nonlabor income than any of the others. The best performance of the economic base approach was found in Rosebud county where energy-related activity is the overriding component of the economy.

In conclusion, the transfer function appears to have promise as a legitimate estimation and forecasting approach to impact analysis using the economic base model. Recent unpublished work by Lesage and Reed (1989) on error-correction models, may yield multipliers and direct economic interpretation of the parameters. Further analysis of the parameters developed using autoregressive techniques may result in a casual model of the economic base.

APPENDIX 1

Basic Industries

Flathead County

Wood Products
Two plywood plants, fiberboard plant, several sawmills, a substantial number of logging companies. Logging may or may not be covered in wood products; some logging is classified in the trucking industry, however the exact amount is not known. Specific SIC codes included are as follows:

0811 Timber tracts
0851 Forestry services
2411 Logging camps and logging contractors
2421 Sawmills and planing mills, general
2431 Millwork
2452 Prefabricated wood buildings
2491 Wood preserving
2492 Particle board
5031 Wholesale trade-lumber and plywood
Jobbers associated with marketing local production of wood products
7362 Temporary manpower
Stolz lumber utilizes temporary manpower for peak periods.

Aluminum refining
The Columbia Falls Aluminum Plant has recently undergone an ownership change, with a substantial restructuring which may affect the data (bonuses and profit sharing). Also included are some closely related wholesale trade components. Specific SIC codes are as follows:

3334 Aluminum refining
3361 Aluminum foundries
5051 Metal service centers and offices
Marketing of local aluminum production

Nonresident travel (tourism)
A major destination ski resort with a substantial export(Canada and surrounding counties) and import-substitution component is located near Whitefish. There are many problems in accurately estimating the basic component of tourism. Specific SIC codes are as follows:

4121 Taxicabs
4452 Ferries
Flathead tours, probably a misclassification of lake and river tours
4459 Local water transportation NEC
River trips
7011 Hotels, motels, and tourist camps
Includes Big Mountain Ski Area
7032 Trailering parks and camp sites for transients

Trade
Some trade center activity from Canada, Lincoln, Sanders, and Lake counties Montana
5082 Wholesale trade-construction Machinery
5084 Industrial machinery-wholesale trade

Federal government
Headquarters of substantial Forest Service workforce and water-project workforce
4911 Electrical service
Bonneville Power Administration
4971 Irrigation systems
Bureau of Reclamation
6131 Agricultural credit institutions
6331 Fire, marine and casualty
Federal crop insurance
9311 Public finance, taxation and monetary policy
US Customs
9512 Land, mineral, wildlife and forest conservation
US Forest Service
US Park Service
US Fish and Wildlife Service
9711 National security
National Guard

Agriculture
Mostly not covered
0111 Cash grains-wheat
0134 Field crops-potatoes
0191 General farms primarily crop
0212 Beef cattle except feedlots
0241 Dairy farms
Production for meadow gold
0723 Crop preparation for market
Hay baling
5153 Wholesale trade-grain
5154 Wholesale trade-livestock
0821 Christmas trees

Mining
1044 Silver mining
Ties to ASARCO near Libby
1081 Metal mining services
1381 Drilling oil and gas wells
1382 Oil and gas field exploration

Other manufacturing
2026 Fluid milk
Meadow Gold
2033 Canned fruits, vegetables, jams and jellies
2511 Wood furniture
2721 Periodicals
Northwest Publishers
2899 Chemicals and chemical preparations NEC
3111 Leather tanning and finishing
3362 Brass, bronze, copper castings
Art castings
3484 Small arms
Custom rifle barrels
3531 Construction machinery
Disappeared in 1976

3553 Woodworking machinery
Sawmill equipment
3559 Special industrial machinery
3715 Truck trailers
3732 Boat building and repair
3769 Missile parts, NEC
3792 Travel trailers
3799 Transportation equipment NEC
3949 Sporting goods NEC
3999 Manufacturing industries NEC

State government
1611 Highway construction
9512 Land, mineral, wildlife and forest conservation
Fish, Wildlife and Parks
State Forest

Local government
7999 Amusement and recreation services
Gaming inspectors

Construction
1611 Highway and street construction
1622 Bridge, tunnel construction
1623 Water, sewer, pipeline,communication, and power line
1629 Heavy construction NEC

Transportation
4131 Intercity transportation
4210 Trucking
Treated as basic because in 1983 local trucking is broken out, very small component of total trucking (2%)

Other Industries
7813 Motion picture production
Heaven's Gate

Butte-Anaconda Region

Federal government
- 4971 Irrigation systems Bureau of Reclamation
- 7391 Research and development laboratories
  - Federal research projects-MERDI and MHD research projects
- 9211 Courts
  - Bankruptcy court
- 9221 Police protection
  - FBI offices
- 9222 Legal counsel and prosecution
- 9512 Land, mineral, wildlife conservation
  - Bureau of Land Management
  - US Forest service
- 9621 Regulation and administration of transportation
- 9711 National security

State government
- 1611 Highway and street construction
- 8063 Psychiatric hospitals
- 8069 Specialty hospitals,exc psychiatric
- 8059 Nursing and personal care NEC
- 8221 Colleges and universities
  - Montana Tech
- 9223 Correctional institutions
- 9512 Land, mineral, wildlife conservation
- 9711 National security

Metal mining

Mining was downscaled in early 1980s; appears to have stabilized and recovered somewhat with the reopening the mines by Montana Resources. Mining on a smaller scale appears probable in the near future. Data are available for the entire period.

- 1021 Copper ores
- 1031 Lead and zinc ores
- 1041 Gold ores
- 1044 Silver ores
- 1051 Bauxite and other aluminum ores
- 1061 Ferroalloy ores except vanadium
- 1081 Metal mining services

Other mining
- 1381 Drilling oil and gas wells
- 1481 Nonmetallic mining services

Heavy construction
- 1611 Highway and street construction
- 1623 Water,sewer and utility lines
- 1629 Heavy construction NEC
- 1795 Wrecking and demolition work

Wood products
- 2411 Logging contractors
- 2491 Wood preserving

Primary metals (smelting)
- 3310 Blast furnace and basic steel products
- 3320 Gray iron foundries
- 3331 Primary copper
- 3334 Primary aluminum

Other manufacturing

A large phosphate processing plant employing about 200 workers is located outside Butte. Also several smaller manufacturing concerns that come and go over time.

2011 Meat packing plants
2037 Frozen fruits and vegetables
2038 Frozen specialties
2819 Industrial organic chemicals NEC
3143 Men's footwear, except athletic
3241 Cement, hydraulic
3433 Heating equipment except electric
3441 Fabricated structural metals
3523 Farm machinery and equipment
3540 Machine tools
3599 Machinery except electrical NEC
3613 Switchgear and switchboard apparatus
3694 Engine electrical equipment
3991 Brooms and brushes

Transportation

Rail and truck transportation; the question is how much is covered?

4131 Intercity highway transportation
4210 Trucking
4712 Freight forwarding

Montana Power and its corporate subsidiaries

Corporate offices are located in Butte
4931 Electric and other services combined
1211 Bituminous coal and lignite

Trade center

Hospitals and wholesale trade facilities for smaller counties to south and east of Butte area.

5141 Groceries, general line
5153 Grain
5154 Livestock
5161 Chemicals and allied products
5194 Tobacco and tobacco products
5198 Paints, varnishes and supplies
8062 General medical and surgical hospitals
7369 Personnel supply services
7391 Research and development laboratories
7392 Management and public relations
8331 Job training and related services

Nonresident travel(tourism)

7011 Hotels, motels and tourist courts
7033 Trailering parks for transients
8411 Museums and art galleries

Valley County

Federal government
4971 Irrigation systems
Bureau of Reclamation
6131 Agricultural credit institutions
6331 Fire, marine and casualty insurance
Federal crop insurance
9311 Public finance, taxation and monetary policy
US Customs
9512 Land, mineral, wildlife and forest conservation
Bureau of Land Management
Fish and Wildlife Service
9711 National security
National Guard
Glasgow Air Base (closed)
7349 Cleaning and maintenance to dwellings and other buildings
7369 Personnel supply services, NEC
7392 Management consultants and Public relations
8611 Business associations

State government
1611 Highway construction
8290 Vocational schools
9512 Land, mineral, wildlife and forest conservation
FWP, State Forest

Agriculture
A largely non-covered industry. Severe drought has affected the area for the last several years after a boom period in the late 1970s.

0111 Cash grains-wheat
0119 Cash grains-barley
0191 General farms primarily crop
0212 Beef cattle except feedlots
0723 Crop preparation for market-hay baling
0910 Commercial fishing - paddlefish
5153 Wholesale trade-grain
5154 Wholesale trade-livestock

Oil and gas
1381 Drilling oil and gas wells
1382 Oil and gas field exploration
1389 Oil and gas fields services
1452 Bentonite

Construction
1611 Highway and street construction
1622 Bridge, tunnel construction
1623 Water, sewer, pipeline, communication, and power line
1629 Heavy construction NEC

Manufacturing
2011 Meat packing
2399 Fabricated textile products, NEC
2899 Chemicals and chemical preparations NEC
3070 Miscellaneous plastic products
3484 Ammunition, except for small arms
3674 Semiconductors and related devices

Transportation
4469 Water transportation services NEC

Nonresident travel
7011 Hotels, motels, and tourist camps
7032 Trailering parks and camp sites for transients

Rosebud County

Federal government
- 6131 Agricultural credit institutions
- 6331 Fire, marine and casualty insurance
- 7391 Research and development laboratories
- 9431 Administration of public health programs
- 9441 Administration of social, manpower, and income maintenance
- 9512 Land, mineral, and forest conservation
- 9711 National security

State government
- 1611 Highway and street construction
- 9512 Land, mineral, and forest conservation

Agriculture and agriculture related
- 0111 Cash grains-wheat
- 0212 Beef cattle, except feedlots
- 0721 Crop planting, cultivating and protection
- 0751 Livestock services, except for animal specialties

Forest products
- 0851 Forestry services
- 2411 Logging camps and logging contractors
- 2421 Sawmills and planing mills, general

Coal mining
- 1211 Bituminous coal and lignite
- 1213 Bituminous coal and lignite services

Oil and gas
- 1311 Crude petroleum and natural gas
- 1381 Drilling oil and gas wells
- 1389 Oil and gas field services NEC
- 1452 Bentonite
- 2911 Petroleum refining

Construction
- 1611 Highway and street construction
- 1622 Bridge, tunnel and elevated highway construction

Power production related
- 1623 Powerline construction
- 1629 Heavy construction not elsewhere classified
- 1791 Structural steel erection
- 1796 Installation or erection of building equipment,NEC
- 4931 Electric and other services combined

Other basic
- 3079 Miscellaneous plastic products
- 4210 Trucking

APPENDIX 2

Identification and Diagnostics of the Univariate and Transfer Function Models Flathead County 1961Q2 - 1980Q4

Variances of the Differenced Series

Derivative Sector

Seasonal	0	1
Non-seasonal		
0	9,111,691	1,880,901
1	1,286,068	1,244,692

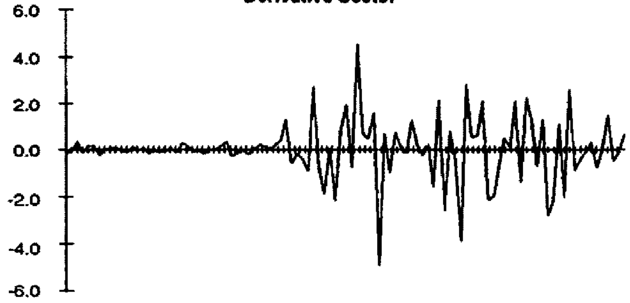
Basic Sector

Seasonal	0	1
Non-seasonal		
0	6,146,379	1,646,132
1	1,530,570	1,416,029

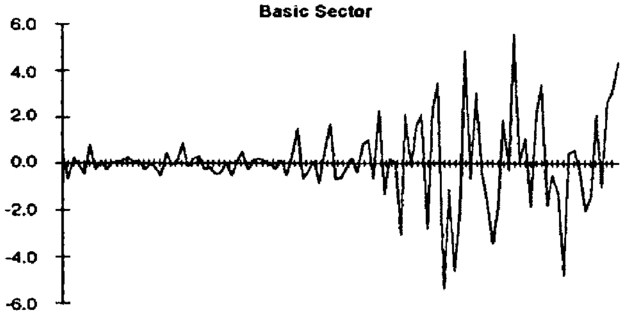
Plot of the Differenced Series

(First difference and one seasonal difference)

Derivative Sector



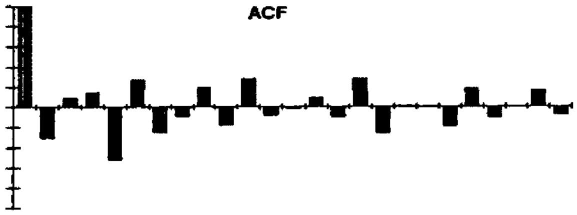
Basic Sector



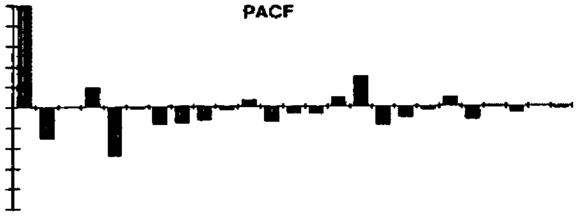
Plot of the Autocorrelation and Partial Autocorelation Functions

(First difference and one seasonal difference)

ACF



PACF



Plot of the Autocorrelation Function of the Residuals

(Transfer function)

Identification and Diagnostics of the Univariate and Transfer Function Models Butte - Silver Bow and Anaconda - Deer Lodge Counties 1961Q2 - 1980Q4

Standard Deviations of the Differenced Series

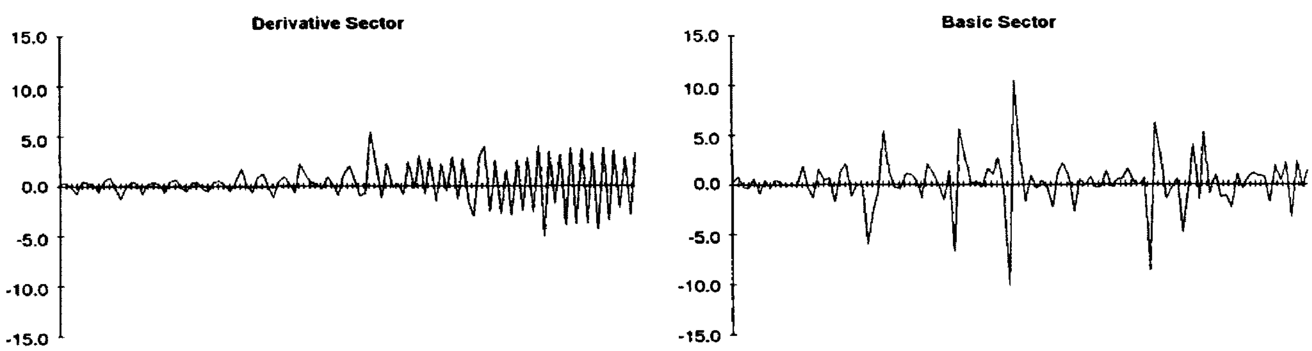
Derivative Sector

Seasonal	0	1
Non-seasonal		
0	9,241,233	1,844,676
1	**1,373,025**	1,417,008

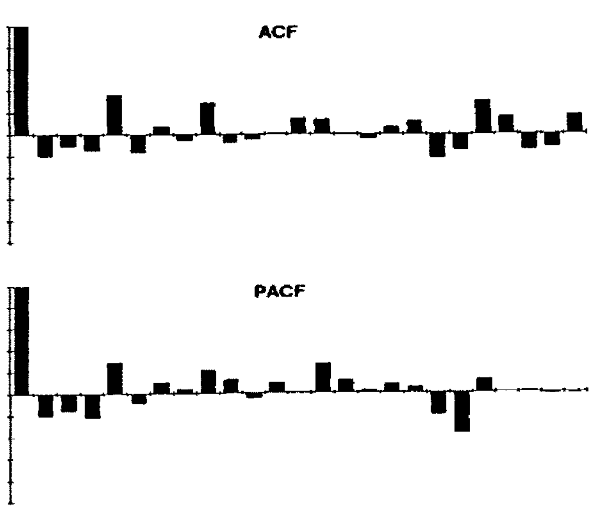
Basic Sector

Seasonal	0	1
Non-seasonal		
0	5,961,688	3,412,316
1	**2,701,030**	3,788,799

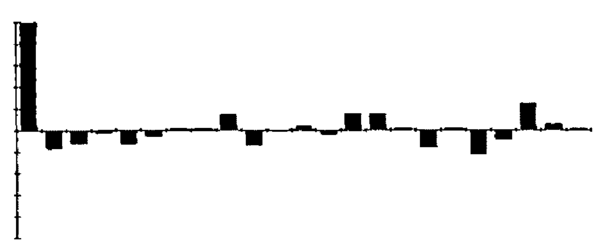
Plot of the Differenced Series
(First difference)



Plot of the Autocorrelation and Partial Autocorelation Functions
(First difference)



Plot of the Autocorrelation Function of the Residuals
(Transfer function)



Identification and Diagnostics of the Univariate and Transfer Function Models Rosebud County 1961Q2 - 1980Q4

Standard Deviations of the Differenced Series

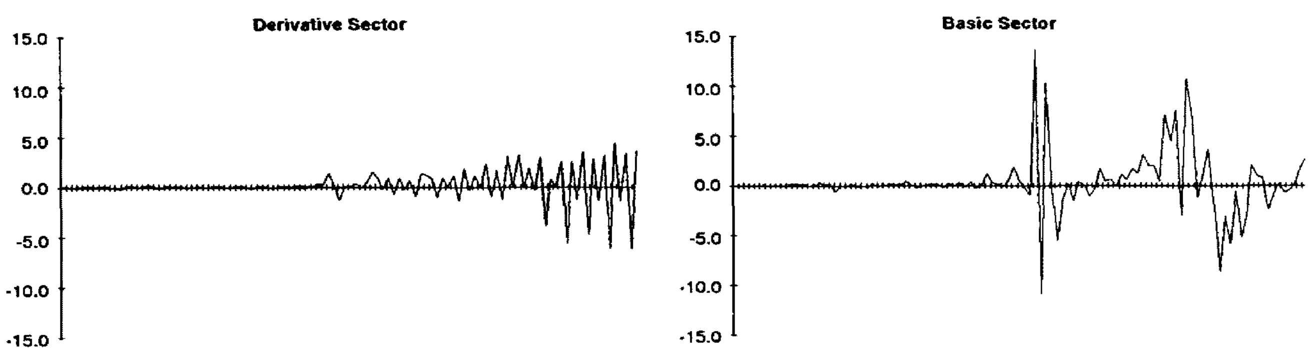
Derivative Sector

Seasonal	0	1
Non-seasonal		
0	1,434,112	363,940
1	**244,261**	225,955

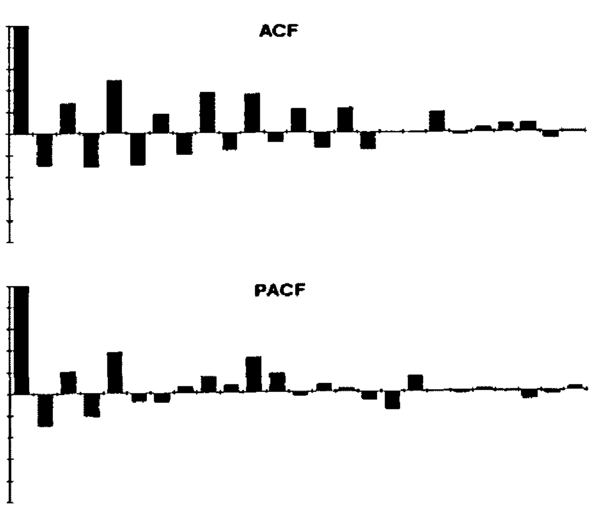
Basic Sector

Seasonal	0	1
Non-seasonal		
0	2,332,484	1,360,899
1	**991,643**	1,472,600

Plot of the Differenced Series
(First difference)



Plot of the Autocorrelation and Partial Autocorelation Functions
(First difference)



Plot of the Autocorrelation Function of the Residuals
(Transfer function)

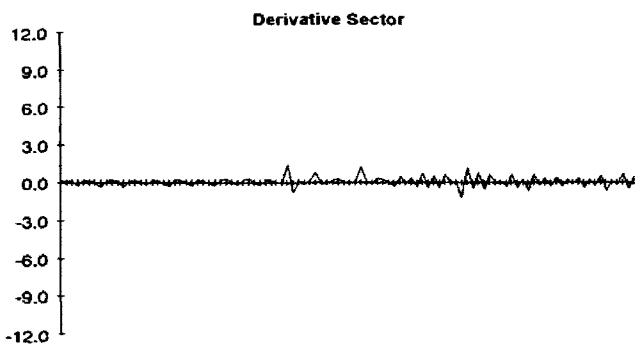
Identification and Diagnostics of the Univariate and Transfer Function Models Valley County 1961Q2 - 1980Q4

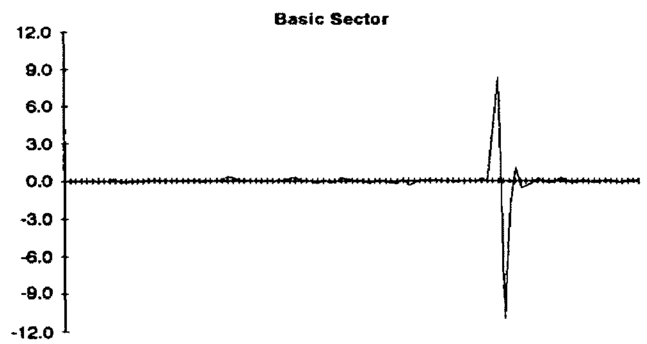
Standard Deviations of the Differenced Series

Derivative Sector		
Seasonal	0	1
Non-seasonal		
0	1,883,906	436,169
1	414,860	417,507

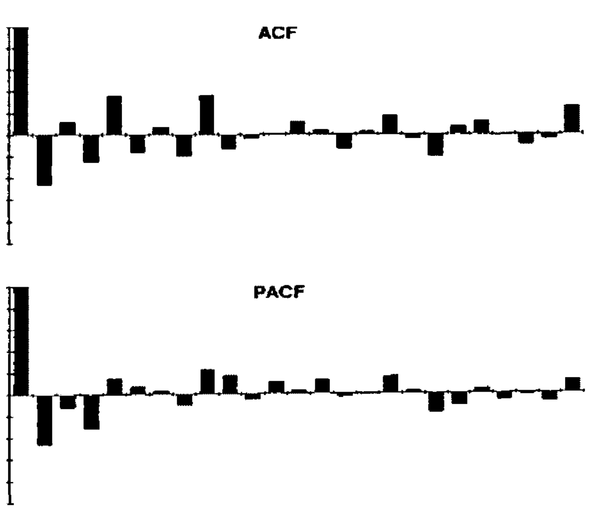
Basic Sector		
Seasonal	0	1
Non-seasonal		
0	646,774	296,541
1	123,418	181,121

Plot of the Differenced Series
(First difference)





Plot of the Autocorrelation and Partial Autocorelation Functions
(First difference)



Plot of the Autocorrelation Function of the Residuals
(Transfer function)

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