INFLUENCE OF THE ECONOMY ON TEEN AND ADULT BIRTH PATTERNS IN OKLAHOMA 1980 THROUGH 1995: A TIME SERIES ANALYSIS

A DISSERTATION

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INFLUENCE OF THE ECONOMY ON TEEN AND ADULT BIRTH PATTERNS IN OKLAHOMA 1980 THROUGH 1995: A TIME SERIES ANALYSIS

ABSTRACT

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While there is evidence that economics and reproductive choices are interrelated, differences in decision-making processes between teen and adult women regarding these choices have not been investigated. Therefore, influence of the economy on birth patterns was examined separately for these two age groups. Fertility and childbearing are often considered indicators of health with both macroeconomic and microeconomic precursors and implications. Competing theories and conceptual frameworks currently exist to describe the cyclic patterns found in reproductive behavior and their relationships to economic condition. Procyclic models suggest a lagged positive association between economic conditions and numbers of births whereas countercyclic models indicate that a negative or inverse relationship exists.

Three distinct problems were addressed in this study. First, the issue of competing economic models was addressed. Secondly, this study examined the number of daily and weekly births instead of the traditional monthly or yearly data aggregates to allow greater sensitivity in testing the relationship of an economic variable with the

number and timing of births. The third problem stemmed from the lack of literature available to describe the differences between teen and adult birth patterns. By conducting separate data analyses for teens and adults, differences in the two age groups were identified.

The procyclic Pennsylvania Model of contemporary economic theory of fertility served as the theoretical framework for this study because it best reflects the sociological and demographic nature of the Western family and fertility during the 1980s, the decade from which 2/3 of the data set was drawn. The economic approach to fertility emphasizes the effects of parents' income and the cost of raising children on reproductive choices. This study disputes Milio's countercyclic Framework for Prevention which states that during periods of poor economic condition, access to health care services decreases causing the birth rate to increase.

The sample for this study consisted of the 800,206 live births that occurred in Oklahoma between January 1, 1980 and December 31, 1995. The daily birth rate was obtained from the certificates of these births recorded by the Oklahoma State Department of Health, with separate data sets created for teen and adult births. The birth count for each of the 5,844 days during the specified sixteen-year period made up the time series analyzed in this study.

A time series design was utilized to examine the pattern or underlying processes of births to teens and adults in Oklahoma over a 16-year period of time in relation to economic changes which occurred in that state during the same time period. The data set used to conduct a time series analysis was collected at fixed intervals with the order of observation of extreme importance offering the advantage of explaining the past and predicting the future behavior of the variables of interest.

Findings of the study revealed that the ARIMA (0, 1, 1) model with a seasonal (0, 1, 1) component was the model that was most statistically adequate to represent the birth data and the oil price data in this study. Crosscorrelation of oil price with each birth data set indicated that there is a procyclic relationship between economic condition and the number of Oklahoma births to teens, adults, and both groups combined. Descriptive data yielded demographic differences in the teen and adult birth groups in regard to age of the mother and father, mother's marital status, race of mother and father, and rurality. Chi Square analysis revealed a significant seasonal cycle within the adult and teen birth data with a significantly higher rate of births during the summer months of July, August, and September. There was no significant seasonal difference, however, between teen and adult birth patterns.

Modeling birth data and recognizing birth patterns have important implications for nurses and other health care providers. Understanding reasoning regarding economic opportunity and childbearing will aid in providing individualized, quality health care. Staffing of obstetrical units can be increased during the periods of time associated with the highest birth rates. The information has implications for the education of health care professionals and clients and in the development of social policy. Long term trends and forecasting could be examined when determining the needs of communities within the geographical area studied to support the development of programs, construction of facilities, and the formation of health care policies intended to serve women and newborns.

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CHAPTER I

INTRODUCTION

Approximately four million births occur each year in the United States. Rates of fertility among American women began to decrease slightly in 1991, reversing the upward trend that had occurred since the mid 1970s (Klerman, 1994). Birth trends vary by age of the mother. Birthrates among women younger than 20 and among those 35 to 39 years of age continued to increase during the early 1990s while rates of women in their twenties and early thirties decreased (Althaus, 1994; Mosher, 1988). Marital fertility had also declined during the same period of time while non-marital fertility continued to rise, accounting for almost 30% of births to American women in 1991 (Althaus, 1994). The National Center for Health Statistics (NCHS, 1993) reported that the incidence of preterm birth, especially to teen mothers, was rising and the delivery of low birth weight infants had increased to its highest level since 1978.

Recent Oklahoma birth trends are considerably different than the national birth trends. The upward birth trend which occurred in Oklahoma following the post-Baby Boom slump, reached its peak in 1982 with 58,741 births occurring in the state (Oklahoma State Department of Health, 1996). A steady decline in births ensued from 1982 to 1990. After a slight increase in 1991 and 1992, the trend continued to move slowly downward in the mid 1990s. During the early 1990s, the fertility rate for the state of Oklahoma was 64.8 per 1,000 women of childbearing age with less variance in trends by age group than was indicated by national figures. In general, birth trends of Oklahoma teens paralleled those of Oklahoma adults with subtle differences explored in this study. While the overall teen birth rate in Oklahoma has been gradually falling, births to very young teens has increased, with 25 females age 9 to 13 years of age giving birth in 1995 (Oklahoma State Department of Health, 1996). Similar to national figures, non-marital fertility and incidence of low birth weight in Oklahoma continued to rise.

The economy of a specific geographic region is a major determinant of health of the inhabitants of that region. Economic conditions directly impact the quality and availability of health-related goods and services. Nutritional status, shelter and transportation needs, type and amount of leisure activities, and socio-political structures and procedures are also determined by the economy, thus indirectly influencing the health of populations.

While it appears that economics and reproductive choices are interrelated, the decision-making processes regarding fertility and childbearing may be quite different between teen and adult women. Therefore, the amount of influence the economy has on the determination of birth patterns was examined separately for these two age groups.

Fertility and childbearing are often considered indicators of health with both macroeconomic and microeconomic precursors and implications. At the aggregate level (macroeconomic), human reproduction is the source of the economic system's labor force and of the consumers who ultimately determine the economy's output. At the individual level (microeconomic), children are an important source of satisfaction that competes with alternatives for the limited parental resources of time, energy, and money (Easterlin, 1989). Time series analysis was utilized to construct a model of adult and teen birth patterns and their relationships to an economic indicator.

Problem of Study

There were three distinct problems addressed in this study. First, the issue of competing economic models was addressed. Currently there are several conflicting models that have attempted to describe fertility as it relates to an economic indicator. Some of these models describe this relationship as procyclic, while others find economy and fertility to be related countercyclically.

Secondly, the traditional use of birth data compiled on a monthly or yearly basis and studied over time had the inherent problem of a loss of information by smoothing out the data. Patterns such as weekly cycles or seasonality were lost by using the yearly number of births to examine fertility and childbearing. This study examined the number of daily births to allow greater sensitivity in testing the relationship of an economic variable with the number and timing of births, as well as identification of subtle differences in teen and adult birth patterns.

The third problem stemmed from the lack of literature available to describe the differences between teen and adult birth patterns. Teens and adults may not respond to the economy in the same way. By conducting separate data analyses for teens and adults, differences in the two age groups could be identified.

The stated problems raised the following questions: (a) which ARIMA model best fits the Oklahoma birth data, (b) what is the relationship between Oklahoma birth trend and the economy, and (c) what differences can be found in the patterns of teen and adult births?

Purpose

The purpose of this study was to conduct separate rigorous tests using daily birth data for teens and adults to identify the best fitting model of Oklahoma births. The dynamics of the time series of births to teen and adult women in Oklahoma from 1980 through 1995 were examined and compared. The impact of the economy on birth trend in Oklahoma was also evaluated.

Rationale for Study

Examination of birth records for dynamic patterns that occur over time and across sociodemographically diverse regions of the state of Oklahoma facilitates identification of community characteristics, needs, and responses to conditions, events, and policies. Defining a model that is a good predictor of the timing and patterns of births is beneficial to nursing and other health care professions. Identification of such a model can be useful in the development of public health policy, planning programs intended to serve women and newborns, and designing women's health care facilities.

Historically, perinatal care focussed on the events surrounding an individual birth. The benefits of this study, however, extend beyond the individual to society. Through more accurate modeling of teen and adult birth patterns, changes in needs for perinatal care can be identified or anticipated, access to care will increase, birth outcomes would improve, and monetary costs will be contained. The information gleaned from this study may be especially useful to Oklahoma communities as they make a transition to the managed care environment.

Conceptual Framework

Competing theories and conceptual frameworks currently exist to describe the cyclic patterns found in fertility behavior. The majority of economic theories describe fertility as being procyclic when compared to business or economic patterns or cycles (ie., as the economy improves, fertility increases). Other theorists, however, describe fertility behavior as being countercyclic (ie., as the economy improves, fertility decreases). Each perspective is supported by a body of literature and research findings. Both procyclic and countercyclic approaches will be addressed in the review of literature.

A procyclic economic theory of fertility provided the framework for this study and offered support for the hypotheses that were tested. The economic theories of fertility apply the principles of supply and demand (microeconomic theory) to the desire for a certain number of children. The "demand" for children varies directly with household income and inversely with the cost of raising a child. The "supply" of children is balanced by the number of surviving children parents would have if they did not deliberately limit fertility and the costs of fertility regulation in terms of monetary expenditure, psychological drawbacks, and time and energy required to learn about and use specific techniques (Easterlin, 1989).

The Evolution of the Economic Theory of Fertility

The family, and subsequently the birth rate, of Western societies has undergone radical change in the last several decades. To understand our current state, it is important to examine the evolution of the economic theories of fertility as they alternate from procyclic to countercyclic and back again.

Beginning in the 1700s with the writings of Adam Smith, the father of modern economics, fertility rates and economic conditions were considered to be procyclic. Although not stated explicitly, his writings implied there was a positive association between economic well-being and the production of many children who he viewed as a source of happiness, opulence, and prosperity (Lorraine, 1982).

Thomas Richard Malthus, in his Essay on the Principle of Population published in 1798, was the first to propose the model of population growth based on the principles of supply and demand. Malthus observed that men and women preferred their own children to children produced by others and this desire is affected by supply conditions. Supply is determined by knowledge of birth control techniques and the capacity to produce children (age, nutrition, health, and other variables). Demand was defined as the maximization of the utility of a family that depends on a specified quantity of children (Becker, 1989). Malthus noted that when economic circumstances were less favorable, couples married later and postponed having children, a procyclic phenomenon.

Malthusian Theory remained unchallenged until the 1950s when economists began to study labor force participation of married women. It was discovered that the demand for children was dependent upon family income, the value of parents' time, and the "quality" of children (Leibenstein, 1957; Becker, 1960; Easterlin, 1978). This contemporary economic theory of fertility became known as the Chicago-Columbia approach and shifted towards a countercyclic model. Because women were entering the workforce outside of the home, family income increased and the number of children per family decreased (Becker, 1965; Lancaster, 1971).

During the late 1970s, another variation of economic theory of fertility began to evolve. Known as the Pennsylvania Model, this theory extended the Chicago-Columbia approach to include theoretical and empirical considerations described in the sociological and demographic literature on fertility. This model introduced the concept of "taste influence" in the demand for children referring to it as "relative income" and additional supply factors termed "natural fertility" (Ben-Porath, 1975; Leibenstein, 1975; Easterlin,1978; Sanderson, 1980; Easterlin, Pollak, & Wachter, 1980). With this re-definition of supply and demand, economics and fertility were once again viewed as procyclic. A summary of the frameworks and research foundations addressing the relationship between fertility and economics can be found in Appendix A.

The Pennsylvania Model

The procyclic Pennsylvania Model, a contemporary economic theory of fertility, served as the theoretical framework for this study because it best reflects the sociological and demographic nature of the Western family and fertility during the 1980s, the decade from which 2/3 of the data set was drawn. The economic approach to fertility emphasizes the effects of parents' income and the cost of raising children. This model is most applicable to developing countries like the United States where availability of goods and services are related to relative income. Relative income is defined as monetary acquisition that is high in relation to an individual's material aspirations and is endogenous to that person's value system (Sanderson, 1976). These values serve as a basis for "preference variables" or "taste influences" derived from consumption experiences in childhood and adolescence which determine an individual's consumption standards and constraints, and thus the values that help govern fertility decisions (Friedman, Hechter, & Kanazawa, 1994).

The Pennsylvania Model stresses two factors as fertility determinants in the demand for children: the potential supply of children (the number of surviving children parents would have if they did not deliberately limit fertility) and the costs of fertility regulation (the subjective or psychic drawbacks and objective costs in terms of time and money required to learn about and use contraceptive techniques)(Easterlin, 1989). It is the introduction of the concept of supply in this context that distinguishes this model from the Chicago-Columbia approach. Sanderson (1980) uses the term "natural fertility" to describe supply conditions which refers to the absence of any attempt to deliberately limit fertility among most segments of the population. However, constraints to supply of children in modern society also exist and include higher age at time of marriage, infertility problems, availability of contraception and abortion, infant mortality, and increased incidence and duration of breastfeeding. The Pennsylvania Model describes two situations in which rational behavior would be consistent with an absence of deliberate fertility regulation: an excess demand for children and high perceived cost of fertility regulation (Easterlin, 1989).

In reference to the relationship between fertility and economics, the Pennsylvania Model builds on the sociological premise that economic socialization experiences early in life play an important role in forming an individual's material tastes. The material environment in which children are raised influences the formation of the socially defined subsistence level they aspire to achieve when reaching adulthood (Ahlburg, 1984). "Only to the extent that actual income exceeds this subsistence constraint would a couple feel free to embark on family formation" (Easterlin, 1989). The Pennsylvania Model predicts a positive association between fertility and business cycles (Ben-Porath, 1973). Variations in actual earnings associated with fluctuations in the business cycle are expected to lead to corresponding variations in fertility as income expectations change (Easterlin, 1989).

Assumptions

The following are theoretical assumptions, drawn from the Pennsylvania Model of contemporary economic theory of fertility, which guided the present study.

1. Number of births reflect the dynamic, multicausal nature of reproductive choices.

2. Individuals are capable of making rational choices among fertility behaviors.

3. The principles of supply and demand can be applied to reproductive choices.

4. Available resources and existing economic conditions influence the choice-making of individuals.

5. Personal values that govern fertility decisions are endogenous.

Assumptions pertinent to the research methodology of this study were also identified. They included:

1. The number of births not recorded by the Oklahoma State Department of Health for the years 1980 through1995 was too small to effect conclusions drawn.

2. Information about each birth was provided and recorded accurately and completely.

3. Data regarding the rate of spontaneous and induced abortions were not crucial to testing the variables of interest in this study.

4. A sixteen-year time period (5,844 days) was an adequate length of time to detect patterns in births.

5. Oil price data were correctly recorded in the Oilprice Bulletin and a daily price for Oklahoma sweet crude oil was accurately extracted.

5. Oil price alone is an adequate economic indicator for the state of Oklahoma during the time period studied.

6. Time lags between change in the economy and birth patterns can be found in the range of the study period.

7. Nine months is the minimum lag expected between economic condition and number of births.

Research Questions and Hypotheses

The following research questions and hypotheses were addressed in this study. They were organized in a manner that allowed a research question to drive each hypothesis. The research questions allowed broad exploration of study variables and a methodology relatively new in the discipline of nursing. The hypotheses were subsequently tested using the appropriate statistical analysis.

RQ_1 : Which ARIMA model best fits the Oklahoma birth data?

H_1 : A procyclic model of economics and fertility better fits the Oklahoma birth data (all births) than a countercyclic model.

H_2 : Fluctuations in economic conditions have a stronger relationship to the pattern of adult births than to the pattern of teen births.

RQ_2 : What other differences can be found in the patterns of teen and adult births?

H_3 : There are differences in seasonal patterns between teen births and adult births in Oklahoma.

Definition of Terms

The following operational definitions were used to specify how each variable or concept was measured in the current study.

Birth pattern is the inclination of the number and timing of births to proceed in a certain direction at a certain rate over a specified duration. In this study, pattern will be measured by changes in daily birth rates to women of all ages in the state of Oklahoma for a 16-year period of time (1980 through 1995).

Economic Condition is the state of economic wellbeing in Oklahoma determined by the daily price of oil as recorded in the crude oil price bulletin supplied by Phillips Petroleum Company in Bartlesville, Oklahoma for a 16-year period of time (1980 through 1995).

Teen births are those births to mothers age 19 and younger at the time the birth occurred per self-report and recorded on the Oklahoma Certificate of Live Birth.

Adult births are those births to mothers age 20 and older at the time the birth occurred per self-report and recorded on the Oklahoma Certificate of Live Birth.

Procyclic model indicates a lagged positive association between economic conditions and number of births.

Countercyclic model indicates a lagged negative association between economic conditions and number of births.

Seasonal differences refers to the number of births occurring to teens or adults during each of the four seasons (spring, summer, autumn, and winter) with statistical significance determined by Chi Square.

Stronger relationship is the degree to which economic conditions influence the birth patterns of teens and adults and will be measured by cross-correlation coefficients.

Limitations

The following limitations of the present study were recognized:

1. Personal, cultural, and religious preferences for number of children are not specifically addressed (controlled) in this study but are assumed to be similar in adults and teens.

2. The birth data used in this study do not reflect number of pregnancies, only number of births.

3. Birth certificates may have missing data.

4. The method of recording and reporting oil price in the state of Oklahoma was modified during the course of the study.

Delimitations

The present study was delimited to:

1. Only live births that occurred in the state of Oklahoma. No data for fetal deaths, spontaneous abortions, or elective abortions were used in this study.

2. Only the years of 1980 through 1995 were examined.

3. A data set that included only the date of birth, age and race of mother and father, mother's marital status, and mother's county of residence was obtained from the Oklahoma State Department of Health.

4. A single economic indicator (oil price) was used to describe economic condition.

Summary

Time series analysis offers a research methodology for nurses that may be used to analyze birth trends and define a model that is a good predictor of birth patterns. Identification of such a model can be useful to nurses and other health care professionals in the development of public health policy, planning programs intended to serve women and newborns, and designing women's health care facilities.

The purpose of this study was to conduct separate rigorous tests using daily birth data for teens and adults to identify the best fitting model of Oklahoma births. Competing economic models were examined to determine if Oklahoma birth trends were procyclic or countercyclic during the sixteen-year period of time studied. The impact of the economy on birth trend in Oklahoma was also evaluated.

The Pennsylvania Model of contemporary economic theory of fertility offered a procyclic framework on which the present study was based. Reflecting the sociologic and demographic nature of the Western family and fertility of the time period under examination, the model utilizes the concepts of supply and demand, relative income, and taste influence for children in rational choice-making regarding fertility issues. This model competes with the countercyclic Chicago-Columbia approach to contemporary economic theory which is based on the premise that as women enter the workforce outside of the home, family income increases while the number of children per family decreases.

Certain theoretical and methodological assumptions were necessary for the implementation of this study and have been stated. Two research questions and three hypotheses were derived from the conceptual framework. Key terms were operationally defined. Limitations and delimitations were also addressed.

CHAPTER II

REVIEW OF THE LITERATURE

This review of the literature addresses studies that have examined the impact of economic conditions on fertility and the use of time series analysis in modeling economic conditions and birth rates. The majority of previous studies investigated the effect of a single variable on birth patterns in a specified population or geographic location, oftentimes with conflicting results. Determining if there is a relationship between fertility and economics and establishing the nature of that relationship (ie., procyclic or countercyclic) have been the goals of numerous research investigations. Studies have also shown that seasonality plays a role in the cyclic nature of birth patterns. Even though the results of some studies were inconclusive, each investigation contributed to the understanding of the choices individuals make regarding their reproductive health and the effect those choices have on the timing and number of births.

Birth Patterns in the United States

Following a decline in birth rate during the post-Baby Boom years, there had been an upward trend in births in the United States since the mid 1970s (Klerman, 1994). Surpassing four million births in 1989, it was the first time that level had been reached since 1964 (United States Department of Health and Human Services, 1993). The total number of births in this country decreased during 1991 and 1992 and is expected to drop below four million during the 1990s (Clarke & Ventura, 1994).

The proportion of births described as "unwanted" or "unplanned" fell from 14 percent in 1973 to eight percent in 1982, but increased to ten percent in 1988 (Chandra, 1995; Williams, 1991). Using a multistage, area probability sampling technique, 8,450 women age 15 to 44 were interviewed to determine couple agreement about fertility decisions. The study found that teenagers, never-married women, black women, and those with less than a high school education were less likely than other women to have a birth that is jointly desired by both partners (Williams, 1994). Williams (1994) attributes these findings to decreased status or interpersonal power of the women in these aggregates, thereby limiting their available choices of reproductive options. The obligation of health and social policy is the assurance of environmental circumstances that do not impose more risks to health for some segments of the population than for others (Milio, 1986).

Although accurate methods of recording and tracking birth statistics are currently available, research has failed to consistently specify a relationship between the number or timing of births and an economic indicator. Because individuals make choices within the context of the environment, economic conditions are likely to contribute, at least in part, to reproductive decision-making.

Economic Conditions

A review of the available research and literature addressing the relationship between economic conditions and fertility or childbearing practices highlighted the existence of numerous competing theories and conflicting research results. Discussion of only current studies would be inadequate to fully illuminate the "seesaw" effect between procyclic and countercyclic views of the association between these variables. Therefore, older studies were included in this review to depict the historical shifting from one model to the other as sociologic, economic, and methodological approaches evolved. Sociologic changes such as the woman's role in society and the cost and value of children have led researchers to re-examine the impact of the economy on decisions regarding the family and choices related to childbearing. Economic changes influenced by the transition from rural farming to urban industrialization and the movement of women to the workforce outside of the home also contributed to the shifting back and forth of procyclic and countercyclic models of economics.

Numerous early studies examining the correlation between economic conditions and birth rates found a positive association between economic activity and fertility (Thomas, 1927; Galbraith & Thomas, 1941; Kirk, 1960; Silver, 1965). Using aggregate time-series data, these analyses were conducted by regressing fertility rates on a business cycle indicator or correlating trend deviations of the two series to identify the procyclicality of fertility (i.e., the positive association between economic activity and fertility). A time series analysis of births, marriage rate, and business cycle found that the procyclicality of fertility exists even after controlling the marriage rate, although the response of the birth rate was substantially lower when the marriage rate was held constant (Silver, 1965). The results of these studies led to the widely accepted

Contemporary Economic Theory of the Fertility in which fertility behavior is explained by the economic theory of household demand. While this Theory added the concept of household demand, it maintained the procyclic views of Malthusian Theory that had existed for almost 200 years.

However, studies conducted during the 1970s of the association between economic conditions and patterns of birth revealed that fertility moved countercyclically over the business cycle (Lancaster, 1971; Nerlove, 1974; Butz & Ward, 1979; Schultz, 1981; Ben-Porath, 1982). Using the results of these studies, the Chicago-Columbia Approach to contemporary economic theory of fertility evolved. This adaptation of the theory incorporated the concept of allocation of time into household production theory. As more women entered the work force, family income increased as the number of children decreased due to time constraints of the mother.

In 1976, Milio proposed a framework of prevention for nursing which supported the countercyclic relationship of economics and childbearing. Citing that health deficits, including unwanted pregnancy and teen pregnancy, result from an imbalance between a population's health needs and its health sustaining resources (Stanhope & Lancaster, 1996). According to Milio (1976), the range of health-promoting or health-damaging choices available to individuals is affected by their personal resources and their societal resources. Personal resources, as summarized by Swanson & Nies (1997), include one's awareness, knowledge, and beliefs and those of one's family and friends as well as money, time, and the urgency of other priorities. Societal resources are "strongly influenced by community and national locale and include the availability and cost of health care services, environmental protection, safe shelter, and the penalties or rewards given for failure to select the given option (Swanson & Nies, 1997, p. 78). Milio (1976) indicates that during periods of poor economic condition, access to health care services such as birth control methods and abortion is decreased causing birth rates to increase.

However, by the late 1970s and early 1980s, the views of the association between economics and fertility tended to revert back to the procyclic model. Building on the Chicago-Columbia Approach, a broader model which came to be known as the Pennsylvania Model, began to evolve (Sanderson, 1980; Behrman & Wolfe, 1984). This model incorporated the social and demographic aspects of fertility and emphasized the effects of parents' income and the cost of raising children. This model is most applicable to developing countries like the United States where availability of goods and services are related to relative income. Relative income is defined as monetary acquisition that is high in relation to an individual's material aspirations and is endogenous to that person's value system (Sanderson, 1976). These values serve as a basis for "preference variables" or "taste influences" derived from consumption experiences in childhood and adolescence which determine an individual's consumption standards and constraints, and thus the values that help govern fertility decisions (Friedman, Hechter, & Kanazawa, 1994).

The Pennsylvania Model stresses two factors as fertility determinants in the demand for children: the potential supply of children (the number of surviving children parents would have if they did not deliberately limit fertility) and the costs of fertility regulation (the subjective or psychic drawbacks and objective costs in terms of time and money required to learn about and use contraceptive techniques) (Easterlin, 1989). Constraints to supply of children in modern society also exist and include higher age at time of marriage, infertility problems, availability of contraception and abortion, infant mortality, and increased incidence and duration of breastfeeding.

In reference to the relationship between fertility and economics, the Pennsylvania Model builds on the sociological premise that economic socialization experience early in life plays an important role in forming an individual's material tastes. The material environment in which children are raised, leads to the formation of the socially defined subsistence level they aspire to achieve when reaching adulthood (Ahlburg, 1984). Becker (1991) extends this idea further in his procyclic Reformulation of the Economic Theory of Fertility. This theory is also derived from the original economic theory of fertility and stresses that fertility rate is based on dynastic utility functions and descendents in different generations. The importance of altruism within families is highlighted.

Literature to date reveals that the relationship between economics and fertility in the 1990s is once again moving toward a countercyclic model. The Theory of the Value of Children – Uncertainty Reduction (Friedman, Hechter, & Kanazawa, 1994) presents the rational choice explanation of contemporary fertility behavior. They propose that during times of uncertainty, including periods of economic uncertainty, the decision to have children is a means to increase certainty and therefore desirable.

Also supporting the countercyclic views of economics and fertility in the 1990s, Mocan (1990) used multivariate vector-autoregressions to describe the dynamic interrelations between fertility, unemployment, proportion of young marriages, and the divorce rate. By including these variables in the study, the sociologic context and fertility dynamics were addressed. "Fertility dynamics," according to Mocan (1990), center around the increasing age of women at marriage which results in a shortened period during which women are exposed to pregnancy, lengthened intervals between generations, and greater education leading to employment opportunities and altered fertility decisions. This indicates that United States fertility is not governed by a deterministic trend as concluded by the early studies, but evolves around a stochastic trend (Mocan, 1990).

Mocan, however, failed to account for the growth of non-marital childbearing among women greater than twenty years of age. Women in this age group now account for a greater percentage of non-marital births than do women in their teen years (Hoffman & Foster, 1997). Using data from the Panel Study of Income Dynamics which surveyed approximately 7,000 American households, Hoffman and Foster (1997) found that the socioeconomic status of women who have had a non-marital birth as an adult have similar median income-to-needs ratios, similar rates of poverty, and receive welfare as often as their teen counterparts. Women who have had both teen and post-teen non-marital births represent the poorest socioeconomic group.

Race and ethnicity also plays a role in birth patterns and contraceptive practices of low-income women. In a survey of 918 low-income women in Los Angeles county which included approximately equal numbers of non-Hispanic whites, blacks, and Hispanics, Radecki (1991) reported that first pregnancies for unmarried white and black women resulted primarily from nonuse of contraception, whereas half of first pregnancies among unmarried Hispanics were intentional.

In an economic analysis of Chinese fertility behavior that examines population census data at the county level in China in 1982, per capita income was found to have a nonlinear effect on fertility behavior (Liu, Yamada, & Yamada, 1996). The U-shaped income effect on fertility in that country suggests that a more equitable income distribution leads to a reduction in the Chinese fertility rate. Liu, et al (1996) also suggested that infant mortality is a prominent measure of the health status of a population and the birth rate as it reflects environmental conditions, socioeconomic status, and "replacement effect." Replacement effect is defined as the fertility behavior of a household as it responds to the anticipated risk of infant and child deaths by increasing the number of births.

The relationship between economic conditions and birth rates is a cyclic process. Just as economic conditions are believed to account for the number and timing of births in a given population, the birth rate has an impact on economic growth. A recent study has revealed a negative correlation between population growth and economic development in the United States during the 1980s (Kelley & Schmidt, 1995). These findings were different from those in the 1960s and 1970s which showed non-significant correlation between those variables. With increased birth rates during this period coupled with increased longevity, the short-term costs of births is apparent with the favorable labor-force impact of births during this decade not yet measurable (Kelley & Schmidt, 1995). Health policymakers must be sensitive to the expected and unexpected impacts of economic reform on health outcomes for individuals and on populations (Peabody, 1996).

Multiple-Variable Studies

The inconsistent findings of the single independent variable studies previously discussed lend support to the premise that determination of past and prediction of future birth trends is contingent upon a multicausal and nonlinear model of birth indicators. Richards (1983) analyzed the short-run fluctuations in national time series or vital events for France during 1740 to 1909. Study results indicated that economic and nutritional variables are more likely to be statistically significant in predicting the time path of fertility than are the demographic variables or the effects of meteorological conditions.

Using longitudinal regression techniques to analyze 1978 to 1988 state-level data collected in all 50 states and the District of Columbia, Matthews, Ribar, and Wilhelm (1997) examined the effects of wages, welfare policies, and access to physicians, family planning clinics, and abortion providers on abortion rates and birth rates. The study revealed several interesting findings:

1. The abortion rate is lower in states where access to providers is reduced and

state policies are restrictive with decreased access accounting for approximately one quarter of the 5% decline in abortion rates between 1988 and 1992.

2. Birth rates are higher where costs of contraception are higher because of decreased access to medical care and family planning clinics.

3. Higher wages and generous welfare benefits were found to be significantly and consistently associated with increased birth rates.

4. Economic factors showed no consistent relationship with abortion rates.

Economic models are particularly useful in sorting out the determinants of reproductive behavior in the United States because of the characteristic heterogeneity of the population's values and preferences, as well as its vast economic resources and wide range of access to different types of health care (Matthews, Ribar, & Wilhelm, 1997).

"Unless the analytical tool used takes care of the dynamics of fertility within a multicausal framework, the complexity of interrelationships involved may not be fully captured" (Masih & Masih, 1997, p. 446). The use of dynamic time-series modeling allows for the "coexistance of both short-term and long-term forces that drive the socioeconomic-institutional influences so inherently interactive with fertility decisions" (Masih & Masih, 1997).

Oil Price as an Indicator of the Oklahoma Economy

For over 100 years, the petroleum industry has been at the forefront of economic development in the region that is now the state of Oklahoma. The first commercial oil discovery took place on April 15, 1897 in Bartlesville, Indian Territory with the tapping of the Nellie Johnstone No.1 well. It was soon discovered there was a need for storage tanks, pipelines, railroads, and refineries. The population of this area grew rapidly and cities and towns sprang up to support the booming oil industry. By the end of 1907, Oklahoma had become a state and was the nation's largest oil-producing area that supplied twenty percent of the world's oil needs (Oklahoma Energy Centennial Committee, 1997).

While Oklahoma's ranking as an oil producer has slipped from first to fifth nationally over the last 90 years, Oklahoma still contains tremendous petroleum reserves and continues to generate large revenues for the state and its people. During the early years of the oil industry, there was no regulation of the amount of oil produced per day and the result was overproduction with a price range of 25 cents per barrel to $1.43 per barrel. There was a general increase in oil production until after World War II, followed by the oil bust of the 1950s.

The oil slump of the 1950s led to the boom of oil technologies of the 1960s and 1970s. New methods of exploration using seismic technology, advanced chemistry, and computer technology once again made Oklahoma a leader in the petroleum industry. During the 1980s, oil and gas production taxes generated nearly 800 million dollars of revenue for the state of Oklahoma (almost 40 per cent of state budget). Private industry related to oil production and oil technology employed more than 80,000 Oklahomans during this time period (Oklahoma Energy Centennial Committee, 1997).

The 1990s brought diversification to the oil industry in Oklahoma. The hydrocarbon (oil) molecule is one of the most complex molecules in existence. Crude oil is used for much more than gasoline and motor oil. It is a major component of more than 3,000 different products used in every household. Some of the products that use oil as a base include: clothing, hygiene products, perfumes, plastics, medicines, sports equipment, candles, paint, soaps, wax, and countless other household items. Oklahoma is also home to three major educational institutions providing undergraduate and graduate degrees in petroleum engineering and related fields. Contractual agreements between state and federal governments, educational institutions, and private industry support numerous research and development endeavors to advance the oil industry and continue to employ Oklahomans.

Seasonality of Conception and Birth

In addition to economic cycles, other factors have been associated with the seasonality or undulating cycles seen in birth patterns. The term 'season' has several definitions. Season may be used to describe the four, equal, natural divisions of the year indicated by the passage of the sun through an equinox or solstice marked by the change in temperature, moisture, vegetation, and daylight. Seasonality may also be used to refer to other divisions or recurrent periods of time. Meteorologic examples of divisions could include the wet/dry seasons or the hot/cold season, depending on the specific geographical area under investigation. Other recurrent periodic events may be characterized by certain festivities, holidays, planting or harvesting of crops, or occupational schedules. In reference to animals, they are said to be in 'season' or in heat when they are ready to mate or breed (Morris, 1973).

The most common areas of interest investigated for their association with birth cycles are seasons of sociologic behavior and the seasons of the year in relation to the meteorological differences in spring, summer, autumn, and winter. Because climate and environment are so intricately interrelated with human behavior, they are addressed under the broad heading of seasonality.

Seasonality is an important source of nontrend variation in births in virtually all populations, but there are significant differences between geographic regions and time periods in the pattern of seasonal variations (Lam & Miron, 1991). Wrigley and Schofield (1981) examined 300 years of birth data from pre-industrial England and found that seasonal birth patterns declined over time. This is consistent with the findings of Knodel and Wilson (1981) who describe a similar secular decline in seasonality of births over a 150 year period during the eighteenth and nineteenth centuries in Germany. In the United States, a comparison of birth seasonality in New York and Georgia revealed that there was a significant decrease in the amplitude of birth seasonality in the white population in the south (Lam & Miron, 1991; Seiver, 1985). It was also noted however, that seasonality for the non-white population in the south and the entire population in the north seasonality changed "very little in either timing or amplitude" (Lam & Miron, 1991, p. 63). Lam and Miron (1991) state that "secular changes in seasonal patterns indicate that although seasonality may be less important now than during the pre-industrial period, it has not disappeared from any population and has actually increased in some" (p.65).

Leisure Time and Seasonality

Festivals, vacation time, and holidays are frequently implicated in contributing to the seasonality of births. The "Christmas effect" is discussed frequently in explanations of the peak in births during September in all populations and geographical regions of the United States and Europe (Rosenberg, 1966; Wrigley & Schofield, 1981). August vacations are associated with a rise in the number of births during the month of May in France (Lam & Miron, 1991). However, Lam & Miron (1991) also suggest that activities associated with the holidays may either compete with or compliment sexual activity, thereby contributing to either an increase or a decrease in the number of conceptions occurring during that period of time. The utility of leisure time is determined by the temporal density of the activities in which individual's choose to engage (Linder, 1970).

Meteorological Changes and Seasonality

Seasonal variation in the timing and number of births due to the influence of meteorological change has been investigated as another contributing factor to birth pattern. Biometeorology is a science which is concerned with the effects of weather and climate on all living things, and is shown to affect all of us from the moment of conception to the time it influences our death (Tromp, 1980). Many sociological aspects of human life are effected directly and indirectly by meteorological conditions. Tromp

(1980) categorizes the effects of weather and climate on health and environment in the following manner:

1. influence on the way of living (i.e., clothing, housing, urban planning)

2. influence on food habits (i.e., kind, quality, quantity, chemical composition)

3. influence on agents causing or transmitting disease (i.e., bacteria, viruses, insects), and

4. influence on socio-economic relationships (i.e., traffic, modes of travel, agriculture, forestry, dairy farming, construction, energy expenditure, riots, invasion of armies).

The most extensive work on biometeorology and its effect on human conception and birth was done by Macfarlane (1974). He found that human conception rates change with the season and the greatest fluctuation is in the warm temperate to subtropical latitudes. There is less seasonality among populations in the subarctic and equatorial regions. Latitude and altitude affect the general pattern of births. Macfarlane (1974) believes that the neuro-endocrine system plays a role in rate of conception. An increased release of thyroxin and cortisol results from the cooling of the body in a cold climate. Both substances increase metabolism and may be associated with reduced gonadotrophic activity with subsequent decreased fertility. Likewise, during periods of extreme heat, there is a reduction in energy with lowered thyroxin and cortisol output resulting in decreased pituitary activity and lower conception rates. Artificial insemination procedures carried out during periods of high ambient temperatures have a lower rate of success (decreased rate of conception) (Tromp, 1980). High temperatures also impede spermatogenesis (Becker, Chowdhury, & Leridon, 1986).

Findings of Lam and Miron (1996) are consistent with those of Macfarlane and Tromp in regard to the association of summer temperature extremes and a reduction in rate of conception. They found no evidence, however, of extreme cold affecting human conceptions. Macfarlane (1974), whose research involves all life forms not just humans, accounts for this phenomenon by stating that most human populations use clothing, heat, and shelter to prevent undue cooling of the body thereby making humans less susceptible to cold temperatures. Lajinian, Hudson, Applewhite, Feldman, and Minkoff (1997), in a historic cohort study at a Brooklyn hospital March 21, 1993 through March 20, 1994, found that a high heat index is associated with increased incidence of preterm labor.

On the other hand, Sherrets (1979) concluded that there was a significant inverse relationship between mean monthly temperature nine months prior to delivery and 7,312 live births in a midwestern community. A curvilinear relationship fit the data more closely, suggesting that extremely hot and cold weather are related to birth rates, with cold weather having the greatest impact. Sherrets (1979) also found that illegitimate and legitimate births followed nearly the same pattern.

Brundtland and Liestol (1982) describe seasonal variations in menstrual cycles and menarche suggesting a female physiologic explanation for seasonality of births. Menstrual cycles of a random sample of women in the northern United States were found to be shorter during the spring and summer leading to more frequent periods of fertility

(Sundararaj, Chern, Gatewood, Kickman, & McHugh, 1978). Sundararaj et al (1978) suggest this observation may be attributed to changes in physical activity and weather.

Barometric pressure has frequently been implicated as an influencing factor in the onset of labor. In a retrospective study of 162 women with term pregnancies who experienced a spontaneous onset of labor, King, Fleschler, Cohen, and Barger (1997) found that the overall number of labor onsets increased in the 24 hours following a significant drop in barometric pressure. Additional studies (Noller, Resseguie, & Voss, 1996; Stern, Glazer, & Sanduleak, 1988; Driscoll & Merker, 1984) resulted in similar findings, although their methodologies and inclusion criteria varied. Steinman and Kleiner (1978) found that the incidence of premature rupture of membranes increased after the barometric pressure dropped.

Trapasso and Yurchisin (1988) conducted a study in Bowling Green, Kentucky in which chronological records of births between January 1, 1984 and December 31, 1984 were examined to determine if there was a relationship between onset of labor and barometric pressure. The study found a relationship between the onset of active labor and the crest regions and selected higher level regions of the barometric curves. The findings of this study are inconsistent with several previous studies that found the onset of labor to be associated with falling barometric pressures. The authors of this study suggest there is an intimate link between prostaglandin synthesis and parturition. The fetus, contained in a closed pressurized system, is sensitive to increasing atmospheric pressure leading to elevated intra-amniotic pressure which stimulates prostaglandin synthesis by the fetal membrane and subsequent labor (Trapasso & Yurchisin, 1988).

When meteorological conditions were examined for their effect on conception rates and "causing" the onset of labor, inconclusive results were produced. Most often, falling barometric pressure and extremely high temperatures were implicated as having an influence on onset of labor, thereby contributing to birth patterns.

Summary

Literature regarding the variables of interest in this study was reviewed and discussed. These variables included birth patterns in the United States, the impact of economic conditions on fertility rates, and oil price as an indicator of the Oklahoma economy. Studies investigating the effect of multiple variables on birth patterns and the seasonality of conception and birth were also discussed.

Numerous studies have examined the relationship of a single variable to birth rates, conception rates, or fertility rates. Results of these studies indicate that there may be a procyclic, countercyclic, nonlinear, or a constantly shifting relationship between fertility and the economy. The shifting relationship of fertility and economics appears to reflect a see-saw pattern of procyclicality and countercyclicality associated with the changing role of women in society. Research also indicates there is a seasonal pattern in all births that varies in timing and amplitude in different geographic regions and must be considered in the analysis of birth data. The inconsistency of results of these single variable studies and the inability to replicate studies in different geographic locations or in different socio-economic groups indicates further research regarding the relationship between birth patterns and economic condition is warranted.

CHAPTER III

PROCEDURE FOR COLLECTION AND TREATMENT OF DATA

This study was designed to search for patterns in the number and timing of live births to teen and adult women that occurred in Oklahoma from 1980 through 1995. Using a time series design, economic conditions and birth patterns were examined to determine if there was a procyclic or countercyclic relationship between the variables. Also, teen and adult birth patterns were compared. Annual patterns were compared to determine if there was a difference in pattern between these two age groups. A model of birth patterns was constructed that may be useful in the prediction of future behavior of economic condition and number of births. The research used archival data for the analysis and to test the hypotheses.

Setting

The setting for this study was the state of Oklahoma. Located in the south-central United States, Oklahoma ranks eighteenth in size and covers a total area of 69,956 square miles. According to the 1990 census, the population of Oklahoma in 1990 was 3,145,585 which reflects a population increase of four percent over the 1980 census figures (Bahr & Johnston, 1995). Of the people counted in 1990, 82 percent identified themselves as white, eight percent as Native American, seven percent as black, three percent as

Hispanic, and one percent as Asian or Pacific Islander. The statewide fertility rate from 1992-1994 was 64.8 percent (Oklahoma State Department of Health, 1996).

The economy of the state of Oklahoma in the early 1980s was driven by the natural gas and oil industry. During the late 1980s, the state faced an economic crisis due to sharply lowered prices for gas and oil on the world market. By the 1990s, greater economic stability was achieved through expansion of oil-related industry, education, and research, as well as diversification and development in the areas of agriculture, mining, and industry (primarily aerospace).

In politics, Oklahoma is a predominantly Democratic state, although since 1952 it has voted Republican in every presidential election except 1964 (Bahr & Johnston, 1995). The predominant religions represented in Oklahoma are Southern Baptist and other Christian religions.

The climate in Oklahoma is moderate with the average January temperatures being about 38 degrees Fahrenheit and the average July temperatures approximately 82 degrees Fahrenheit. Winter temperatures only occasionally drop to zero, while temperatures above 100 degrees Fahrenheit in the summer are very common. Most of Oklahoma receives twenty inches or more of precipitation annually with the eastern part of the state more humid than the western portion.

Population and Sample

In this study, the population was all live births occurring in the state of Oklahoma. The total number of births per year in Oklahoma during the years of 1980 through 1995 ranged from 45,000 to 58,000, with greater than 99 percent of the births occurring in a hospital setting attended by an MD (84%) or a DO (14%) (Oklahoma State Department of Health, 1996). It is required that all births greater than twenty weeks gestation be registered with the Oklahoma State Department of Health as a live birth.

The sample for this study consisted of the 800,206 live births that occurred in Oklahoma from January 1, 1980 through December 31, 1995. The daily birth count was determined by data from the certificates of these births recorded by the Oklahoma State Department of Health, with separate data sets created for teen and adult births. The birth count for each of the 5,844 days during the specified sixteen-year period created the time-series analyzed in this study.

Protection of Human Subjects

This study followed the guidelines set forth by the Texas Woman's University Human Subjects Review Committee for a Level 1 study (no risk to the participants). Permission to conduct the study was obtained from the Human Subjects Review Committee and from the Dean of the Graduate School prior to initiation of the formal investigation (Appendix B). Birth information was obtained from an existing public data set. Due to the limited number of variables that were available to the researcher for each birth, it was impossible to link any birth to a specific individual thereby making each record anonymous. The request for birth certificate information from the Oklahoma State Department of Health can be found in Appendix C.

Instrumentation and Data Collection

The data set used to construct the time-series of births examined in the study was compiled from birth certificate information stored electronically at the Oklahoma State Department of Health in Oklahoma City, Oklahoma. The specified variables (date of birth, age and race of mother and father, marital status, and the mother's county of residence) were downloaded to 3.5 inch floppy disk in fixed ascii format for use in the study. Two forms were used to collect information about live births in the state of Oklahoma during the period of time under investigation in this study. The form that was used from July 1, 1968 through August 31, 1990 was brief and contained primarily demographic information about the parents and narrative information about complications noted about the pregnancy, birth, or condition of the newborn. The revised form that became effective September 1, 1990 and remains in effect today is more comprehensive, providing more in-depth and coded information for tracking birth statistics. Although the forms for gathering birth certificate information were changed during the course of this study, it was believed that this change did not influence the outcome of the study because the variables of interest were recorded on both forms. Of primary interest was the number of births that occurred during the years of 1980 through 1995 and that could be determined regardless of the specific form used to record the birth. The forms can be found in Appendix D and E.

The oil price data to be used as the economic indicator for this study was obtained from the crude oil price bulletin supplied by the Phillips Company, a division of Phillips

Petroleum Company located in Bartlesville, Oklahoma. The prices posted in the bulletin represent the price of crude petroleum based upon computation of the available volume by use of the 100% tank tables to determine its value on the state, national, and international market. The daily price for Oklahoma Sweet Crude Oil was extracted from the paper copy of the bulletin and entered onto computer disk. A single page of the oil price bulletin (1980-1) that was used in the creation of the data set is presented as an example in Appendix F. The adjustment of the daily price of oil changed during the time period represented by the study. While a daily price of oil was always posted, the method of disseminating the information regarding the change in oil price was updated from paper distribution to electronic distribution during the course of the study. In mid 1988, electronic transfer of information allowed greater ease in more frequent oil price changes with more rapid dissemination of the information. A paper copy of each oil price change was also generated. This also reflected greater sensitivity to changes in domestic and foreign oil-related markets. On May 2, 1990, the format of the Price Bulletin (the paper copy) changed, placing all changes made during a one-week period of time on a single bulletin to reduce the number of mailings. These changes affected the outcome of the study only in the sense that more frequent changes in oil price during the later years of the study gave the time series representing this data set a more jagged or irregular appearance.

Treatment of Data

A time series design was utilized to examine the pattern or underlying processes of births to teens and adults in Oklahoma over a sixteen-year period of time in relation to economic trend which occurred in that state during the same time period. The data set used to conduct a time series analysis was collected at fixed intervals with the order of observation of extreme importance offering the advantage of explaining the past and predicting the future behavior of the variables of interest (Franses, 1998; Faithfull, 1997; Ostrom, 1990). A minimum of 50 data points was necessary to have confidence in the estimated "structure of the correlated error in the series" (Cook & Campbell, 1979, p. 228). Each data set in this study (teen births, adult births, and oil price) had 5,844 data points. Descriptive statistics were run to describe each data set and a time series was graphed to allow for visualization of each raw data set. Through examination of the mean and variance, the time series was determined to be non-stationary. Because the time series was found to be non-stationary, the data were differenced to achieve stationarity.

There are four components of a time series: the trend, the variation around the trend, deterministic patterns or cycles, and the random residual effects (Woods & Catanzaro, 1988). Although variation around the trend and many patterns are apparent by simple visualization of the data, trend and residual effects (noise) are not described as easily (Taylor, 1990). Because adjacent data values in a time series are often highly correlated, autocorrelation coefficients were used to examine the strength of the relationship at different lags. The resultant pattern of autocorrelation was then used in the selection of parameters for ARIMA modeling of the series and in the evaluation of the residuals. Partial autocorrelation obtained a correlation coefficient from which the effects of the lower-order correlation coefficients had been removed. The ARIMA model that best fits the series was determined by the final parameters and analysis of variance (Clinton, Beck, Radjenovic, Taylor, Westlake, & Wilson, 1986).

Testing the stated hypotheses for this study required the examination of the relationship between pairs of time series (ie., adult births with teen births, adult births with oil price, teen births with oil price). This was done by computing the cross-correlation function to determine whether one series was a leading indicator for another and what orders of lags were the most useful in defining the model. Using this information, conclusions were drawn about the similarities (or differences) in birth trend of teens and the birth trend of adults, as well as the relationship between birth trend and economic condition. A flow sheet of data analysis can be found in Appendix G.

Summary

Permission was granted to conduct this Level I study by the Texas Woman's University Human Subjects Review Committee and the Dean of the Graduate School. The data for this study was collected from existing public data sets and analyzed using time-series analysis. The study examined patterns of births to teens and adults in Oklahoma and their relationships to economic conditions. Birth patterns of adults and teens were compared and a model of birth patterns was constructed.

CHAPTER IV

ANALYSIS OF DATA

This chapter presents the analysis of the data collected for the study. Data were extracted from existing public data sets as previously discussed. The sample is described, followed by a presentation of the findings of the analyses associated with each hypothesis and research question. Finally, a summary of the findings is presented.

Description of the Sample

The sample for this study included the 800,206 live births that occurred in Oklahoma from January 1, 1980 through December 31, 1995. Variables included in the data set obtained from the Maternal-Child Health Division of the Oklahoma State Department of Health were date of birth, age and race of mother and father, marital status of the mother, and the mother's county of residence. The complete data set, obtained in fixed ascii format, was entered into SPSS 8.0 for Windows. Separate data sets were created for teen and adult births. No data were obtained regarding the gestational age, repeat pregnancies to the same mother, or multiple births and, therefore, cannot be examined for their effects on the conclusions drawn.

A daily birth count for each of the 5,844 days of the specified sixteen-year period was calculated for teen births, adult births, and total births occurring in Oklahoma. Births to teen mothers comprise 17.1% (136,788 births) of the total number of births in this state from 1980 through 1995. Data were also aggregated to 835 weeks, for which a total number of births per week to teens and adults was calculated.

In the sample, the age of mothers ranged from 11 to 50 years of age with a mean age of 24.8 years of age. All certificates of live birth included the self-reported age of the mother. Table 1 summarizes the age of mothers in each of the data sets.

Table 1

Age of Mother in Years

	Teen Births	Adult Births	All Births
Mean	17.75	26.30	24.80
Median	18	26	24
Mode	19	22	22
Range	11-19	20-50	11-50
Missing Info	0	0	0

The age of fathers ranged from 12 to 88 years of age with a mean age of 27.6 years of age. Due to the lack of information provided about the father of the baby, a large percentage of birth certificates lacked the father's age. For teen births, 36.23% of birth certificates lacked father's age. Table 2 summarizes the age of fathers in the sample.

Table 2

Age of Father in Years

	Teen Births	Adult Births	All Births
Mean	26.70	30.20	27.60
Median	23	28	26
Mode	20	26	26
Range	12-71	15-88	12-88
Missing Info	49,555 (36.23%)	73,371 (11.06%)	122,926 (15.36%)

In regard to marital status, 78.5% of all mothers in the sample were married. This number is considerably lower for teens, with only 51.9% of teen mothers reporting their marital status as married at the time of the birth. Very few women indicated a marital status of separated or divorced on the certificate of live birth. Mother's marital status is summarized in Table 3.

Table 3

Mother's Marital Status

	Teen Births		Adult Births		All Births	
Married	71,005	(51.9%)	556,906	(83.9%)	627,911	(78.5%)
Single	65,286	(47.7%)	104,119	(15.7%)	169,405	(21.2%)
Separated	3	(.0%)	30	(.0%)	33	(.0%)
Divorced	0	(.0%)	7	(.0%)	7	(.0%)
Unknown	494	(.4%)	2,356	(.4%)	2,850	(.4%)

Race of mother is presented in Table 4. The majority of births in Oklahoma (80.6%) were to white women. The instrument used to obtain birth certificate data during the 1980s did not have a separate category for 'Hispanic' and therefore these women are classified as 'white' in this sample. Blacks comprised 9.8% of the sample, while American Indians represented 7.9% of the sample. Oklahoma has one of the largest Native American populations in the United States, second only to California in per capita Native American population. Asian and other non-white groups make up less than one percent of the sample in this study.

Table 4

Race of Mother

	Teen Births		Adult Births		All Births	
White	99,413	72.7%)	545,298	(82.2%)	644,711	(80.6%)
Black	20,353	14.9%)	58,266	(8.8%)	78,619	(9.8%)
Indian	15,901	11.9%)	47,660	(7.2%)	63,561	(7.9%)
Asian	562	(.4%)	8,497	(1.3%)	9,059	(1.1%)
Chinese	10	(.0%)	732	(.1%)	742	(.1%)
Japanese	36	(.0%)	351	(.1%)	387	(.0%)
Hawaiian	23	(.0%)	95	(.0%)	118	(.0%)
Other non-white	6	(.0%)	106	(.0%)	112	(.0%)
Filipino	52	(.0%)	745	(.1%)	797	(.1%)
Missing Info	432	(.3%)	1,668	(.3%)	2,100	(.3%)

Race of father is distributed similarly to race of mother in the state of Oklahoma. The majority of fathers (71.5%) are recorded on certificates of live birth as being white. As with race of mother, race of father specified as white includes those fathers of Hispanic descent. Blacks comprised 5.3% of the sample, while American Indians represented 5.6% of the sample. Due to the large number of birth certificates with missing information about the father, 16.5% of all births list the father's race as missing or unknown. For teen births, this number is even higher, with 38.2% of certificates missing this information. Data concerning race of father are summarized in Table 5.

Table 5

Race Of Father

	Teen Births		Adult Births		All Births	
White	69.979	(51.2%)	502.360	(75.7%)	572,339	(71.5%)
Black	5,167	(3.8%)	36,974	(5.6%)	42,141	(5.3%)
Indian	8,793	(6.4%)	35,887	(5.4%)	44,680	(5.6%)
Asian	446	(.3%)	6,690	(1.0%)	7,136	(.9%)
Chinese	5	(.0%)	660	(.1%)	665	(.1%)
Japanese	29	(.0%)	256	(.0%)	285	(.0%)
Hawaiian	17	(.0%)	111	(.0%)	128	(.0%)
Other non-white	2	(.0%)	80	(.0%)	82	(.0%)
Filipino	45	(.0%)	332	(.1%)	377	(.0%)
Missing Info	52,305	(38.2%)	80,068	(12.1%)	132,373	(16.5%)

There are 77 counties in the state of Oklahoma of which 14 are considered to be urban by the Oklahoma State Department of Health. Using the definition established by the Oklahoma Department of Commerce, rurality is determined by population density and availability of goods and services. During the years of 1980 through 1995, 495,876 births were to women whose county of residence was considered to be urban. This number accounts for 62% of all births that occurred during the sixteen-year period of time under investigation. A summary of the number of teen births, adult births, and all births by rurality can be found in Table 6. The specific number of births by county of residence for teens, adults, and all births are listed in Appendix H.

Table 6

Mother's County of Residence Urban vs. Rural

	Teens	**Adults**	**All Births**
Urban	76,297 (55.8%)	419,579 (63.2%)	495,876 (62%)
Rural	60,488 (44.2%)	243,836 (36.8)	304,324 (38%)

The data for the economic indicator, daily price of oil, were extracted from the oil price bulletin obtained from the Phillips 66 Company. Daily oil price was entered into SPSS 8.0 for Windows, SAS, and S Plus for the same sixteen-year period as the birth data set, January 1, 1980 through December 31, 1995. Over this period of time, the mean daily oil price was \$21.77 per barrel. The median oil price was \$19.00 per barrel and the mode was \$30.00 per barrel. The standard deviation was 7.076, with a variance of 50.067. The average weekly price of oil was also calculated and a weekly data set for the price of oil was constructed using SPSS 8.0 for the purpose of comparing the weekly birth data with an economic indicator.

Creation of the Time Series

To aid in the visualization of the data, a time series was created for each of the data sets. Figure 1 depicts the teen birth count plotted against the number of the days in the series (5,844 days of the specified sixteen-year period of time). The graph illustrates the highest number of births that occurred during the summer of 1982 and the lowest number that occurred during the last week in June of 1991.

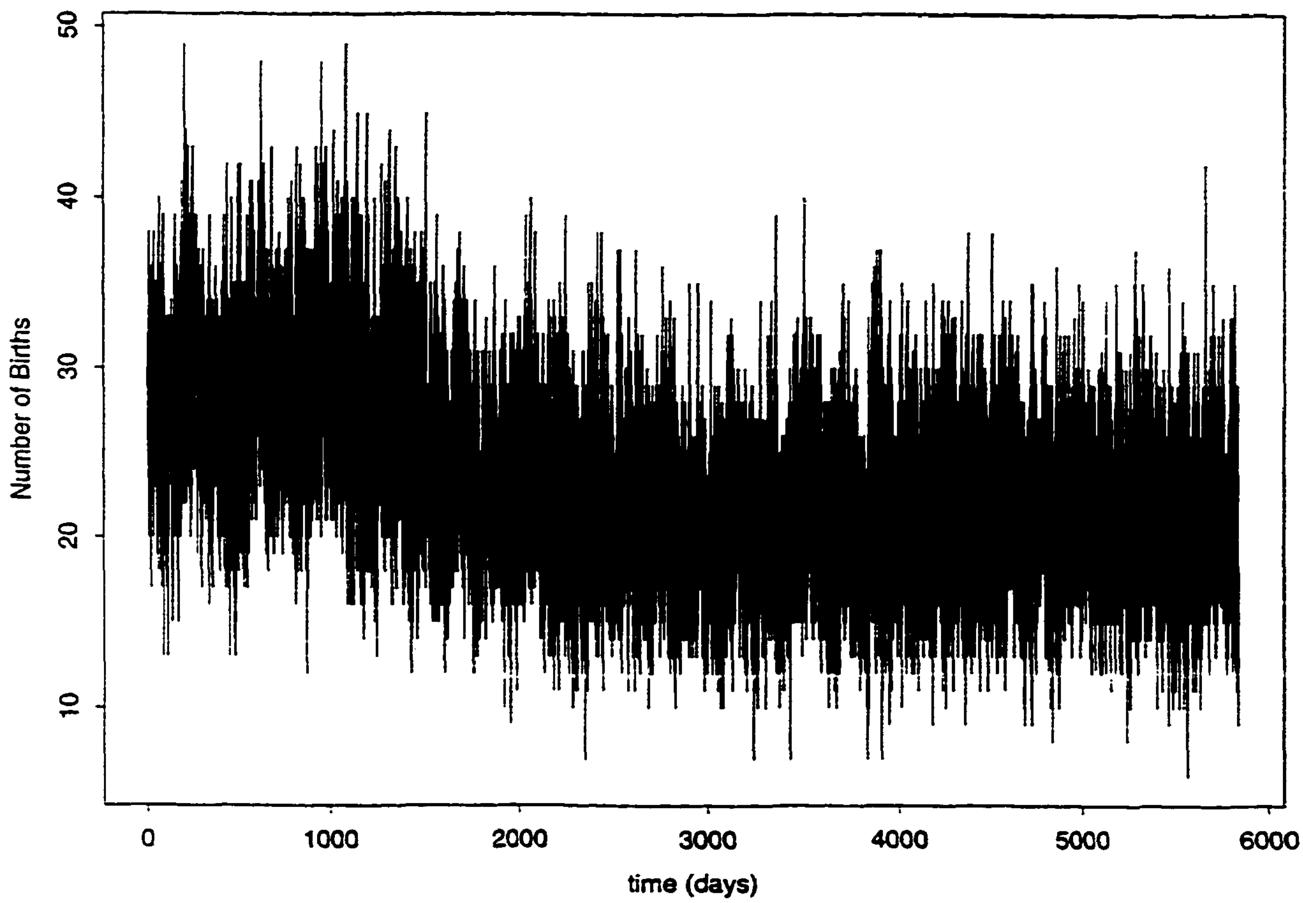

Figure 1. Daily Count of Births to Teens 1980-1995

Similarly, Figure 2 depicts the adult birth count plotted against the number of the days in the series (5,844 days of the specified sixteen-year period of time). This graph also illustrates that the highest number of births occurred during the summer and into early October of 1982. The lowest point on the graph is evidenced by a sharp drop in numbers of adult births during the first week in July of 1991.

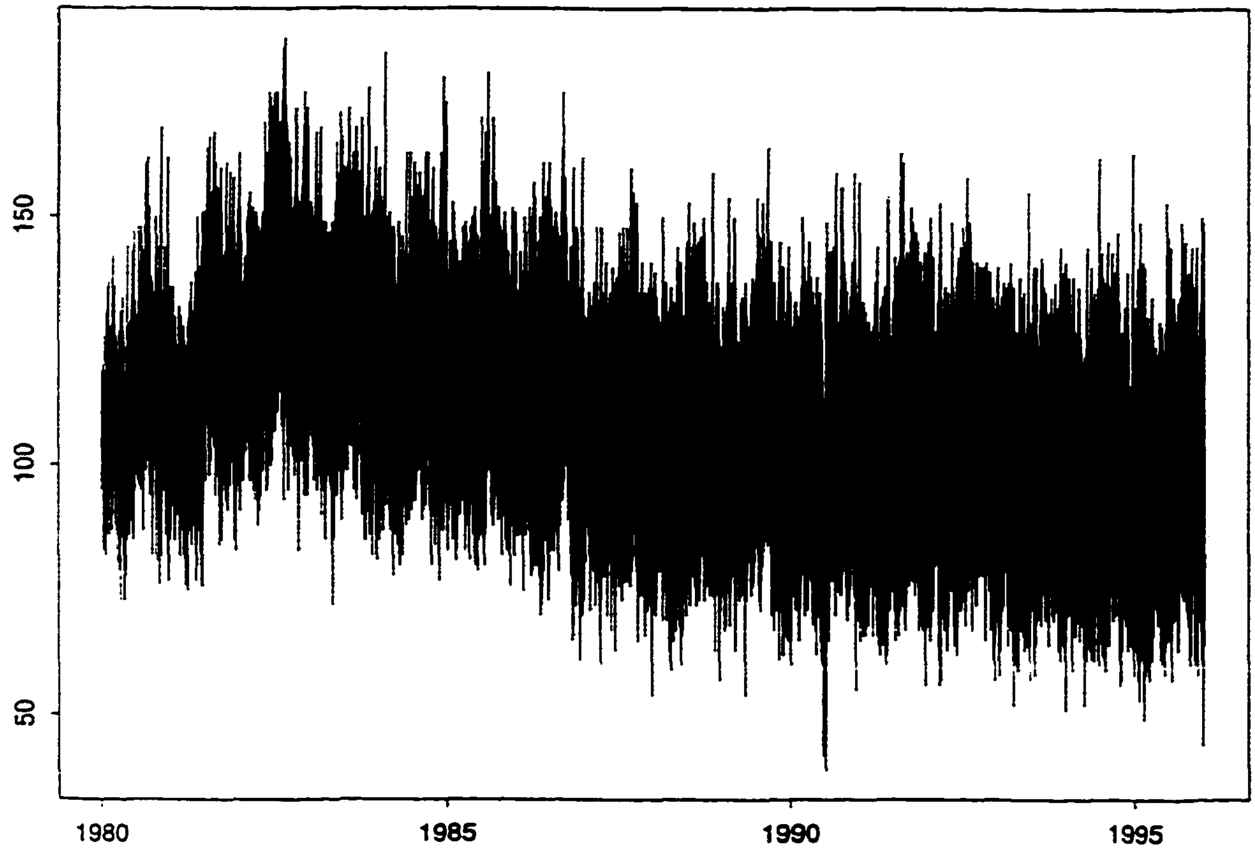

Figure 2. Daily Count of Births to Adults 1980-1995

When all births are plotted on the same time line, there is a loss of definition of the time series. Because there is a significantly smaller number of teen births than adult births occurring on any given day, any uniqueness in the teen data is lost when the teen and adult birth data are aggregated to create a data set of the total number of births per day. This is shown in Figure 3.

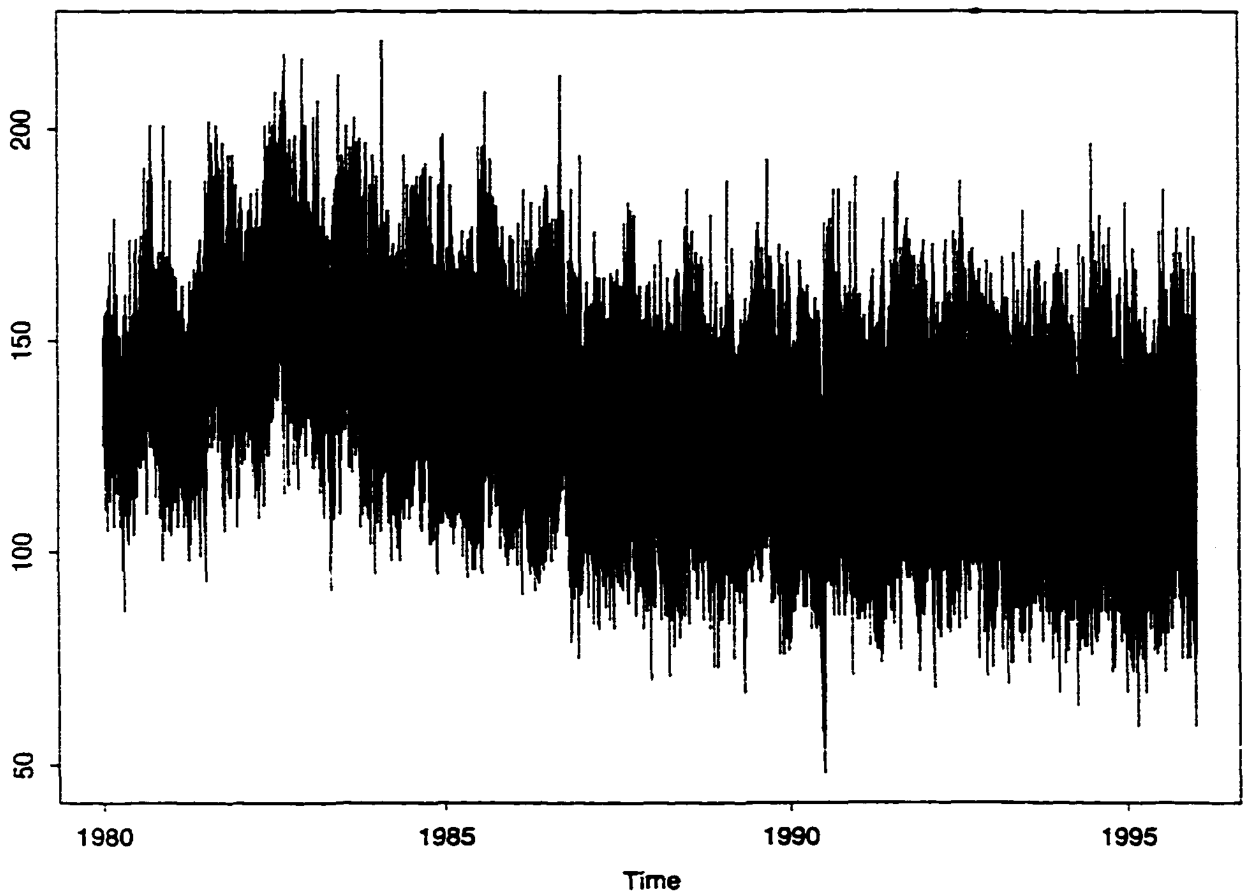

Figure 3. Daily Count of All Births 1980-1995

The daily price of oil was also illustrated in a time series format. Figure 4 represents the oil price plotted against the number of the days in the series (5,844 days of the specified sixteen-year period of time). The "oil boom" years of the early and mid 1980s can be clearly identified. The sharp increase during late 1990 and early 1991 coincides directly with the Persian Gulf War and the burning of oil fields in Kuwait.

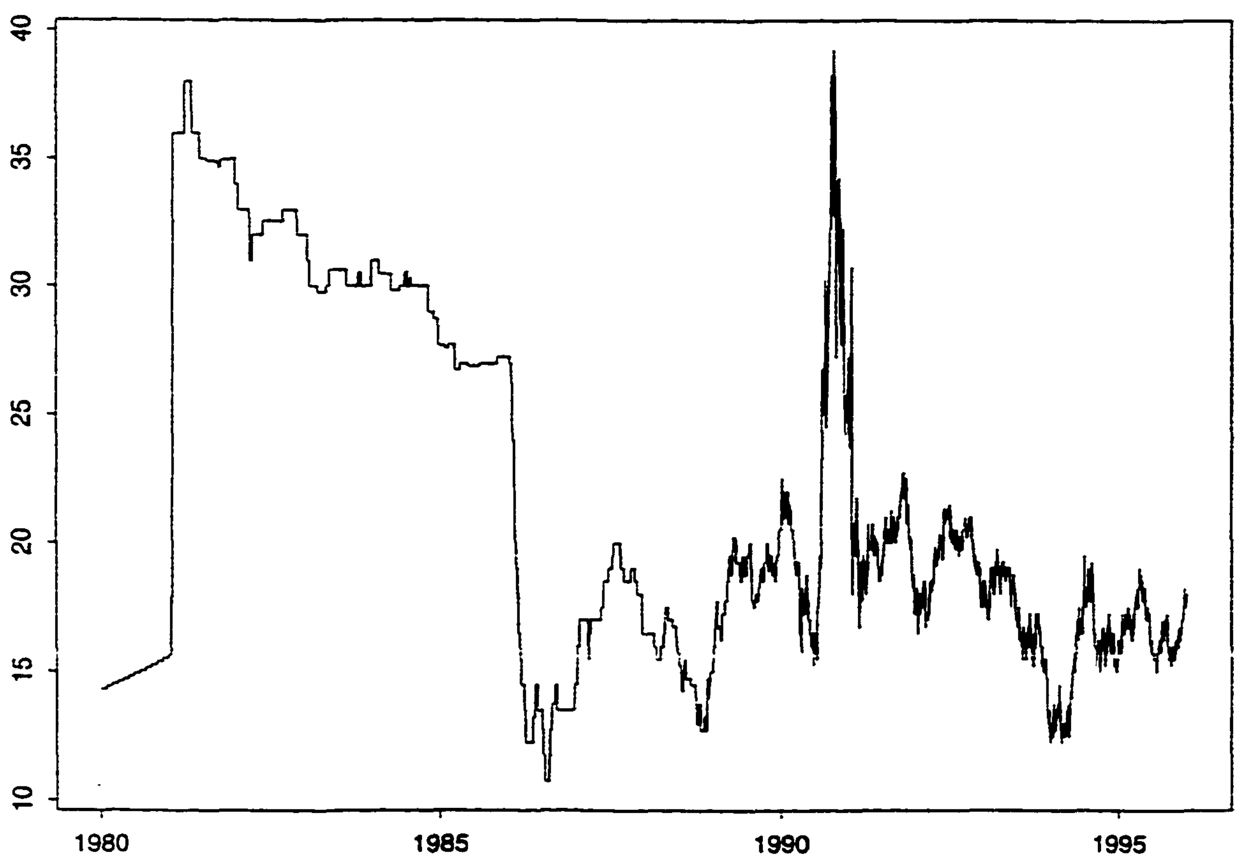

Figure 4. Daily Oil Price 1980-1995

Findings

The findings of the study are presented in this section in relation to the specific research question or hypothesis addressed.

Research Question #1: Which model best fits the Oklahoma birth data?

Univariate time series analysis was used to address research question number one. Analysis of the time series was based on autocorrelation of data which made it useful for the analysis of trend within a single data set (Jensen, 1990). Autocorrelation of the time series was removed by taking it into account in the model that was produced to describe the data (McCleary & Hay, 1980). Autoregressive-Integrated-Moving Average (ARIMA), based on the work of Box and Jenkins (1976), was used to model the Oklahoma birth data. Three separate models were constructed to describe the deterministic and stochastic components of each time series for adult births, teen births, and total births. The deterministic (or systematic) component refers to the parameters of the time series that were not dependent on error (or random variation) in the data. The stochastic (or noise) component were "those parameters that described the structure of the underlying process of unobserved error or random variance in the data" (Jensen, 1990, p 431). The stochastic component was further divided into two parts: the systematic part responsible for the correlation of unexplained variance and the unsystematic part which was the error variance (typical random error) found in all data (Jensen, 1990).

Discovering the component patterns of past events facilitated the development of descriptive models from the time series. The components of the time series were mixed and represented both deterministic and stochastic elements (Metzger & Schultz, 1982).

The seasonal pattern found in the Oklahoma birth data (described under the findings for Hypothesis #3) was considered a deterministic function of time. Seasonal effects of weather and leisure time on birth patterns vary to some degree depending upon geographic location and climate as well as the specific population being studied, though it is generally believed there is a "predictable degree of regularity to cyclic generators of seasonal components" (Metzger & Schultz, 1982, p. 376).

ARIMA models combine up to three different processes, represented by p, d, and q, to describe the data where p is the order of autoregression (AR) parameters, d is the number of differencings required to strip off the integration (I) of the time series to produce stationarity, and q is the order of moving average (MA) parameters (Jensen, 1990). Because there is no computer algorithm that can determine the correct model, a combination of model building procedures, described by Box and Jenkins (1976) and Cromwell, Labys, and Terraza (1994) were used to construct the most appropriate model of teen births, adult births, and all births in the state of Oklahoma for the years under investigation. In summary, this procedure consisted of three basic steps: identification, estimation, and diagnosis of proposed ARIMA models, which were repeated until a satisfactory model was constructed for teen births, adult births, and all births (SPSS Inc., 1994). A detailed flow chart of the test procedure for univariate model identification can be found in Appendix I.

<u>Model of Teen Births.</u> The first step in the identification of the underlying process in the time series of teen births was to determine the stationarity of the series. A stationary time series would have approximately the same mean and variance for the

duration of time under investigation. Examination of the birth data quickly revealed that this was not a stationary series. The series had wide variation of daily values and a mean that changed over time. During the sixteen-year time period that was examined, the daily number of teen births ranged from 6 to 49 with a mean of 23.4, standard deviation of 6.2, and a variance of 38.5. Examination of the mean for the teen birth data for the single years of 1980 and 1995 revealed a significant change over time. The mean number of daily teen births declined from 27.8 in 1980 to 21.3 in 1995.

The autocorrelation function (ACF) of the raw data revealed strong positive correlations which do not die out over time indicating the data set is an integrated series. Figure 5 is the graphic display of the ACF of the raw data for teen births with a lag of 400 (representing data for a period of time greater than one year). The strong positive correlations reflect weekly and seasonal cycles which continue to be significant for a prolonged period of time. Because the average values varied over time, the short term variation was greater during some time periods than others, and the ACF of the raw data indicated an integrated series, the data set for teen births was considered non-stationary indicating that transformation was required to achieve stationarity.

It was also necessary for the teen birth data to pass a test of normality before time series analysis could proceed. To determine if the numbers of teen births per day were normally distributed, a histogram depicting the data was constructed and a one-sample Kolmogorov-Smirnov Goodness of Fit Test was run to compare the observed cumulative distribution function of teen births with the theoretical normal distribution. The histogram representing the teen birth data is shown in Figure 6 and shows a slight positive skew.

The Kolmogorov-Smirnov (K-S) Z statistic of 4.46 was statistically significant, p = .0000, indicating that the data were not normally distributed and required transformation.

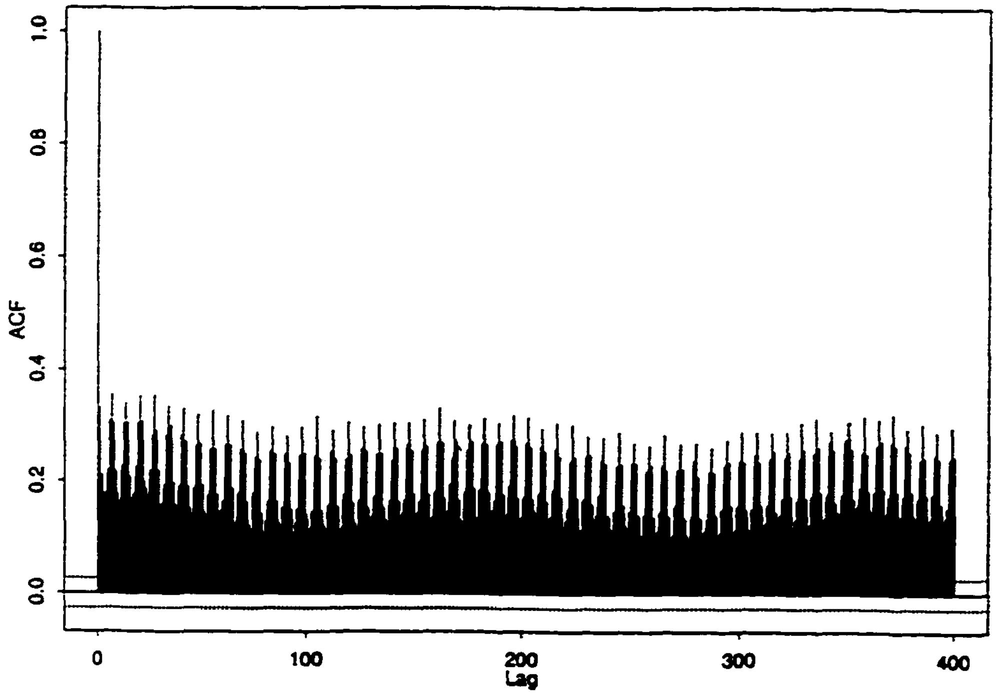

Figure 5. ACF of the Raw Data for Daily Teen Births, Lag of 400

Based on the above tests for stationarity and normality, several transformations were done to prepare the data for time series analysis. Because the strong seven day cycle dominated the teen birth data, the data were aggregated to weeks to eliminate this influence. The time series plot for the weekly number of teen births is displayed in Figure 7. Secondly, a natural log transformation was done to normalize the data and create stationarity of the variance in the data set. Then the data were differenced once to achieve stationarity of the mean. This resulting time series is depicted in Figure 8. Even after the data had been differenced, a couple outliers remained in the series. The high number of births that occurred during the oil boom produced one outlier at the 126th week

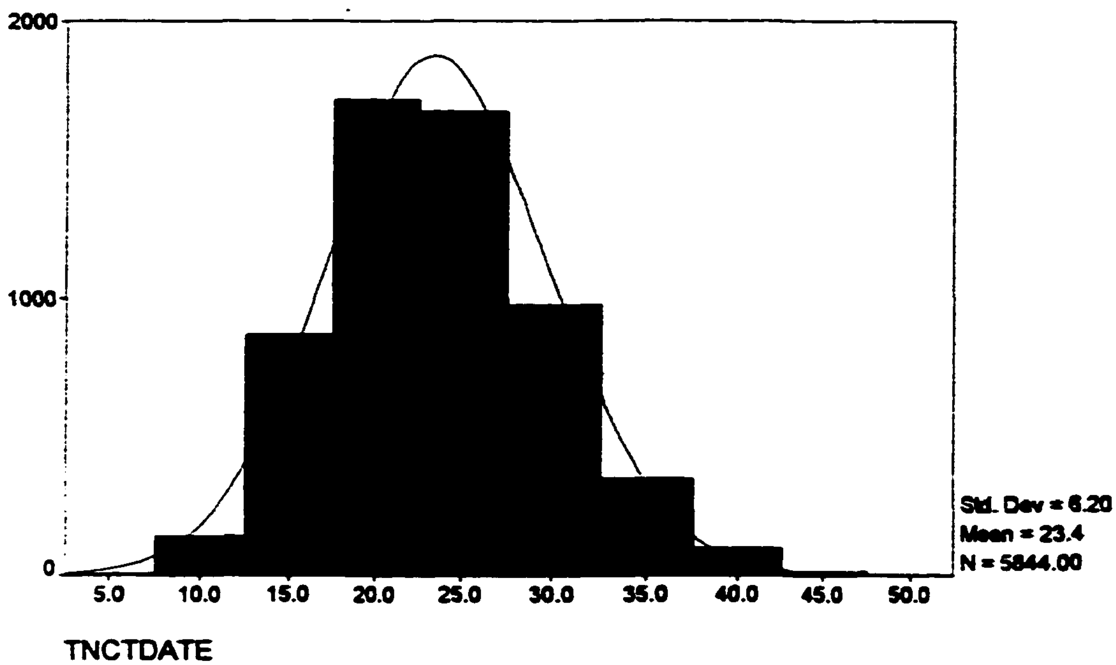

Figure 6. Histogram of Daily Teen Birth Data

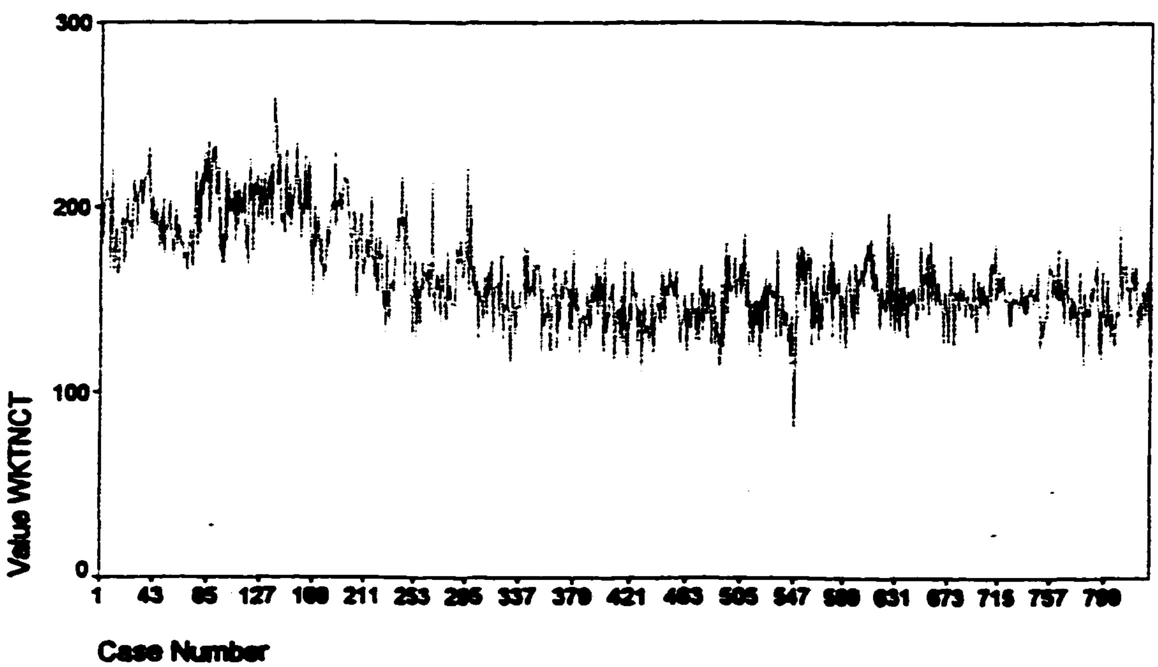

Figure 7. Weekly Count of Births to Teens 1980-1995

of the series. Another outlier can be seen at the 575th week of the series when the number of births dropped sharply and suddenly during the Persian Gulf War. After the time series had been transformed to achieve stationarity and passed the test of normality, it was then possible to specify a linear model to describe the behavior of the teen birth time series (Cromwell, Labys, & Terraza, 1994).

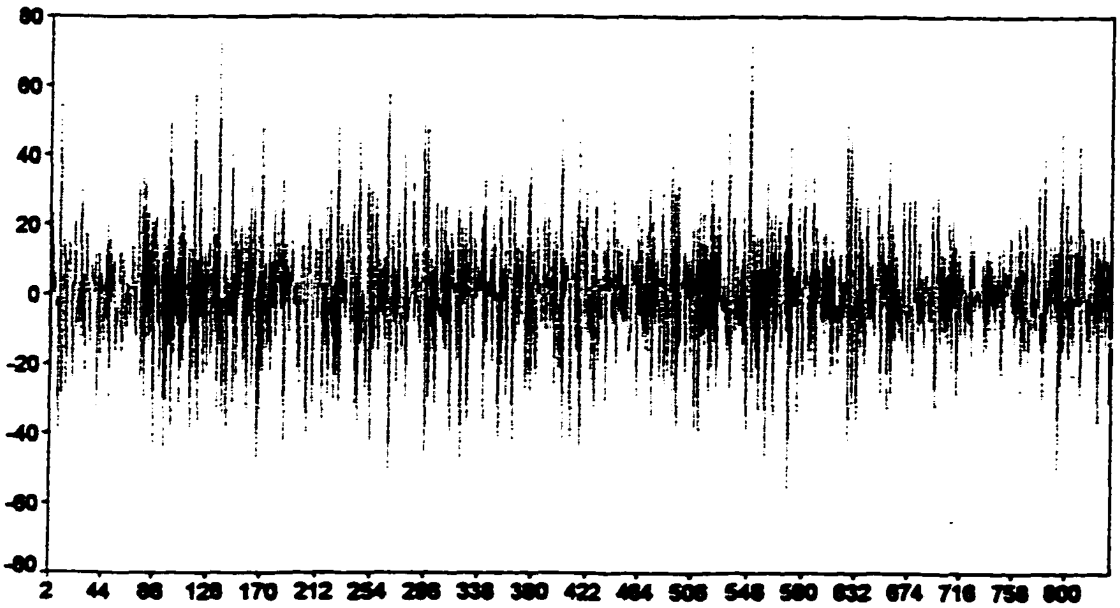

Figure 8. Weekly Count of Teen Births After One Differencing

Multiple attempts at estimating a model for teen births were carried out. Because the time series was an integrated series, at least one differencing was necessary to meet the assumptions of the method. The Autoregressive orders of one, two, and three were then attempted but were unsuccessful in reducing the series to white noise. Because the autoregressive process is one with "memory," each value is correlated with all preceding values. Any shock or disturbance to the system should have had a diminishing effect on subsequent values and the influence of earlier observations should have died out exponentially (SPSS, 1994). Because application of the autoregressive process was not effective for the teen birth series, the moving average process was applied. In a moving average series, each value is a weighted average of the most recent random disturbances. Because these values are weighted averages of the previous ones, the effect of the disturbance decreases over time and ceases (SPSS, 1994). One, two, and three orders of the moving average were attempted. A first order moving average was used because it produced the "best" results. A (0, 1, 1) model with a (0, 1, 1) seasonal component was determined to be the best fitting model for this data. The ACF plot was compared with signature plots of pure ARIMA processes to confirm the appropriateness of the model. Using SPSS 8.0, The Trends ARIMA procedure estimated the coefficients for the model that was identified. The SPSS Trends program performed the iterative calculations needed to determine the maximum-likelihood coefficients, and added a new series representing the fit, the residual, and the confidence limits for the fit. The ACF and the PACF for this model are illustrated in Figures 9 and 10.

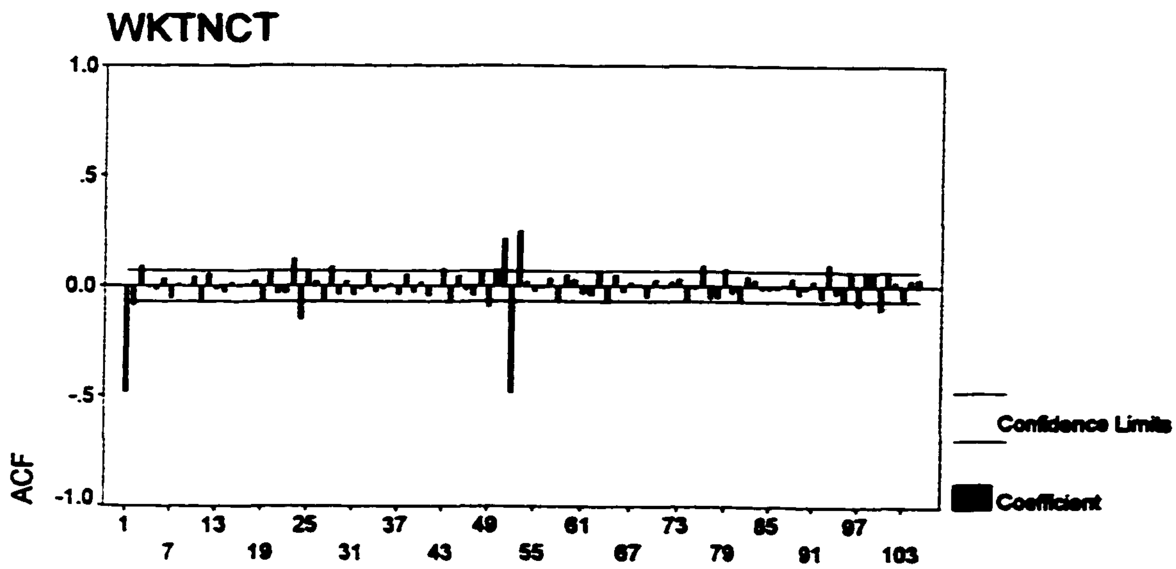

Figure 9. ACF of the Transformed Weekly Teen Birth Series

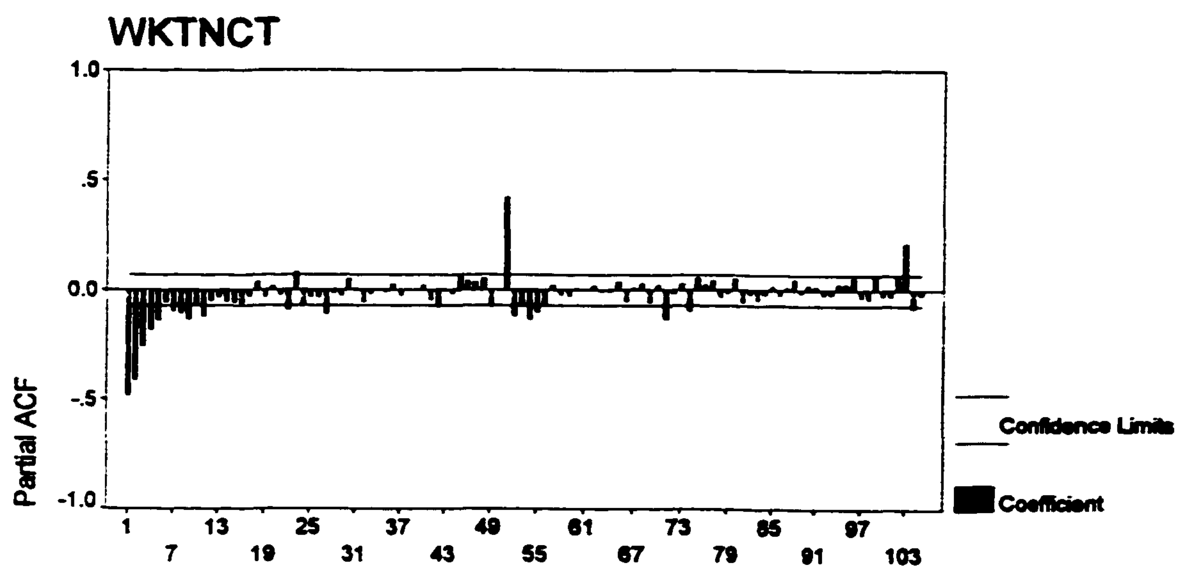

Figure 10. PACF of the Transformed Weekly Teen Birth Series

The final step in the ARIMA modeling procedure was diagnosis. To determine if the (0, 1, 1) model with a (0, 1, 1) seasonal component was the best-fitting model, the following checks were employed. First, the coefficients were examined and found to be within the .05 significance bands. Then, the ACF and the PACF of the error series were examined to determine that no value was significantly different than zero. Additionally, the residuals were determined to be without pattern. The lack of pattern signifies the residual is truly representing "white noise." Because of the complexity of this model, this was not achieved in its entirety but will be discussed in Chapter Five. Figures 11 and 12 illustrate the ACF and PACF of the residuals for the specified model.

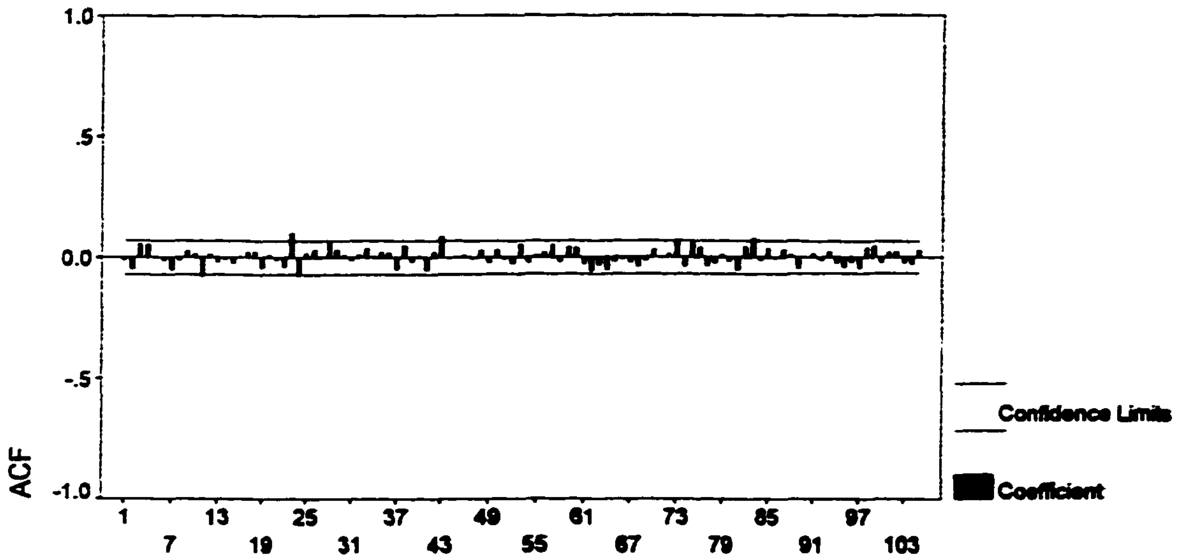

Figure 11. ACF of the Residuals for the Teen Birth Model (0, 1, 1) (0, 1, 1)

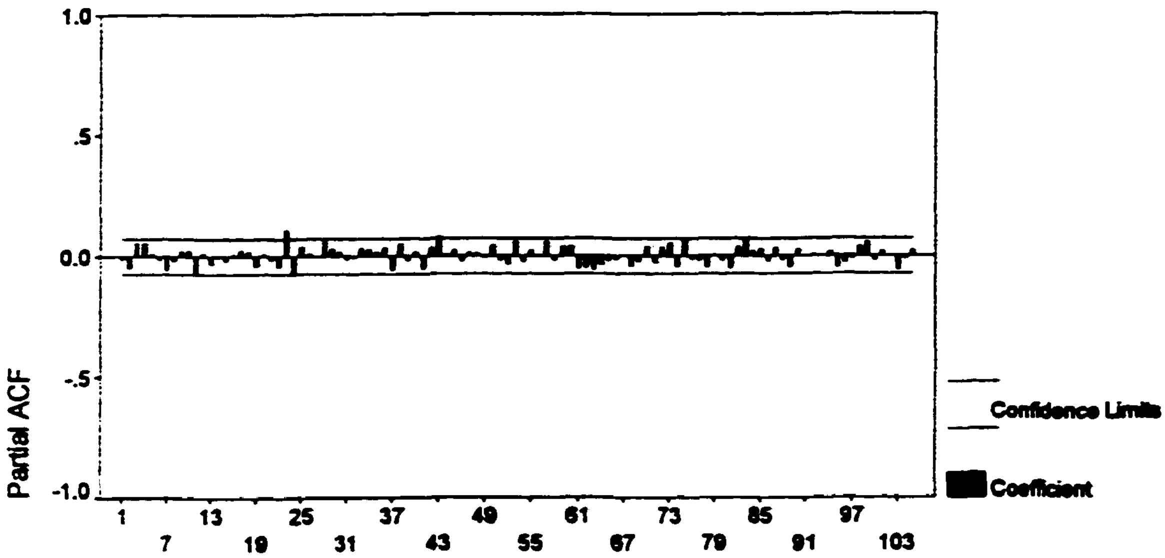

Figure 12. PACF of the Residuals for the Teen Birth Model (0, 1, 1) (0, 1, 1)

An ARIMA (0, 1, 1) model indicates that the current time series observation Y_t is equal to the preceding observation Y_{t-1} plus the current random shock a_t plus a portion of the preceding random shock a_{t-1}. The integrated moving average process seen in the teen birth data was determined by the average of the current disturbance and one previous disturbance. In addition, a seasonal (0, 1, 1) component was necessary to address the seasonal patterns seen in this data.

Model of Adult Births. As in the examination of teen births, the first step in the identification of the underlying process in the time series of adult births was to determine the stationarity of the series. A stationary time series would have approximately the same mean and variance for the duration of time under investigation. Examination of the adult birth data quickly revealed that this data set also was not a stationary series. The series had wide variation of daily values and a mean that changed over time. During the same sixteen-year time period that was examined for teen births, the daily number of adult births ranged from 39 to 186 with a mean of 113.5, standard deviation of 23.48, and a variance of 551.359. Examination of the mean for the adult birth data for the single years of 1980 and 1995 revealed a significant change over time. In 1980, the mean number of daily adult births was 114, dropping to a mean of 102 daily adult births in 1995.

The autocorrelation function (ACF) of the raw data revealed strong positive correlations which do not die out over time indicating the data set is an integrated series. Figure 13 is the graphic display of the ACF of the raw data for adult births with a lag of 500 (representing data for a period of time greater than one year). The strong positive correlations reflect weekly and seasonal cycles that continue to be significant for a prolonged period of time. Because the average values varied over time, the short term variation was greater during some time periods than others, and the ACF of the raw data indicated an integrated series, the data set for adult births was considered to be non-stationary indicating that transformation was required to achieve stationarity.

It was also necessary for the adult birth data to pass a test of normality before time series analysis could proceed. To determine if the numbers of adult births per day were normally distributed, a histogram depicting the data was constructed and a one-sample Kolmogorov-Smirnov Goodness of Fit Test was run to compare the observed cumulative distribution function of adult births with the theoretical normal distribution. The histogram representing the adult birth data is shown in Figure 14 and shows a slight negative skew. The Kolmogorov-Smirnov (K-S) Z statistic of 4.03 was statistically significant, p = .0000, indicating that the data were not normally distributed and required transformation.

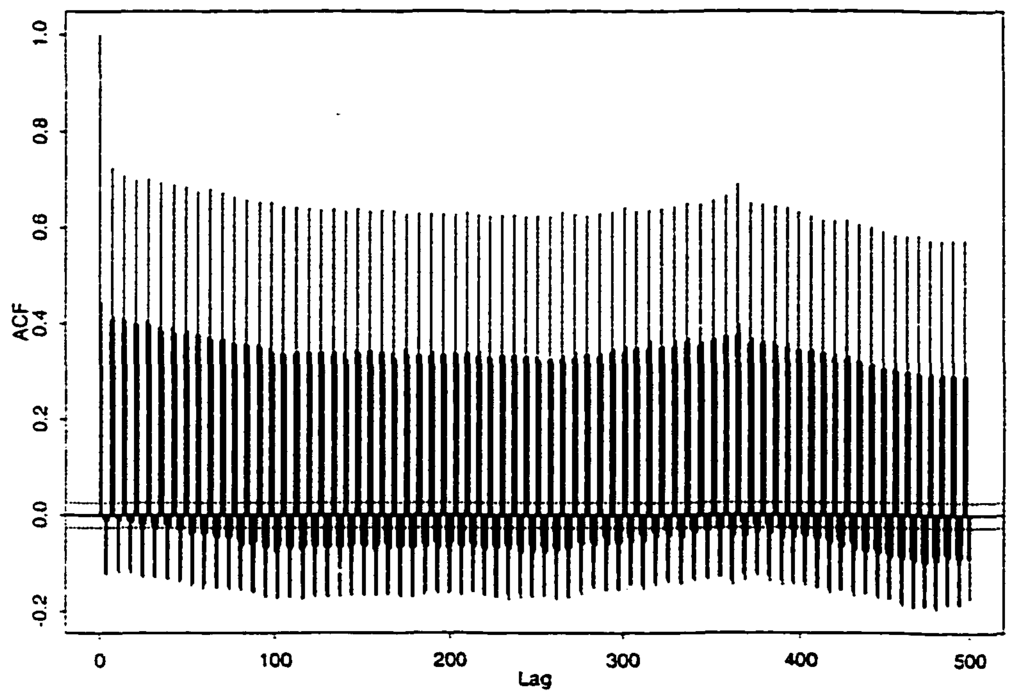

Figure 13. ACF of the Raw Data for Daily Adult Births, Lag of 500

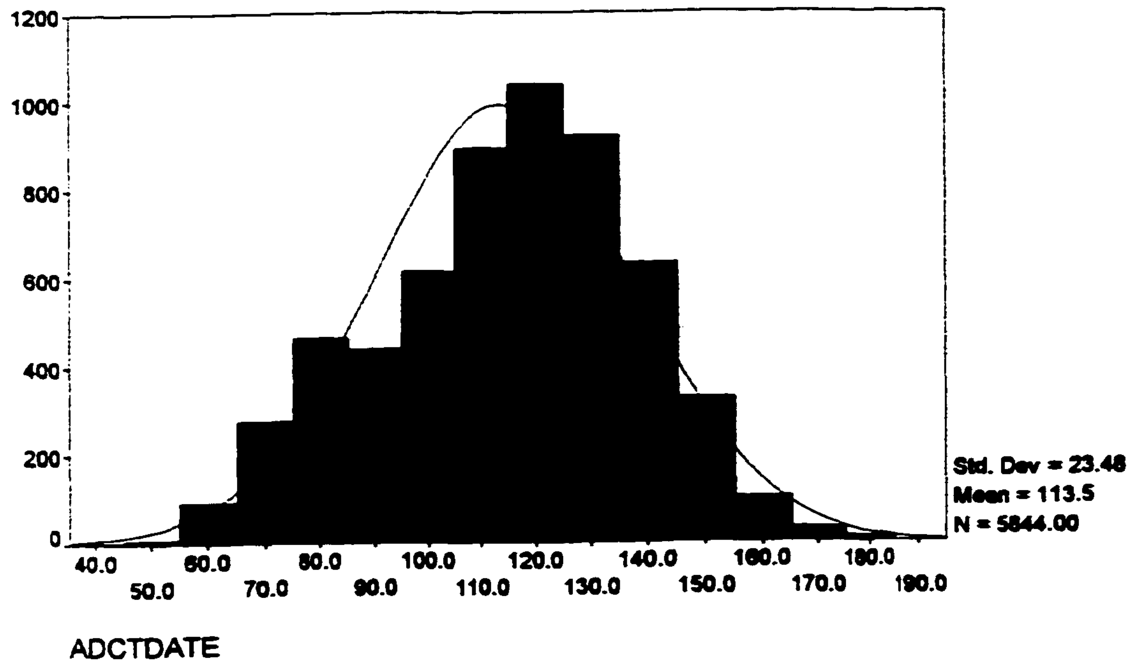

Figure 14. Histogram of Daily Adult Birth Data

Based on the above tests for stationarity and normality, several transformations were done to prepare the data for time series analysis. Because the strong seven-day cycle dominated the adult birth data just as it did with the teen births, the data was aggregated to weeks to eliminate this influence. The time series plot for the weekly number of adult births is displayed in Figure 15. Secondly, a natural log transformation was done to normalize the adult birth data and create stationarity of the variance in the data set. Then the data were differenced once to achieve stationarity of the mean. This resulting time series is depicted in Figure 16. Even after the data had been differenced, an outlier remained in the series. An increase in the number of adult births that may have occurred as a result of men being deployed in the Persian Gulf War appears to have produced an outlier at the 540th week of the series. After the time series had been transformed to achieve stationarity and passed the test of normality, it was then possible to specify a linear model to describe the behavior of the adult birth time series (Cromwell, Labys, & Terraza, 1994).

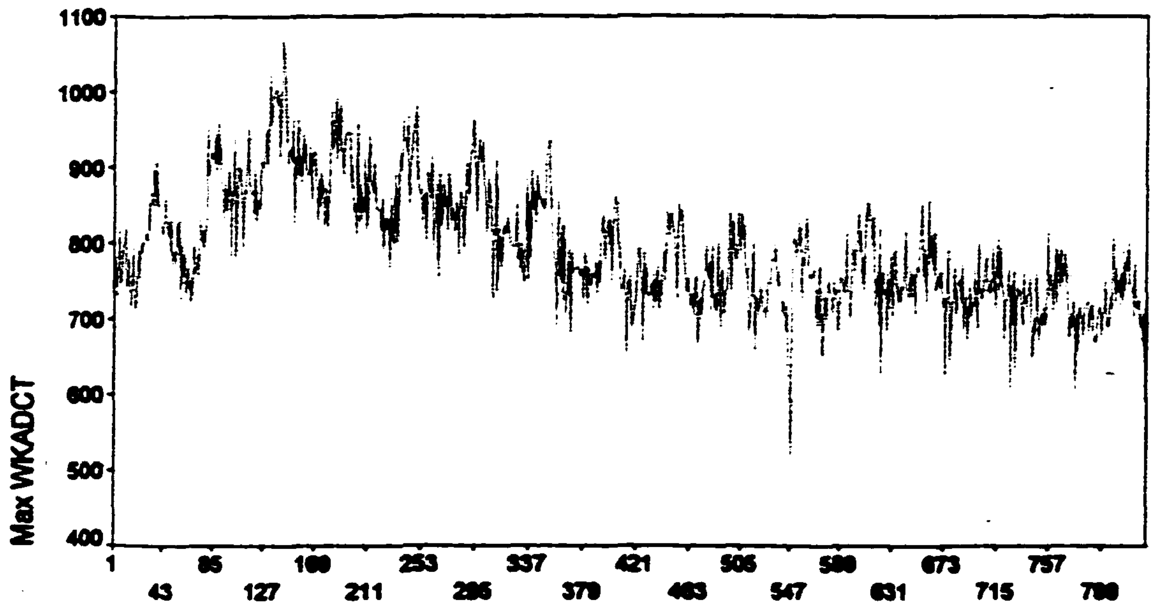

Figure 15. Weekly Count of Births to Adults 1980-1995

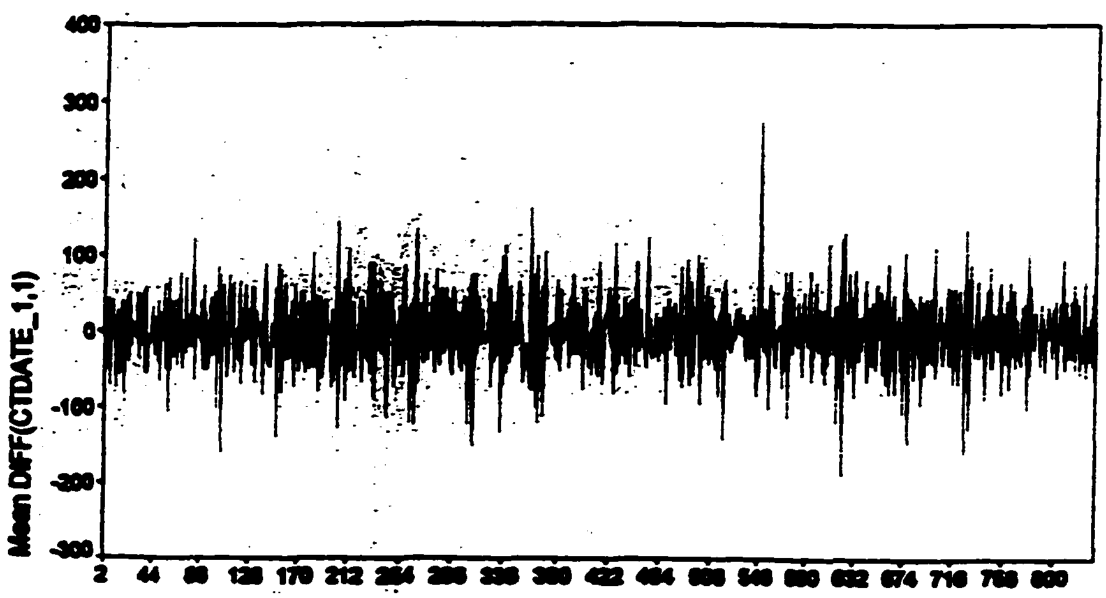

Figure 16. Weekly Count of Adult Births After One Differencing

Multiple attempts at estimating a model for adult births were carried out. Because the time series was an integrated series, at least one differencing was necessary to meet the assumptions of the method. The Autoregressive orders of one, two, and three were then attempted but were unsuccessful in reducing the series to white noise. Because the autoregressive process is one with "memory," each value is correlated with all preceding values. Any shock or disturbance to the system should have had a diminishing effect on subsequent values and the influence of earlier observations should have died out exponentially (SPSS, 1994). Because application of the autoregressive process was not effective for the adult birth series, the moving average process was applied. In a moving average series, each value is a weighted average of the most recent random disturbances. Because these values are weighted averages of the previous ones, the effect of the disturbance decreases over time and ceases (SPSS, 1994). One, two, and three orders of the moving average were attempted. A first order moving average was used because it produced the best results. A (0, 1, 1) model with a (0, 1, 1) seasonal component was determined to be the best fitting model for this data. The ACF plot was compared with signature plots of pure ARIMA processes to confirm the appropriateness of the model. Using SPSS 8.0, The Trends ARIMA procedure estimated the coefficients for the model that was identified. The SPSS Trends program performed the iterative calculations needed to determine the maximum-likelihood coefficients, and added a new series representing the fit, the residual, and the confidence limits for the fit. The ACF and the PACF for this model are illustrated in Figures 17 and 18.

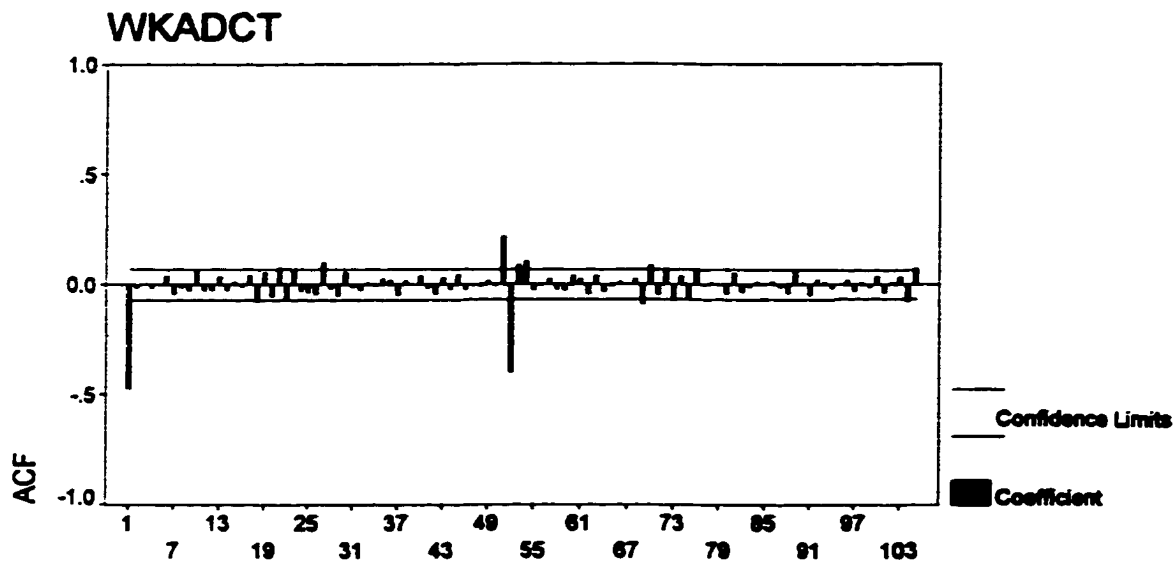

Figure 17. ACF of the Transformed Weekly Adult Birth Series

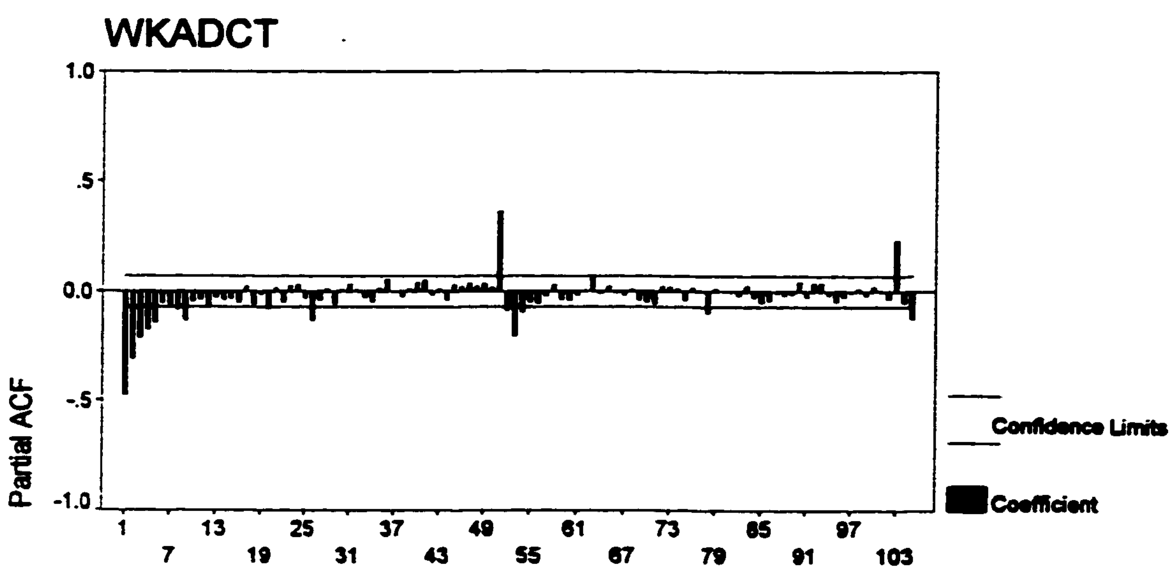

Figure 18. PACF of the Transformed Weekly Adult Birth Series

The final step in the ARIMA modeling procedure was diagnosis. To determine if the (0, 1, 1) model with a (0, 1, 1) seasonal component was the best-fitting model, the following checks were employed. First, the coefficients were examined and found to be within the .05 significance bands. Then, the ACF and the PACF of the error series were examined to determine that no value was significantly different than zero. Additionally, the residuals were determined to be without pattern. The lack of pattern signifies the residual is truly representing "white noise." Because of the complexity of this model, this was not achieved in its entirety but will be discussed in Chapter Five. Figures 19 and 20 illustrate the ACF and PACF of the residuals for the specified model.

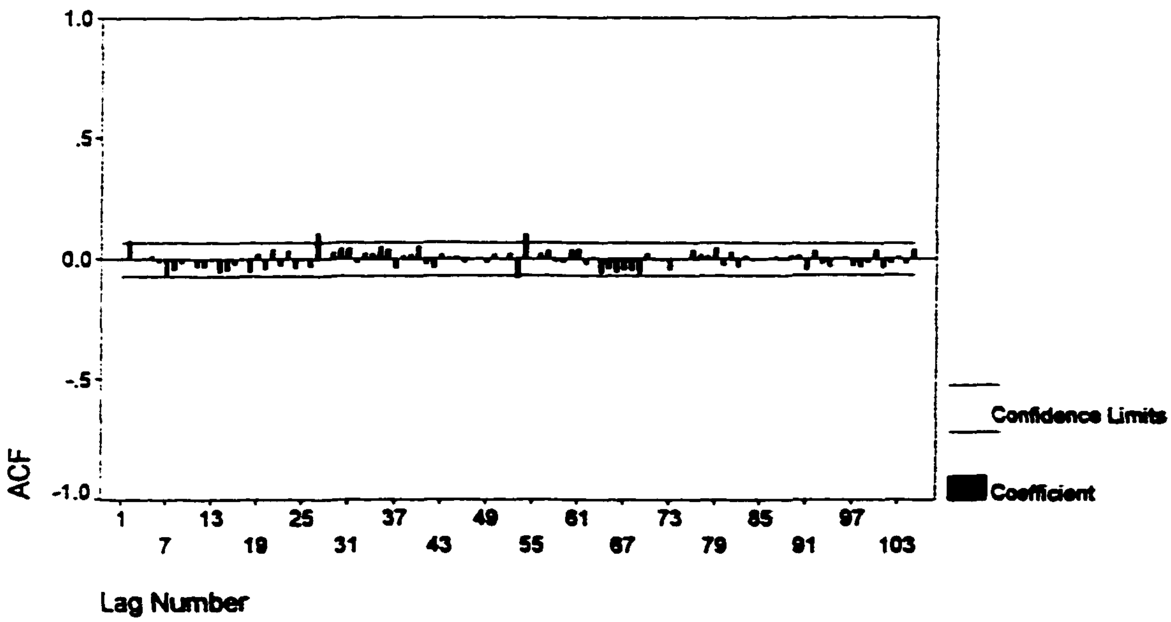

Figure 19. ACF of the Residuals for the Adult Birth Model (0, 1, 1) (0, 1, 1)

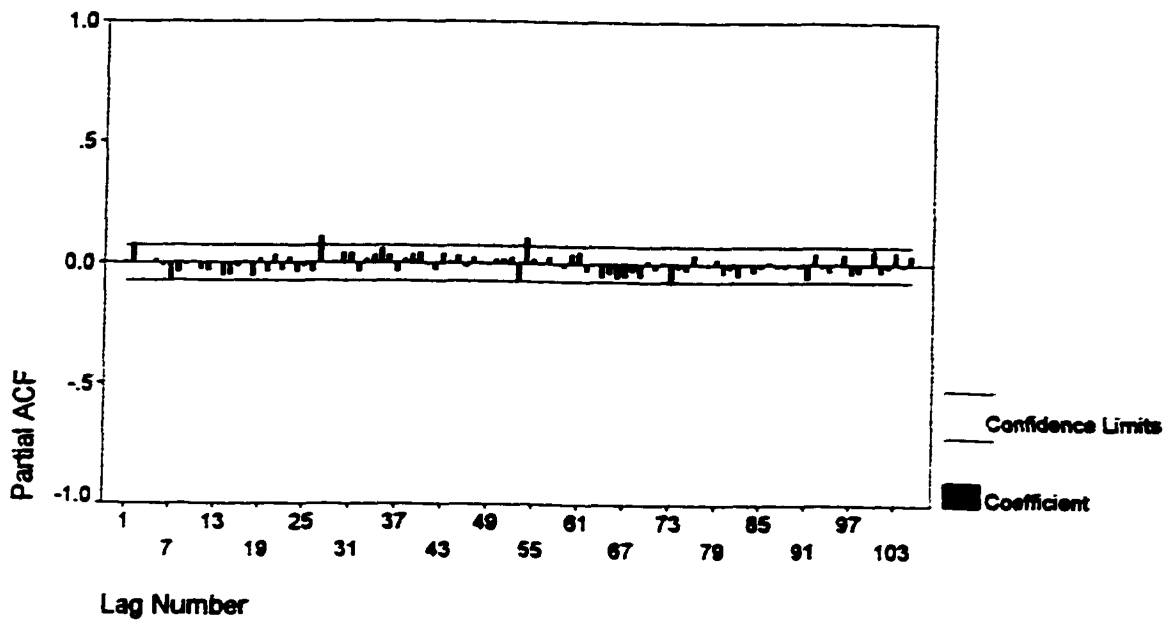

Figure 20. PACF of the Residuals for the Adult Birth Model (0, 1, 1) (0, 1, 1)

An ARIMA (0, 1, 1) model indicates that the current time series observation Y_t is equal to the preceding observation Y_{t-1} plus the current random shock a_t plus a portion of the preceding random shock a_{t-1}. The integrated moving average process seen in the adult birth data was determined by the average of the current disturbance and one previous disturbance. In addition, a seasonal (0, 1, 1) component was necessary to address the seasonal patterns seen in this data.

Model of All Births. As in the examination of teen and adult births, the first step in the identification of the underlying process in the time series of all births in Oklahoma that occurred from 1980 through 1995 was to determine the stationarity of the series. A stationary time series would have approximately the same mean and variance for the duration of time under investigation. Examination of the combined adult and teen birth data quickly revealed that this data set also was not a stationary series. The series had wide variation of daily values and a mean that changed over time. During the same sixteen-year time period that was examined for teen and adult births separately, the daily number of all births ranged from 48 to 221 with a mean of 136.9, standard deviation of 26.8, and a variance of 718.97. Examination of the mean for the combined adult and teen birth data for the single years of 1980 and 1995 revealed a significant change over time. In 1980, the mean number of all daily births was 142.2, dropping to a daily mean of 124.3 for all births in 1995.

The autocorrelation function (ACF) of the raw data revealed strong positive correlations which do not die out over time indicating the data set is an integrated series. Figure 21 is the graphic display of the ACF of the raw data for all births with a lag of 1200 (representing data for a period of time greater than three years). The strong positive correlations reflect weekly, seasonal, and annual cycles that continue to be significant for a prolonged period of time. The extremely slow decay indicated there was a strong possibility of long range dependency. Because the average values varied over time, the short term variation was greater during some time periods than others, and the ACF of the raw data indicated an integrated series, the data set for all births was also considered to be non-stationary indicating that transformation was required to achieve stationarity.

It was also necessary for the combined birth data to pass a test of normality before time series analysis could proceed. To determine if the total number of births per day

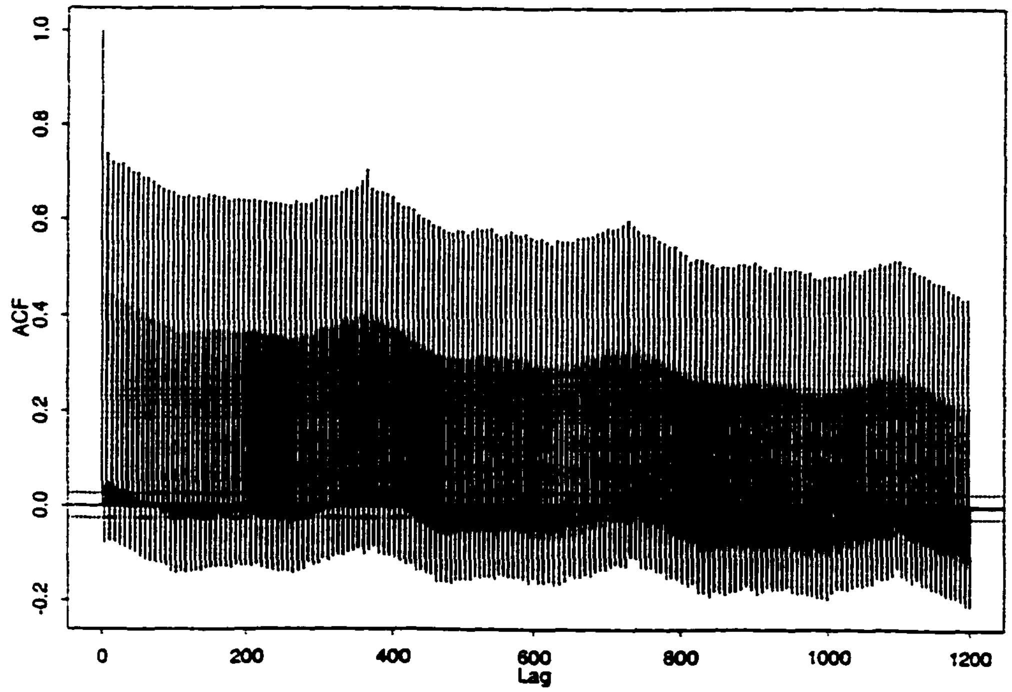

Figure 21. ACF of the Raw Data for All Daily Births, Lag of 1200

were normally distributed, a histogram depicting the data was constructed and a one-sample Kolmogorov-Smirnov Goodness of Fit Test was run to compare the observed cumulative distribution function of all births with the theoretical normal distribution. The histogram representing the combined birth data is shown in Figure 22 and shows a positive skew. The Kolmogorov-Smirnov (K-S) Z statistic of 2.153 was statistically significant, $p = .0002$, indicating that the data was not normally distributed and required transformation.

Based on the above tests for stationarity and normality, several transformations were done to prepare the data for time series analysis. Because the strong seven-day cycle dominated the data set for all births just as it did with the teen and adult data sets individually, the data was aggregated to weeks to eliminate this influence. The time

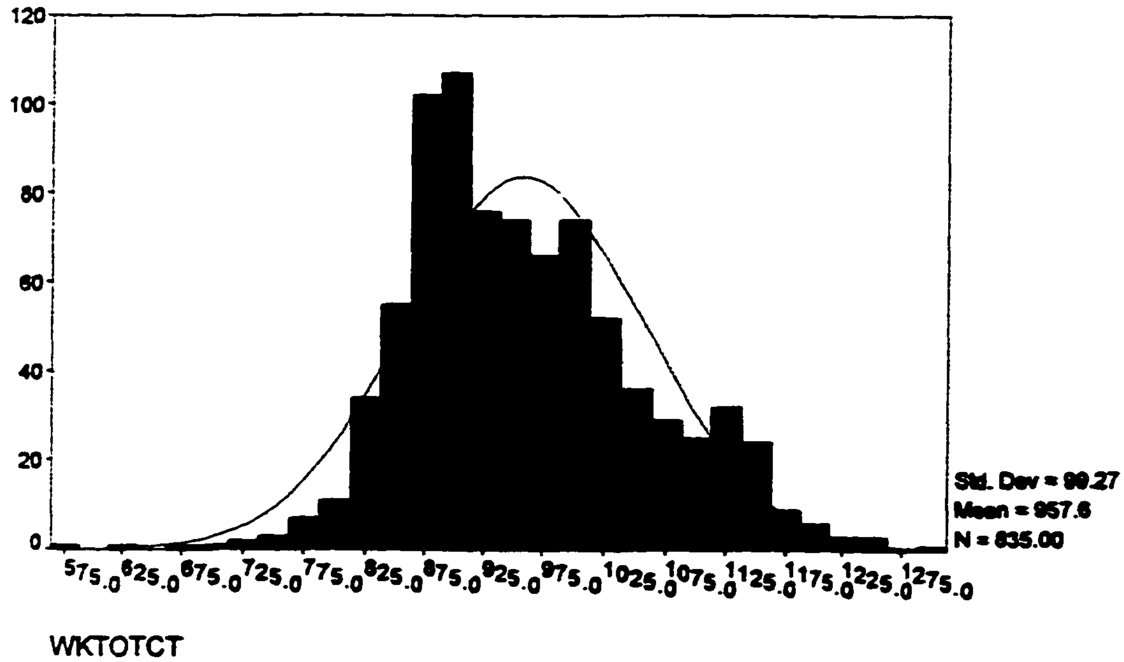

Figure 22. Histogram of Daily Data for All Births

series plot for the weekly number of all births is displayed in Figure 23. Secondly, a natural log transformation was done to normalize the data for total births and create stationarity of the variance in the data set. Then the data were differenced once to achieve stationarity of the mean. This resulting time series is depicted in Figure 24. Even after the data had been differenced, an outlier remained in the series. This outlier appears to represent the drop in the number of births during and immediately following the Persian Gulf War. After the time series had been transformed to achieve stationarity and passed the test of normality, it was then possible to specify a linear model to describe the behavior of the time series for total births (Cromwell, Labys, & Terraza, 1994).

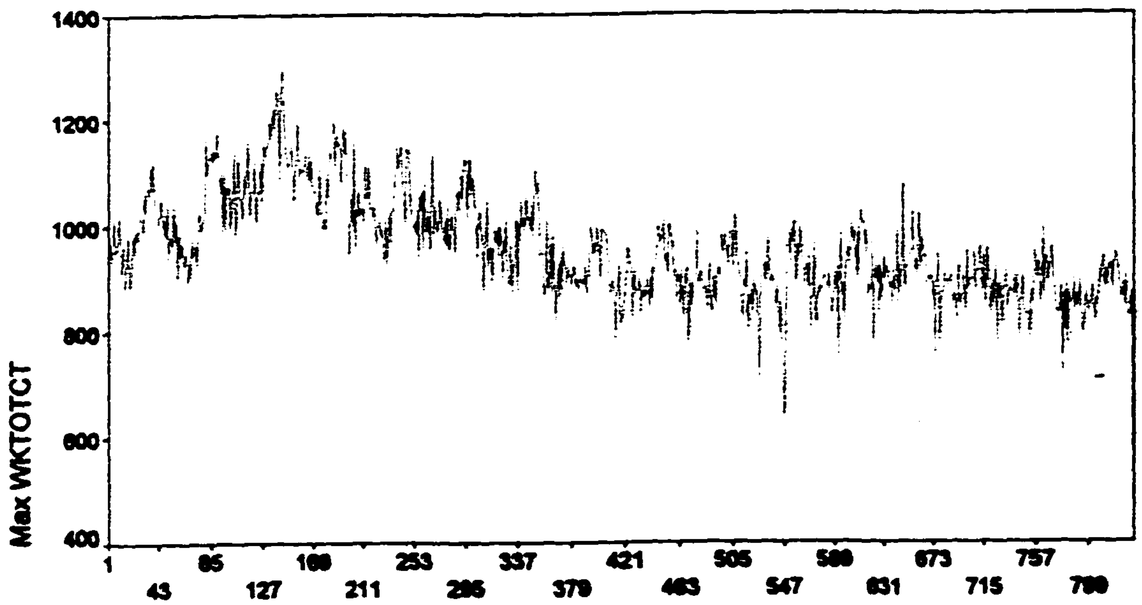

Figure 23. Weekly Count of All Births 1980-1995

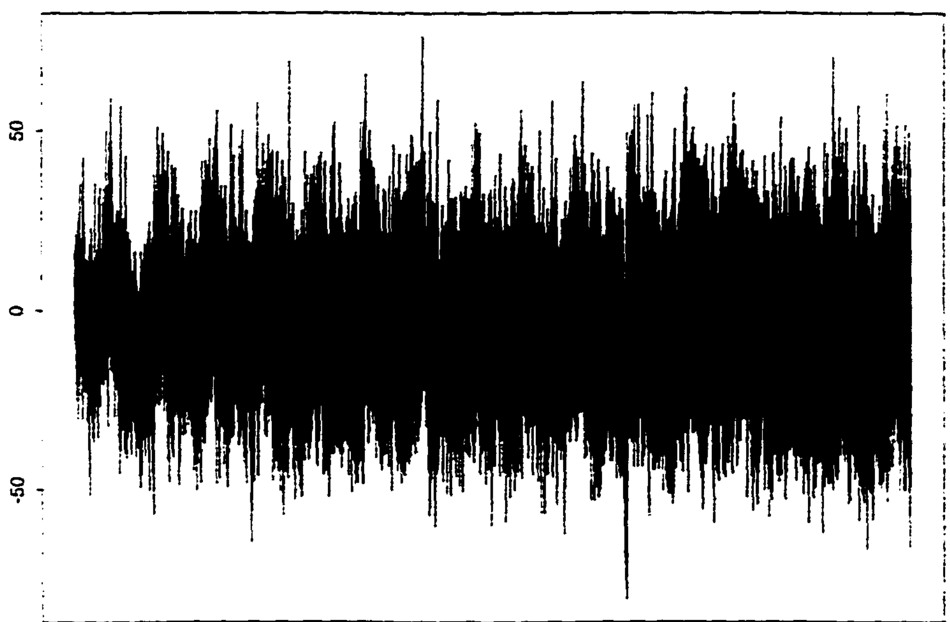

Figure 24. Weekly Count of All Births After One Differencing

Multiple attempts at estimating a model for total births were carried out in the same manner as for the teen and adult births. Because this time series was also an integrated series, at least one differencing was necessary to meet the assumptions of the method. The Autoregressive orders of one, two, and three were then attempted but were again unsuccessful in reducing the series to white noise. Because the autoregressive process is one with "memory," each value is correlated with all preceding values. Any shock or disturbance to the system should have had a diminishing effect on subsequent values and the influence of earlier observations should have died out exponentially (SPSS, 1994). Because application of the autoregressive process was not effective for the series representing total births, the moving average process was applied. In a moving average series, each value is a weighted average of the most recent random disturbances. Because these values are weighted averages of the previous ones, the effect of the disturbance decreases over time and ceases (SPSS, 1994). One, two, and three orders of the moving average were attempted. A first order moving average was used because it produced the best results. A (0, 1, 1) model with a (0, 1, 1) seasonal component was determined to be the best fitting model for this data. The ACF plot was compared with signature plots of pure ARIMA processes to confirm the appropriateness of the model. Using SPSS 8.0, The Trends ARIMA procedure estimated the coefficients for the model that was identified. The SPSS Trends program performed the iterative calculations needed to determine the maximum-likelihood coefficients, and added a new series representing the fit, the residual, and the confidence limits for the fit. The ACF and the PACF for this model are illustrated in Figures 25 and 26.

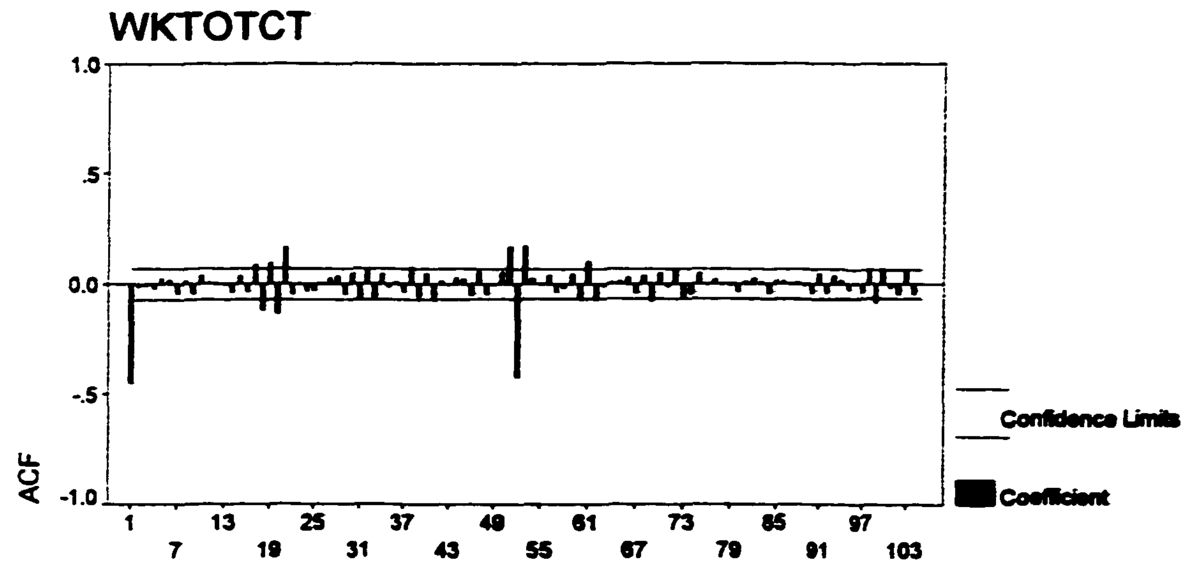

Figure 25. ACF of the Transformed Weekly Birth Series for All Births

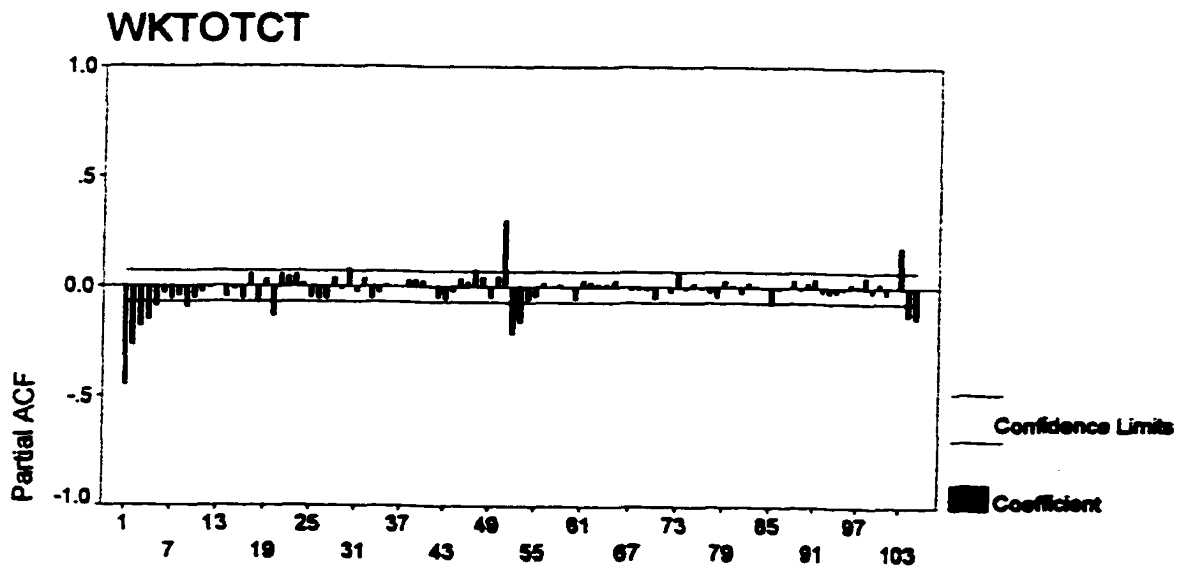

Figure 26. PACF of the Transformed Weekly Birth Series for All Births

The final step in the ARIMA modeling procedure was diagnosis. To determine if the (0, 1, 1) model with a (0, 1, 1) seasonal component was the best-fitting model, the following checks were employed. First, the coefficients were examined and found to be within the .05 significance bands. Then, the ACF and the PACF of the error series were examined to determine that no value was significantly different than zero. Additionally, the residuals were determined to be without pattern. The lack of pattern signifies the residual is truly representing "white noise." Because of the complexity of this model, this was not achieved in its entirety but will be discussed in Chapter Five. Figures 27 and 28 illustrate the ACF and PACF of the residuals for the specified model.

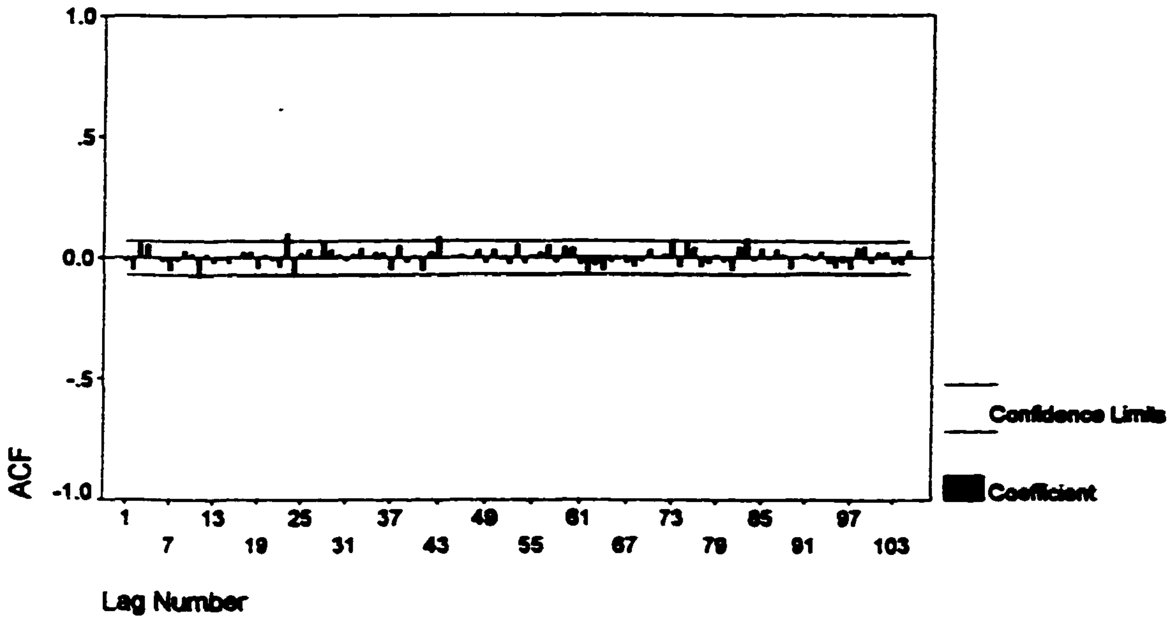

Figure 27. ACF of the Residuals for the Birth Model for All Births (0, 1, 1) (0, 1, 1)

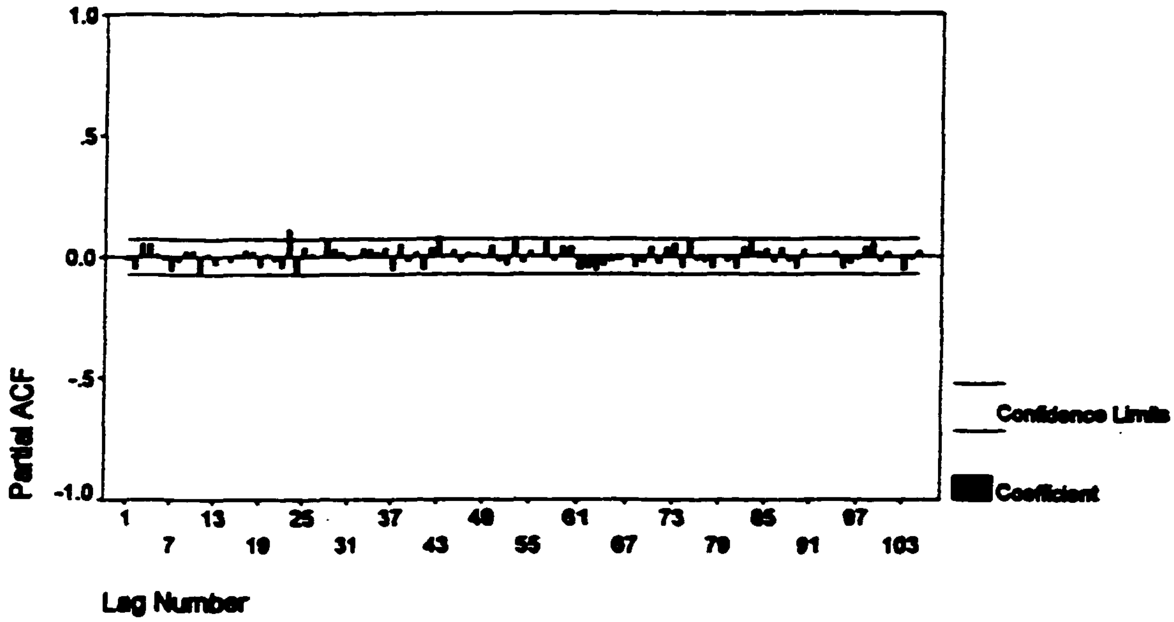

Figure 28. PACF of the Residuals for the Birth Model for All Births (0, 1, 1) (0, 1, 1)

An ARIMA (0, 1, 1) model indicates that the current time series observation Y_t is equal to the preceding observation Y_{t-1} plus the current random shock a_t plus a portion of the preceding random shock a_{t-1}. The integrated moving average process seen in the birth data for all births was determined by the average of the current disturbance and one previous disturbance. In addition, a seasonal (0, 1, 1) component was necessary to address the seasonal patterns seen in this data.

Hypothesis #1: A procyclic model of economics and fertility better fits the Oklahoma birth data (all births) than a countercyclic model.

Visual comparison of the Oklahoma birth data and the economic indicator (oil price) appeared to have a procyclic relationship. To test this relationship statistically, multivariate time series analysis was employed to examine the influence that changing oil price had on birth patterns in Oklahoma during the sixteen-year time period beginning in 1980 and continuing through 1995. Multivariate time series analysis is similar in concept to other multivariate techniques in which the relationship between two or more variables is examined (Metzger & Schultz, 1982). For the purposes of addressing this hypothesis, the two variables examined were the time series of all births and the time series of oil price. Both time series were recorded at daily intervals for the sixteen-year period of time under investigation.

The cross-correlation function (CCF) was the principal technique used to determine the strength of the association between the two time series. This process allowed examination of birth patterns as they were influenced by the exogenous variable of economic condition represented by oil price. The multivariate model was constructed by testing the time series of all births by comparing it to the contemporaneous, lagged, and leading values of the oil price time series. The strength of the relationships at particular points in time was then determined. Because the input series was highly autocorrelated, the direct cross-correlation function between the input and the response series would have given a misleading indication of the relationship between the two series if the raw data would have been used. Therefore, the process of prewhitening was employed. First an ARIMA model for the input series was determined to be sufficient in reducing the residuals to white noise. Then, the series was filtered to produce the white noise residual series. The response series was filtered with the same model and cross correlated with the filtered input series (SAS, 1993). This process, as it applied to the time series for all births, was carried out in Research Question Number One in the univariate analysis of this data. This prewhitening process was completed on the oil price series prior to implementing the CCF.

Model of Oil Price. As in the examination of births, the first step in the identification of the underlying process in the time series of oil price was to determine the stationarity of the series. A stationary time series would have approximately the same mean and variance for the duration of time under investigation. Examination of the oil price data quickly revealed that this data set also was not a stationary series. The series had wide variation of daily values and a mean that changed over time. During the sixteen-year time period under investigation, the daily price of oil ranged from $10.75 to$39.25 with a mean of $21.77, standard deviation of 7.07, and a variance of 50.06. Like the birth data, examination of these same statistics for oil price for the isolated years of 1980 and 1982 revealed a significant change over a short period of time. In 1980, the average oil price was $14.92 and rose sharply to a mean oil price of $32.635 in 1982. Unlike the birth data, variance within each year was relatively small for most years (ie., 1982 variance in oil price was only 0.41). As stated above, however, the variance in daily oil price was 50.06 over the duration of the study period. In addition, the ACF of the raw data for oil price indicated an integrated series similar to the time series of births.

Figure 29 is the graphic display of the ACF of the raw data for daily oil price with a lag of 1200. The strong positive correlations reflect weekly and annual trends that continue to be significant for a prolonged period of time. Because the average values varied over time, the short term variation was greater during some time periods than others, and the ACF of the raw data indicated an integrated series, the data set for oil price was considered to be non-stationary indicating that transformation was required to achieve stationarity before CCF could be calculated.

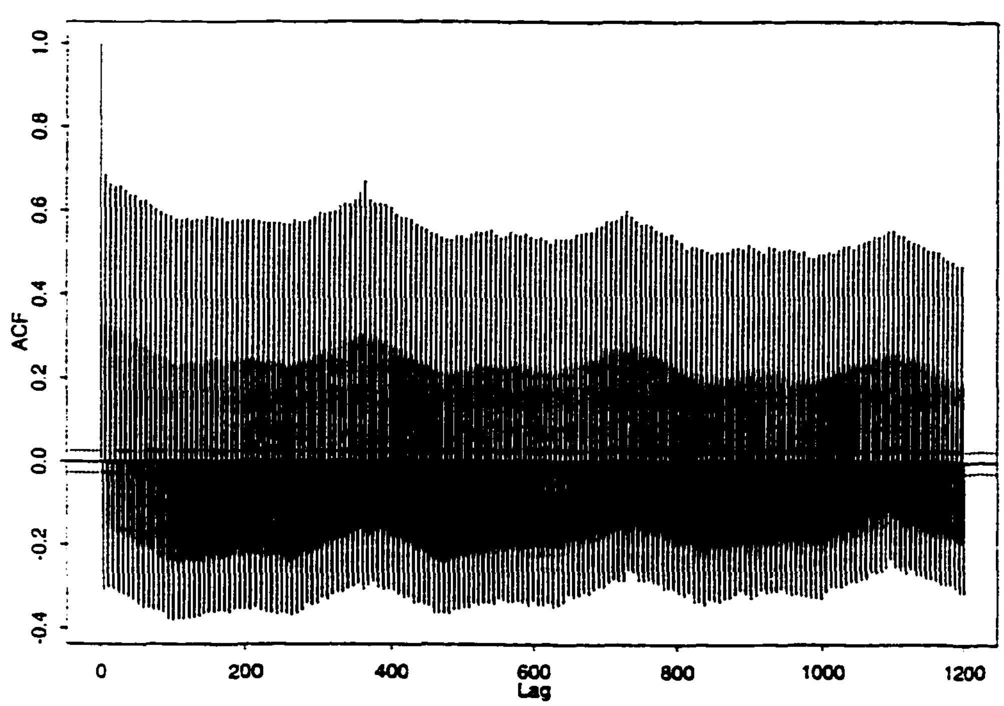

Figure 29. ACF of the Raw Data for Daily Oil Price, Lag of 1200

It was also necessary for the daily oil price data to pass a test of normality before time series analysis could proceed. To determine if the daily price of oil was normally distributed, a histogram depicting the data was constructed and a one-sample Kolmogorov-Smirnov Goodness of Fit Test was run to compare the observed cumulative distribution function of oil price with the theoretical normal distribution. The histogram representing the oil price data is illustrated in Figure 30 and shows a bimodal distribution with a positive skew. The Kolmogorov-Smirnov (K-S) Z statistic of 5.505 was statistically significant, p = .0000, indicating that the data were not normally distributed and required transformation.

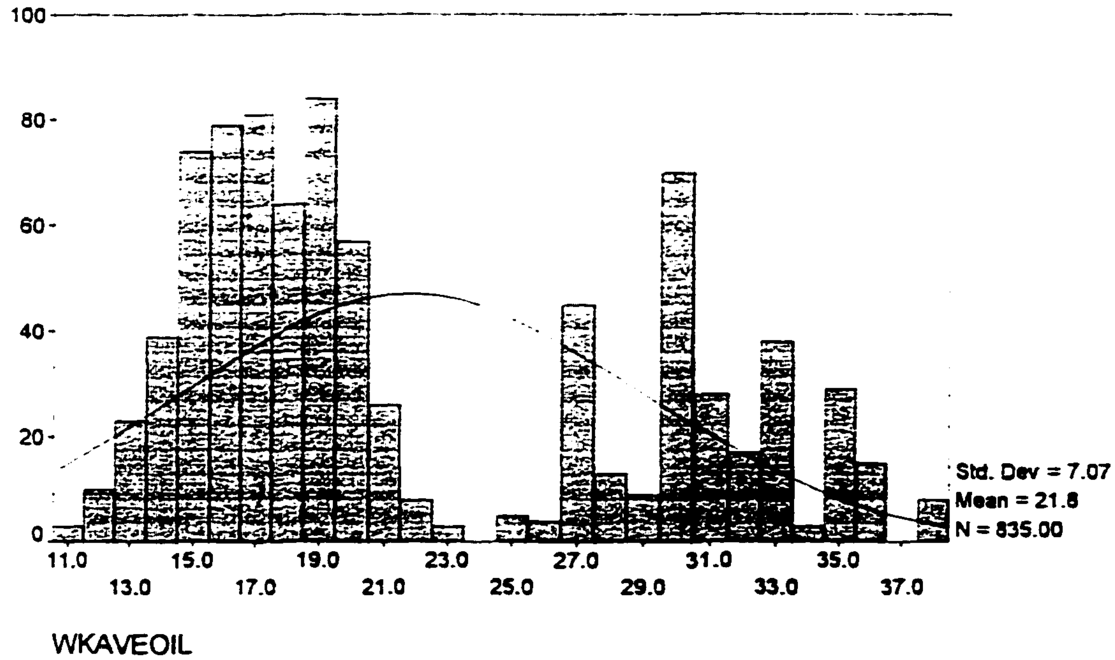

Figure 30. Histogram of Daily Oil Price Data

Based on the above tests for stationarity and normality, several transformations were done to prepare the data for time series analysis. Because the strong seven-day cycle dominated the oil price data just as it did with the birth data, this data was also aggregated to weeks to eliminate this influence. The time series plot for the weekly average oil price is displayed in Figure 31. Secondly, a natural log transformation was done to normalize the data. Then the data were differenced once to achieve stationarity. This phenomenon is depicted in Figure 32. After the time series had been transformed to achieve stationarity and passed the test of normality, it was then possible to proceed with the CCF.

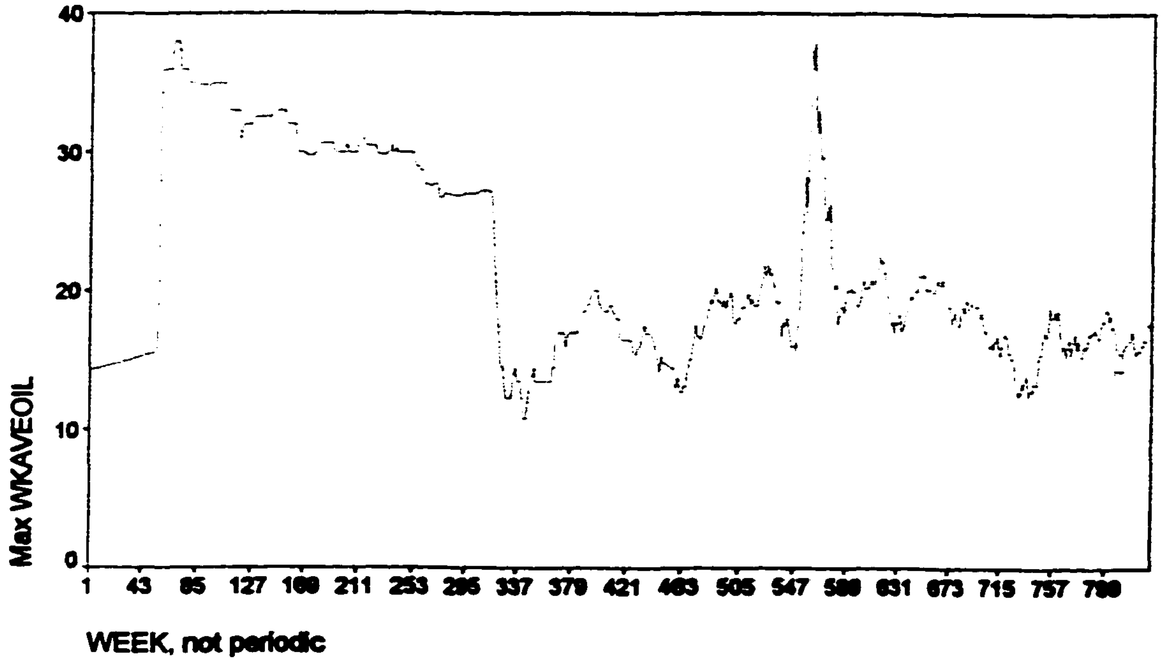

Figure 31. Average Weekly Oil Price 1980-1995

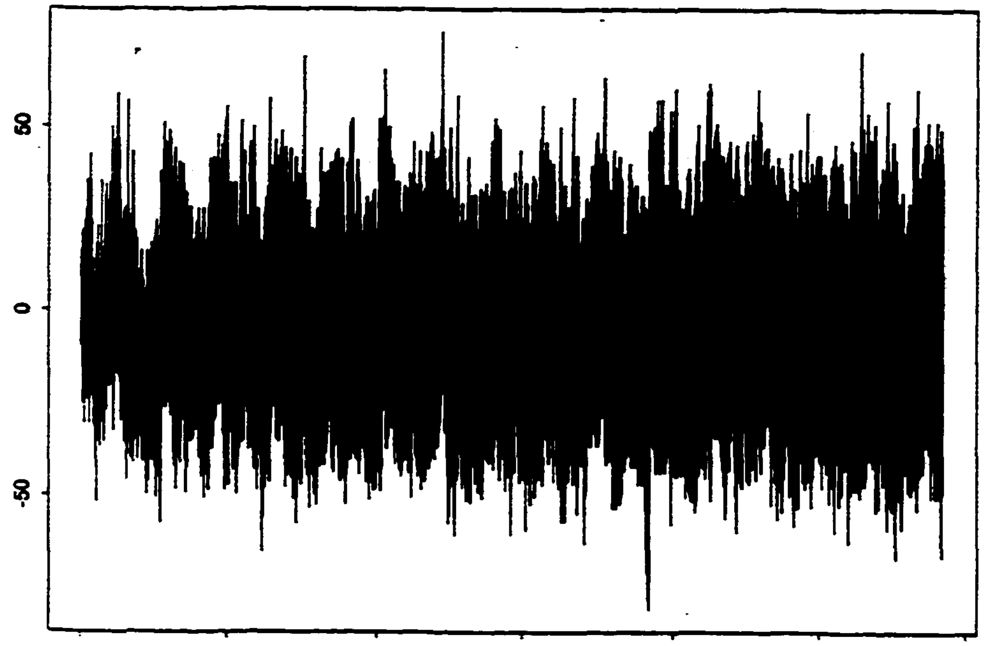

Figure 32. Average Weekly Oil Price After One Differencing

Multiple attempts at estimating a model for oil price were carried out in the same manner as for the birth data. Because this time series was also an integrated series, at least one differencing was necessary to meet the assumptions of the test. The Autoregressive orders of one, two, and three were then attempted but were again unsuccessful in reducing the series to white noise. Because the autoregressive process is one with "memory," each value is correlated with all preceding values. Any shock or disturbance to the system should have had a diminishing effect on subsequent values and the influence of earlier observations should have died out exponentially (SPSS, 1994). Because application of the autoregressive process was not effective for the series representing oil price, the moving average process was applied. In a moving average series, each value is a weighted average of the most recent random disturbances. Because these values are weighted averages of the previous ones, the effect of the disturbance decreases over time and ceases (SPSS, 1994). One, two, and three orders of the moving average were attempted. A first order moving average was used because it produced the best results. A (0, 1, 1) model with a (0, 1, 1) seasonal component was determined to be the best fitting model for this data. The ACF plot was compared with signature plots of pure ARIMA processes to confirm the appropriateness of the model. Using SPSS 8.0, The Trends ARIMA procedure estimated the coefficients for the model that was identified. The SPSS Trends program performed the iterative calculations needed to determine the maximum-likelihood coefficients, and added a new series representing the fit, the residual, and the confidence limits for the fit. The ACF and the PACF for this model are illustrated in Figures 33 and 34.

The final step in the ARIMA modeling procedure was diagnosis. To determine if the (0, 1, 1) model with a (0, 1, 1) seasonal component was the best-fitting model, the following checks were employed. First, the coefficients were examined and found to be within the .05 significance bands. Then, the ACF and the PACF of the error series were examined to determine that no value was significantly different than zero. Additionally, the residuals were determined to be without pattern. The lack of pattern signifies the residual is truly representing "white noise." Because of the complexity of this model, this was not achieved in its entirety but will be discussed in Chapter Five. Figures 35 and 36 illustrate the ACF and PACF of the residuals for the specified model.

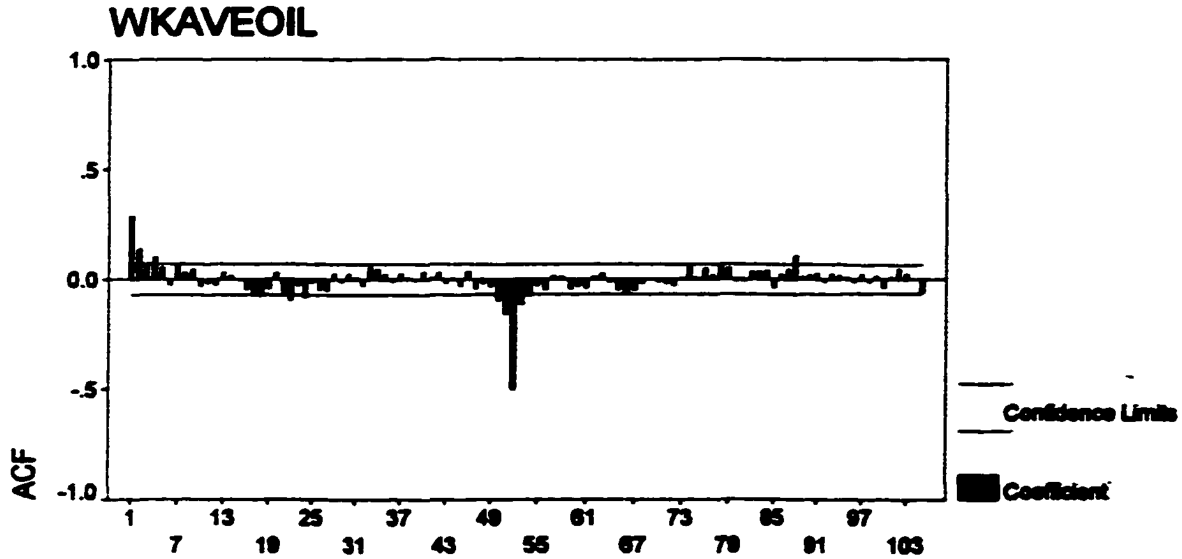

Figure 33. ACF of the Transformed Weekly Oil Price Series

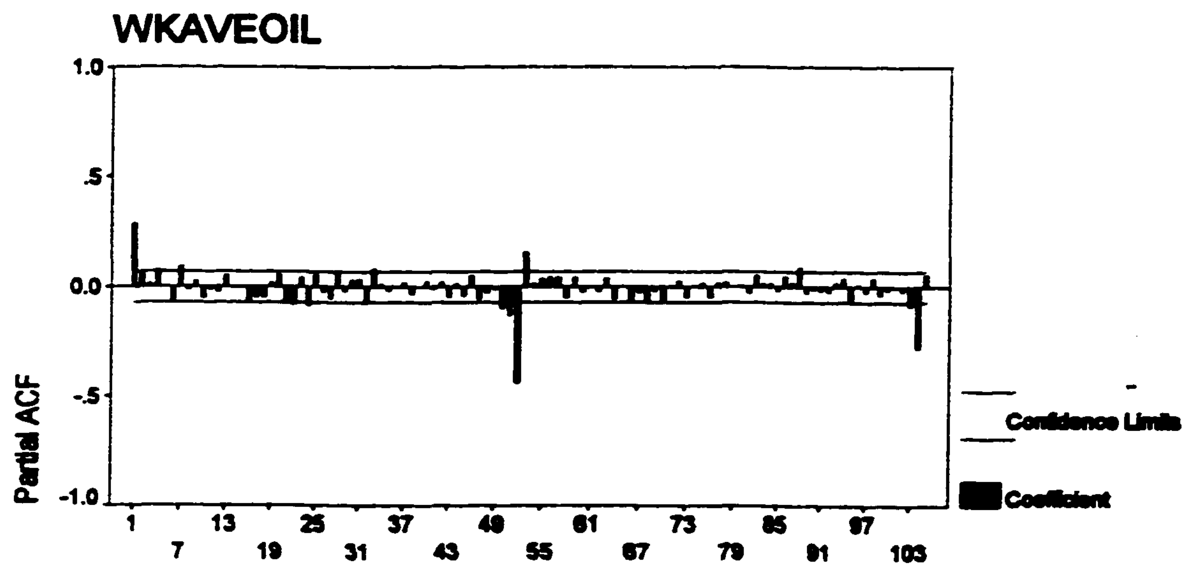

Figure 34. PACF of the Transformed Weekly Oil Price Series

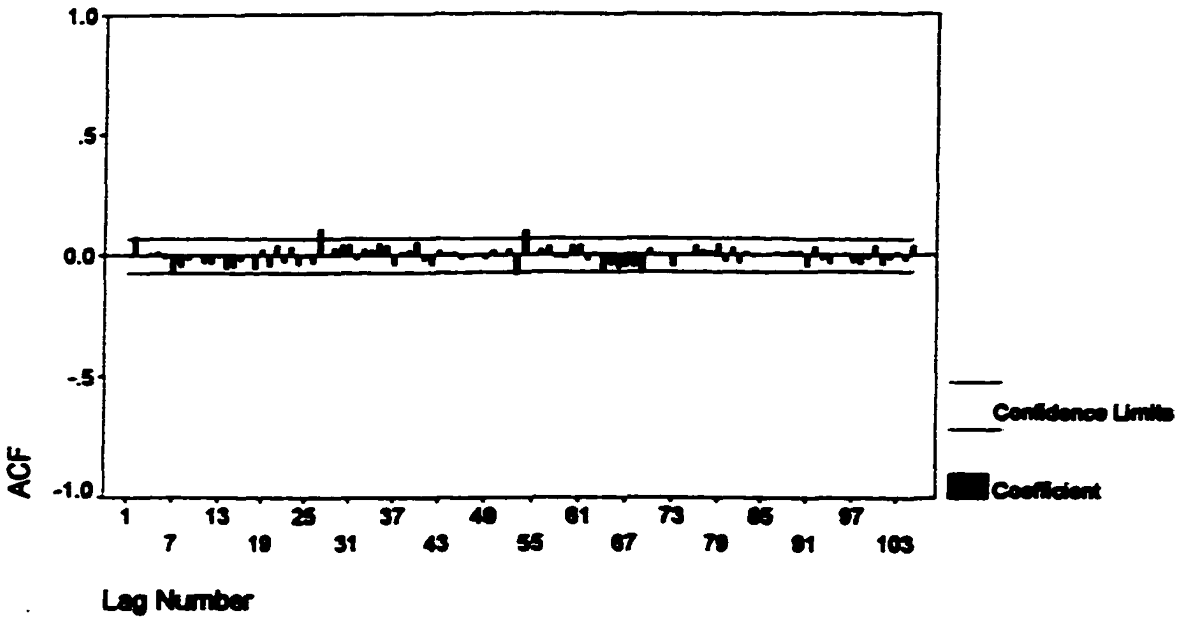

Figure 35. ACF of the Residuals for the Oil Price Model (0, 1, 1) (0, 1, 1)

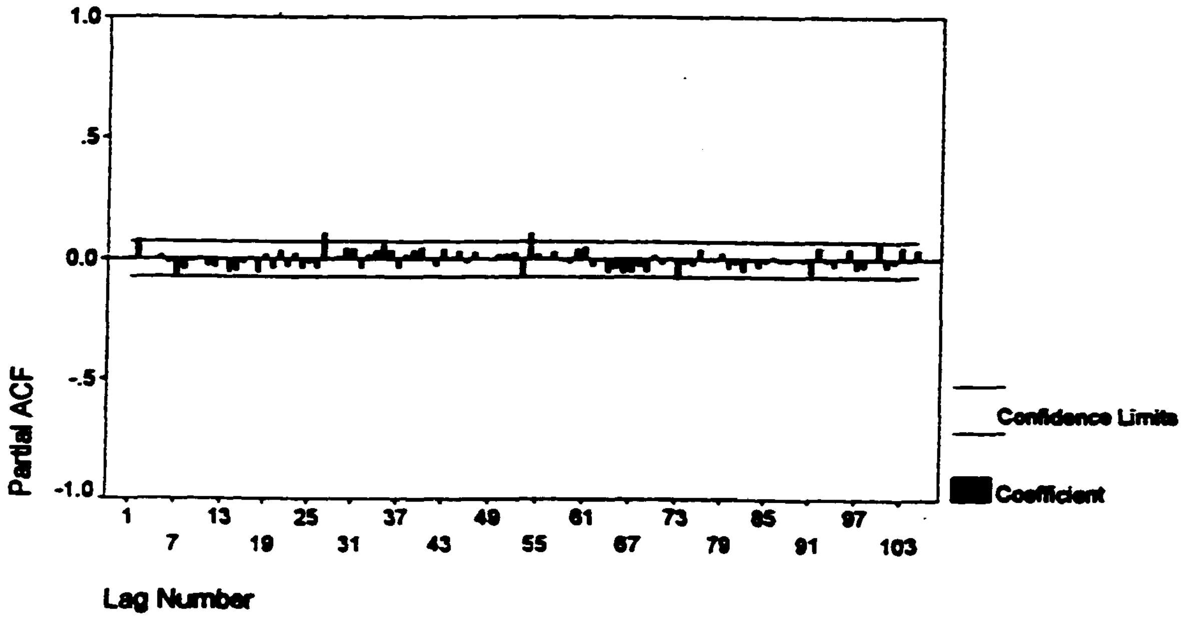

Figure 36. PACF of the Residuals for the Oil Price Model (0, 1, 1) (0, 1, 1)

An ARIMA (0, 1, 1) model indicates that the current time series observation Y_t is equal to the preceding observation Y_{t-1} plus the current random shock a_t plus a portion of the preceding random shock a_{t-1}. The integrated moving average process seen in the oil price data was determined by the average of the current disturbance and one previous disturbance. In addition, a seasonal (0, 1, 1) component was necessary to address the seasonal patterns seen in this data.

Crosscorrelation of All Births with Oil Price. The Crosscorrelation function (CCF) is a procedure that can be performed only on series that are stationary. This was accomplished by the prewhitening process described above which removed the cyclical and trend component of the data, reducing the series to white noise. The CCF was performed to examine the correlation between the two series (all births and oil price) for the purpose of determining if a relationship exists between the two variables and the nature of that relationship. Using SPSS 8.0, the cross-correlation procedure was used to calculate the crosscorrelation coefficients for the two series. Figure 37 provides a graphic representation of the relationship of the average weekly oil price and the total number of births per week. The plot displays correlations that are significantly positive, reaching a peak correlation of number of births with oil price at a lag of one year.

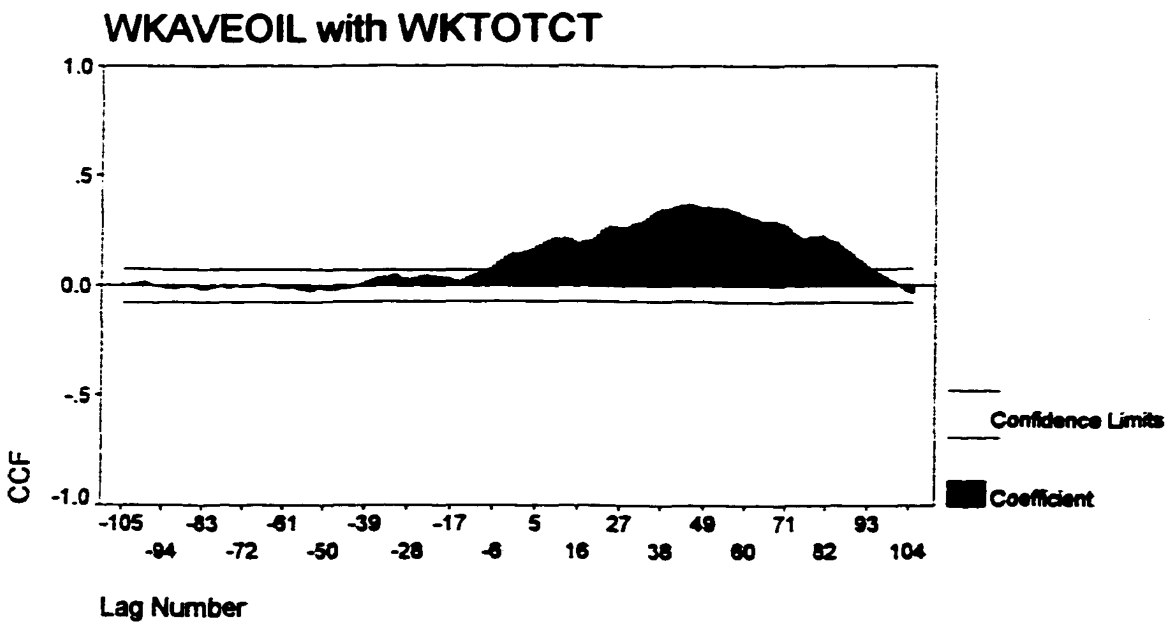

Figure 37. Crosscorrelation of Weekly Average Oil Price and Weekly Number of Births Correlation coefficients are greater than .35 for weeks 38 through 55, indicating that there is a procyclic relationship between economic condition and the number of births in Oklahoma. The positive lag indicates that the first series leads the second, meaning that oil price leads births.

Use of Autoregression. As an additional test of the relationship between oil price and birth count at a lag of one year, the autoregression procedure was employed using SAS Version 6 (1993). The regression R^2 is computed as 1 – TSSE/TSST where TSST is the total sum of squares of the transformed series corrected for the transformed intercept and TSSE is the error sum of the squares for this transformed model. The regression R^2 is a measure of the fit of the structural part of the model after transforming for the autocorrelation and is the R^2 for the transformed regression. The total R^2 is computed as

1 – SSE/SST where SST is the corrected sum of the squares for the original response variable and the SSE is the final obtained error sum of squares. The total R^2 is a measure of how well the next value can be predicted using the structural part of the model and the past values of the residuals (Akaike & Kitagawa, 1999). When the transformed series of total number of births was regressed on the transformed oil price series (lagged for one year), the total $\underline{R}^2 = .62$, $\underline{p} = .0001$ confirming there is a significant relationship between oil price and all births in Oklahoma during the sixteen-year period of time under investigation for this study.

<u>Conclusion.</u> Both the CCF and autoregression procedures support the hypothesis that a procyclic model of economics and fertility better fits the Oklahoma birth data (all births) than a countercyclic model.

<u>Hypothesis #2: Fluctuations in economic conditions have a stronger relationship to the pattern of adult births than to the pattern of teen births.</u>

Multivariate time series analysis using the crosscorrelation function (CCF) described in the discussion of Hypothesis number one was also used to address Hypothesis number two. For this hypothesis, the two variables under examination were the time series of teen births as compared to the time series of oil prices and the time series of adult births as compared to the oil price time series. Each time series was recorded at daily intervals for the sixteen-year period of time being investigated. The data was then aggregated to weekly data to remove the dominant seven-day cycle and transformed to meet the assumptions of normality and stationarity.

The crosscorrelation function (CCF) was the principal technique used to determine the strength of the association between the two pairs of time series. This process allowed examination of birth patterns of two different age groups as they were influenced by the exogenous variable of economic condition represented by oil price. By comparing the time series of teen births and the adult births to the contemporaneous, lagged, and leading values of the oil price time series, the strength of the relationships at particular points in time were determined.

Crosscorrelation of Adult Births with Oil Price. The Crosscorrelation function (CCF) is a procedure that can be performed only on series that are stationary. This was accomplished by the prewhitening process described in the discussion of Research Question Number One. Completion of the identified transformations removed the cyclical and trend component of the data, reducing the series to white noise. The CCF was performed to examine the correlation between the two series (adult births and oil price) for the purpose of determining if a relationship exists between the two variables and the nature of that relationship. Using SPSS 8.0, the cross-correlation procedure was used to calculate the cross-correlation coefficients for the two series. Figure 38 provides a graphic representation of the relationship of the average weekly oil price and the number of adult births per week. The plot displays correlations that are significantly positive, reaching a peak correlation of number of adult births with oil price at a lag of one year.

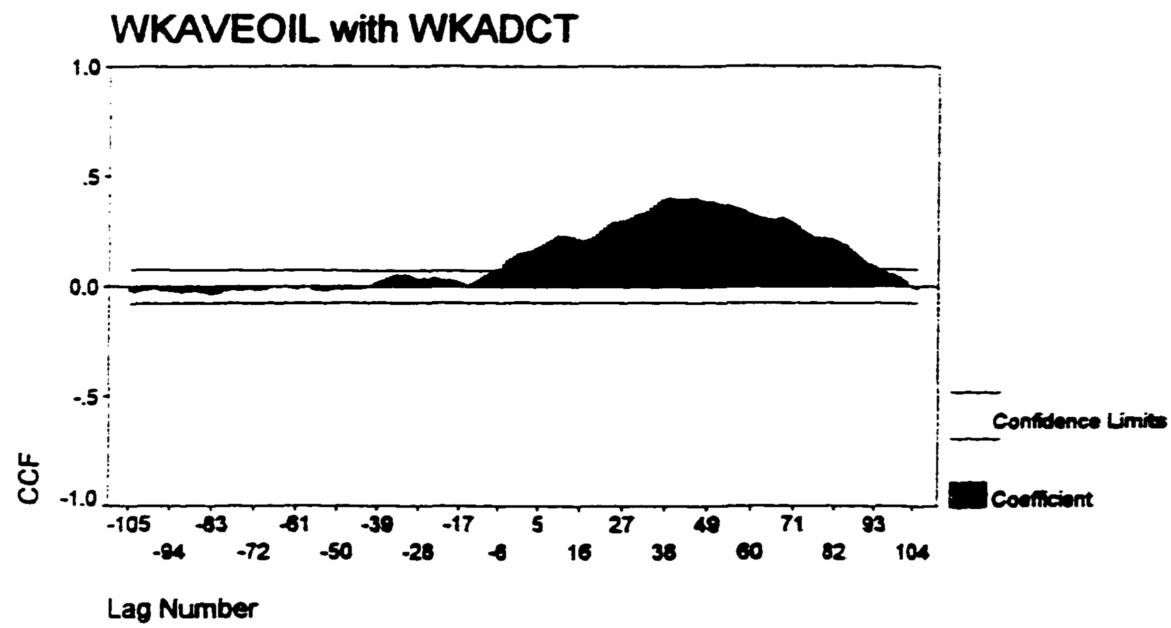

Figure 38. Crosscorrelation of Weekly Average Oil Price and Number of Adult Births

Correlation coefficients are greater than .35 for weeks 34 through 56, indicating that there is a significant procyclic relationship between economic condition and the number of adult births in Oklahoma. The positive lag indicates that the first series leads the second, meaning that oil price leads births.

Use of Autoregression. As an additional test of the relationship between oil price and adult birth count at a lag of one year, the autoregression procedure was employed using SAS Version 6 (1993). The regression R^2 is computed as 1 – TSSE/TSST where TSST is the total sum of squares of the transformed series corrected for the transformed intercept and TSSE is the error sum of the squares for this transformed model. The regression R^2 is a measure of the fit of the structural part of the model after transforming for the autocorrelation and is the R^2 for the transformed regression. The total R^2 is computed as 1 – SSE/SST where SST is the corrected sum of the squares for the original response variable and the SSE is the final obtained error sum of squares. The total R^2 is a measure of how well the next value can be predicted using the structural part of the model and the past values of the residuals (Akaike & Kitagawa, 1999). When the transformed series of total number of adult births was regressed on the transformed oil price series (lagged for one year), the total $\underline{R}^2 = .72$, $\underline{p} = .0001$ confirming there is a significant relationship between oil price and adult births in Oklahoma during the sixteen-year period of time under investigation for this study.

Crosscorrelation of Teen Births with Oil Price. The Crosscorrelation function (CCF) is a procedure that can be performed only on series that are stationary. This was accomplished by the prewhitening process described in the discussion of Research Question Number One which removed the cyclical and trend component of the data, reducing the series to white noise. The CCF was performed to examine the correlation between the two series (teen births and oil price) for the purpose of determining if a relationship exists between the two variables and the nature of that relationship. Using SPSS 8.0, the cross-correlation procedure was used to calculate the cross-correlation coefficients for the two series. Figure 39 provides a graphic representation of the relationship of the average weekly oil price and the number of teen births per week. The plot displays correlations that are positive at both negative and positive lags with correlations that are not as strong as the correlations seen in the adult data. The peak correlation of number of teen births with oil price, although less strongly correlated than the adult births with oil price, continued to be at a lag of one year.

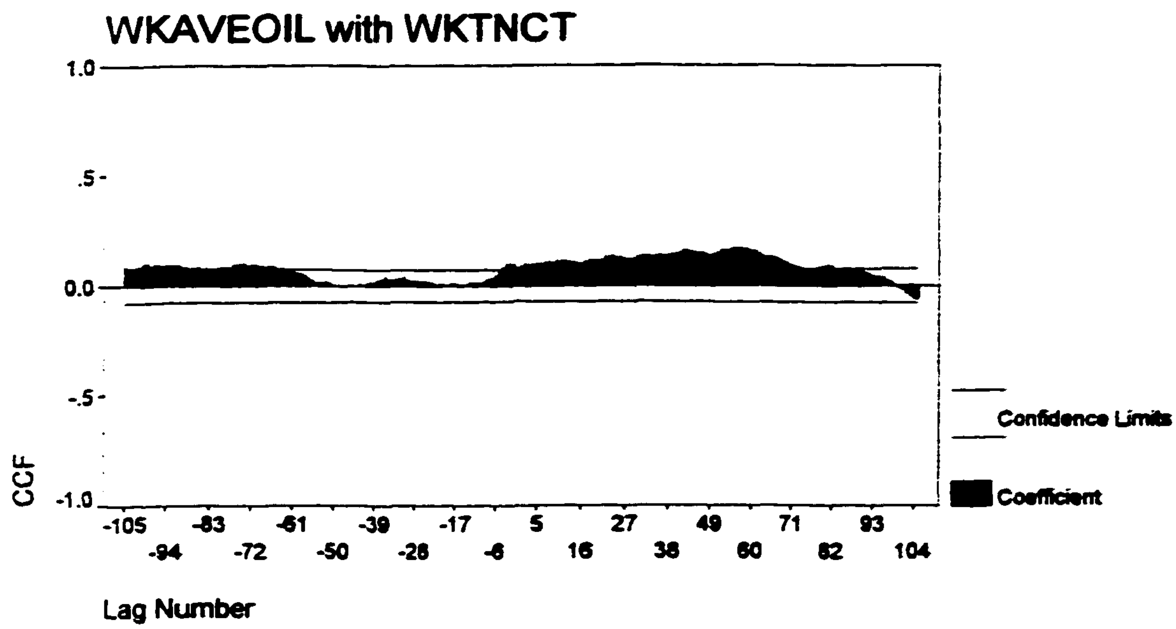

Figure 39. Crosscorrelation of Weekly Average Oil Price and Number of Teen Births

The largest correlation coefficient was .171 and seen at week 56. Significant correlation coefficients ranging from .135 to .171 were seen during weeks 35 through 62 indicating that there is a weaker relationship between economic condition and the number of teen births in Oklahoma than for adult births in the same state. The positive lag indicates that the first series leads the second, meaning that oil price leads births. However, the teen data also display positive correlations at negative lags indicating that teen births also lead oil price, suggesting other factors were impacting both the price of oil and the number of teen births.

Use of Autoregression. As an additional test of the relationship between oil price and teen birth count at a lag of one year, the autoregression procedure was employed using SAS Version 6 (1993). The regression R^2 is computed as 1 – TSSE/TSST where

TSST is the total sum of squares of the transformed series corrected for the transformed intercept and TSSE is the error sum of the squares for this transformed model. The regression R^2 is a measure of the fit of the structural part of the model after transforming for the autocorrelation and is the R^2 for the transformed regression (Akaike & Kitagawa, 1999). The total R^2 is computed as 1 – SSE/SST where SST is the corrected sum of the squares for the original response variable and the SSE is the final obtained error sum of squares. The total R^2 is a measure of how well the next value can be predicted using the structural part of the model and the past values of the residuals. When the transformed series of number of teen births was regressed on the transformed oil price series (lagged for one year), the total $\underline{R}^2 = .31$, $\underline{p} = .018$ confirming there is a significant but weak relationship between oil price and teen births in Oklahoma during the sixteen-year period of time under investigation for this study.

Conclusion. Findings suggest that adult births were more strongly correlated with oil price than teen births, supporting Hypothesis number two which states that fluctuations in economic conditions have a stronger relationship to the pattern of adult births than to the pattern of teen births.

Research Question #2: What other differences can be found in the patterns of teen and adult births?

In order to address Research Question number two, numerous processes were implemented to identify differences in the patterns of teen and adult births. Descriptive statistics, including the age of the mother and father in years, mother's marital status, race of mother and father, and mother's county of residence, were compiled and presented in the description of the sample portion of this document. Each time series was also graphed, providing an opportunity for visual inspection of the time series of teen and adult births as previously presented. The processes of testing for normality and stationarity, detrending, ACF, PACF, and ARIMA modeling were completed for each data set. The differences identified by these univariate analyses were presented in the discussion of Research Question number one.

Multivariate time series analysis using the cross-correlation function (CCF) described in the discussion of Hypothesis number one was also used to address Research Question number two. In this instance, the two variables under examination were the time series of teen births and the time series of adult births. Each time series was originally recorded at daily intervals for the sixteen-year period of time being investigated, then aggregated to weekly data to eliminate the dominance of the seven-day cycle present in the daily data. In an attempt to identify additional differences or similarities between teen and adult birth patterns, several additional crosscorrelations were performed. Urban and rural adult births were crosscorrelated with oil price, as were urban and rural teen births. Married and unmaried adult births were then crosscorrelated with oil price, followed by the same procedure for married and unmarried teen births.

The crosscorrelation function (CCF) was the principal technique used to identify the interrelationships of the two time series. This process allowed examination of potential differences of birth patterns found in the two age groups. By comparing the time series of teen births to the time series of adult births, the contemporaneous, lagged, and leading values of each series determined the strength of the relationship at particular points in time.

Crosscorrelation of Adult Births with Teen Births. The Crosscorrelation function (CCF) is a procedure that can be performed only on series that are stationary. This was accomplished by the prewhitening process described above which removed the cyclical and trend component of the data, reducing the series to white noise. The CCF was performed to examine the correlation between the two series (adult births and teen births) for the purpose of determining if a relationship exists between the two variables and the nature of that relationship. Using SPSS 8.0, the cross-correlation procedure was used to calculate the cross-correlation coefficients for the two series. Figure 40 provides a graphic representation of the relationship of the number of adult births and the number of teen births per week. The plot displays correlations that are both positive and negative at both negative and positive lags. The strongest correlation of number of teen births with adult births is seen at zero lags with a positive correlation of $r = .279$. This fairly strong correlation seems to indicate that neither group is leading the other. The positive and negative correlations at positive and negative lags may indicate that one group is tracking the other due to the influence of a third, or possibly several other variables. It is also possible that the groups are not related and the sporadic significant correlations are random associations.

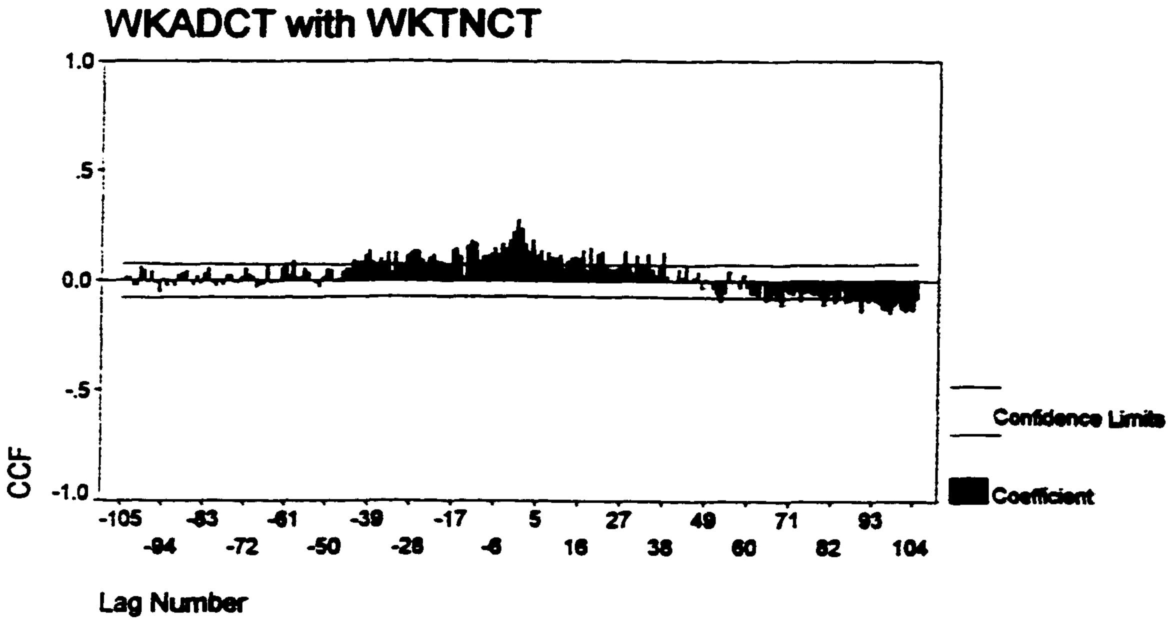

Figure 40. Crosscorrelation of Number of Adult Births and Number of Teen Births

Crosscorrelation of Urban Adults and Rural Adults with Oil Price. The CCF is a procedure that can be performed only on series that are stationary. This was determined through the same procedures described for the entire adult birth series. Completion of the identified transformations removed the cyclical nature of the data, reducing the series to white noise. The CCFs were performed to examine the correlation between the two pairs of series (urban adult births with oil price and rural adult births with oil price) for the purpose of determining if a relationship exists between the two variables and the nature of that relationship. Using SPSS 8.0, the cross-correlation procedure was used to calculate the cross-correlation coefficients for the two series. Figure 41 provides a graphic representation of the relationship of the average weekly oil price and the number of urban adult births per week. Figure 42 provides a graphic representation of the relationship of the average weekly oil price and the number of rural adult births per week. These plots display correlations that are significantly positive, reaching peak correlations at a lag of one year r = .398, p = .05. These crosscorrelations are not significantly different than the crosscorrelation of the entire adult birth series with weekly average oil price seen in Figure 38.

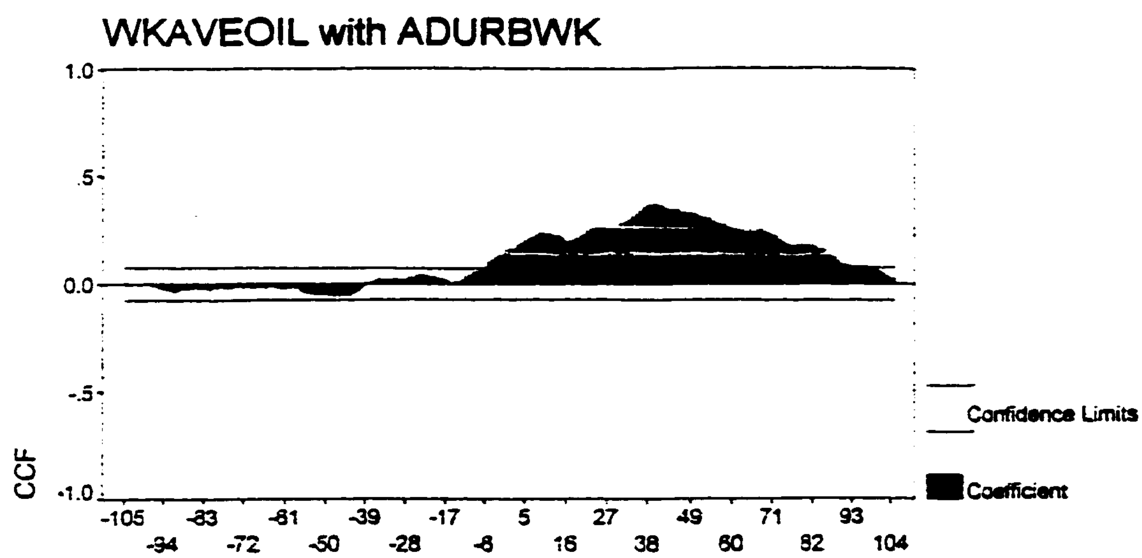

Figure 41. Crosscorrelation of Oil Price and Number of Urban Adult Births

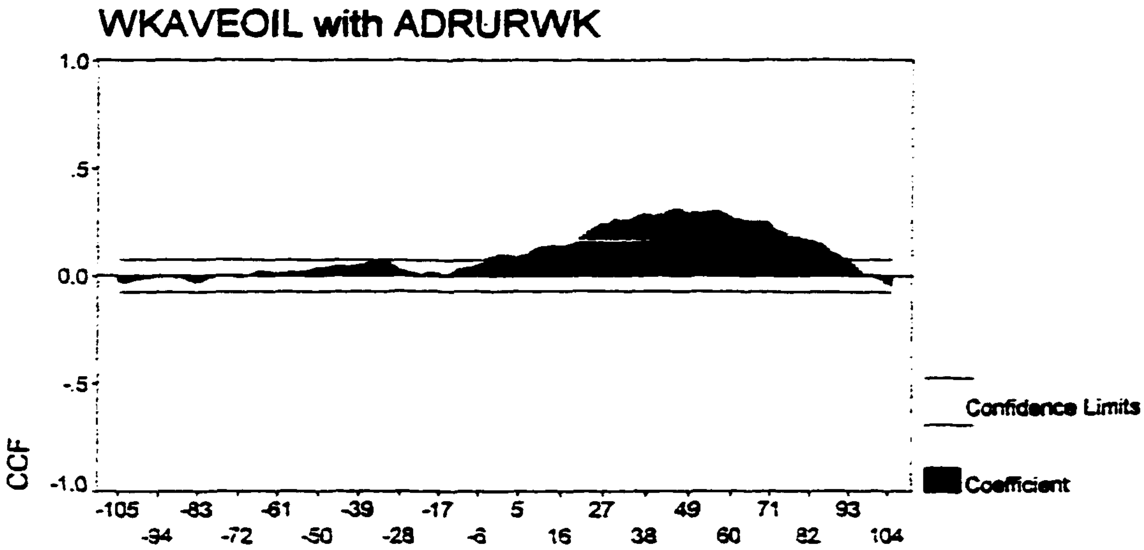

Figure 42. Crosscorrelation of Oil Price and Number of Rural Adult Births

Crosscorrelation of Urban Teens and Rural Teens with Oil Price. The CCF is a procedure that can be performed only on series that are stationary. This was determined through the same procedures described for the entire teen birth series. Completion of the identified transformations removed the cyclical nature of the data, reducing the series to white noise. The CCFs were performed to examine the correlation between the two pairs of series (urban teen births with oil price and rural teen births with oil price) for the purpose of determining if a relationship exists between the two variables and the nature of that relationship. Using SPSS 8.0, the cross-correlation procedure was used to calculate the cross-correlation coefficients for the two series. Figure 43 provides a graphic representation of the relationship of the average weekly oil price and the number of urban teen births per week. Figure 44 provides a graphic representation of the relationship of the average weekly oil price and the number of rural teen births per week. These plots display correlations that are weakly positive, reaching peak correlations at a lag of one year $r = .154$, $p = .05$. These crosscorrelations are not noticeably different than the crosscorrelation of the entire teen birth series with weekly average oil price seen in Figure 39.

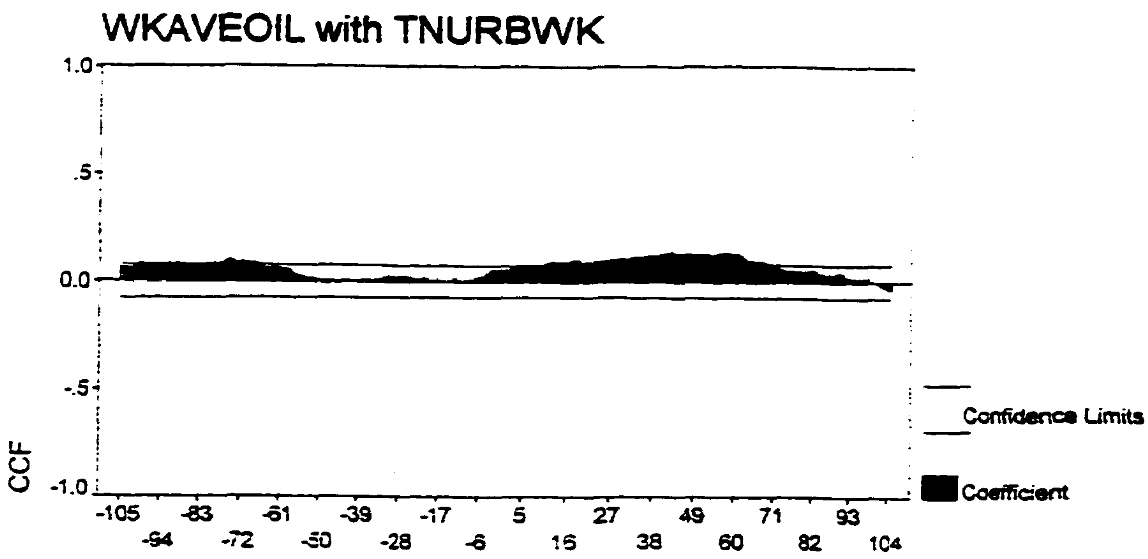

Figure 43. Crosscorrelation of Oil Price and Number of Urban Teen Births

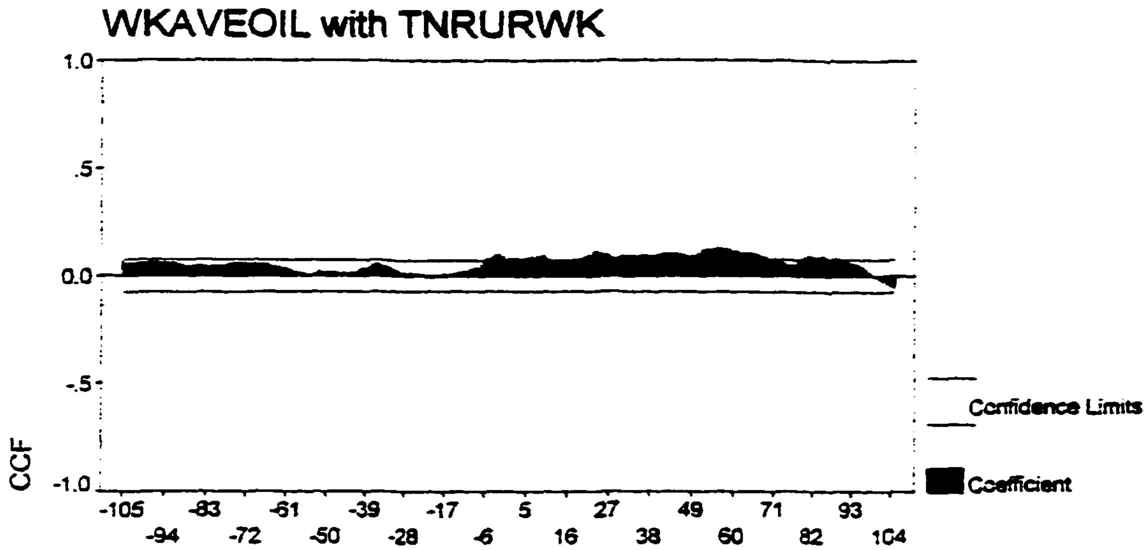

Figure 44. Crosscorrelation of Oil Price and Number of Rural Teen Births

Crosscorrelation of Married Adults and Unmarried Adults with Oil Price. The CCF is a procedure that can be performed only on series that are stationary. This was determined through the same procedures described for the entire adult birth series. Completion of the identified transformations removed the cyclical nature of the data, reducing the series to white noise. The CCFs were performed to examine the correlation between the two pairs of series (married adult births with oil price and unmarried adult births with oil price) for the purpose of determining if a relationship exists between the two variables and the nature of that relationship. Using SPSS 8.0, the cross-correlation procedure was used to calculate the cross-correlation coefficients for the two series. Figure 45 provides a graphic representation of the relationship of the average weekly oil price and the number of married adult births per week. Figure 46 provides a graphic representation of the relationship of the average weekly oil price and the number of unmarried adult births per week. The plot of the married adults displays correlations that are significantly positive $r = .384$, $p = .05$, reaching peak correlations at a lag of one year very similar to the crosscorrelation of the entire adult birth series with weekly average oil price seen in Figure 38. The plot of the unmarried adults however, displays correlations at a lag of one year that are only weakly positive, $r = .161$, $p = .05$, indicating marriage strengthens the relationship between birth choices and economics.

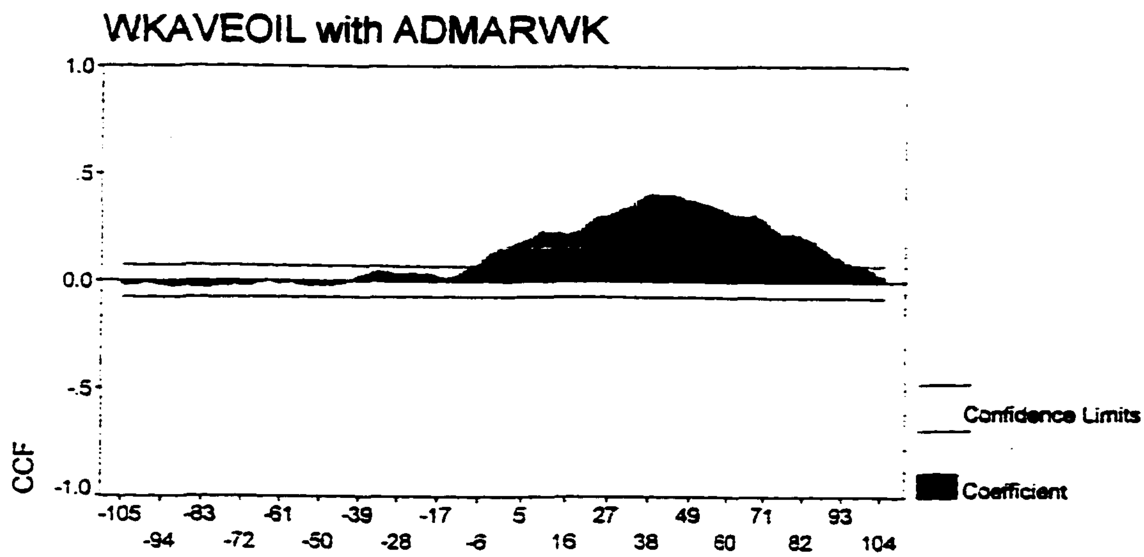

Figure 45. Crosscorrelation of Oil Price and Number of Married Adult Births

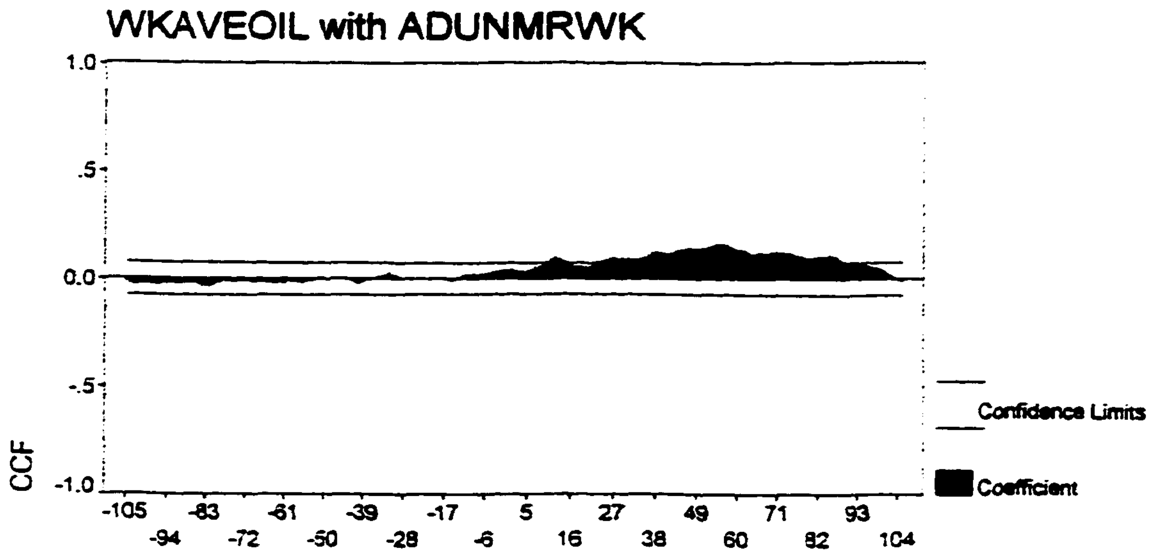

Figure 46. Crosscorrelation of Oil Price and Number of Unmarried Adult Births

Crosscorrelation of Married Teens and Unmarried Teens with Oil Price. The CCF is a procedure that can be performed only on series that are stationary. This was determined through the same procedures described for the entire teen birth series. Completion of the identified transformations removed the cyclical nature of the data, reducing the series to white noise. The CCFs were performed to examine the correlation between the two pairs of series (married teen births with oil price and unmarried teen births with oil price) for the purpose of determining if a relationship exists between the two variables and the nature of that relationship. Using SPSS 8.0, the crosscorrelation procedure was used to calculate the cross-correlation coefficients for the two series. Figure 47 provides a graphic representation of the relationship of the average weekly oil price and the number of married teen births per week. Figure 48 provides a graphic representation of the relationship of the average weekly oil price and the number of unmarried teen births per week. The plot of the married teens displays correlations that are weakly positive, reaching peak correlations at a lag of one year, r = .168, p = .05, very similar to the crosscorrelation of the entire teen birth series with weekly average oil price seen in Figure 39. The plot of the unmarried teens however, displays essentially no correlation with oil price.

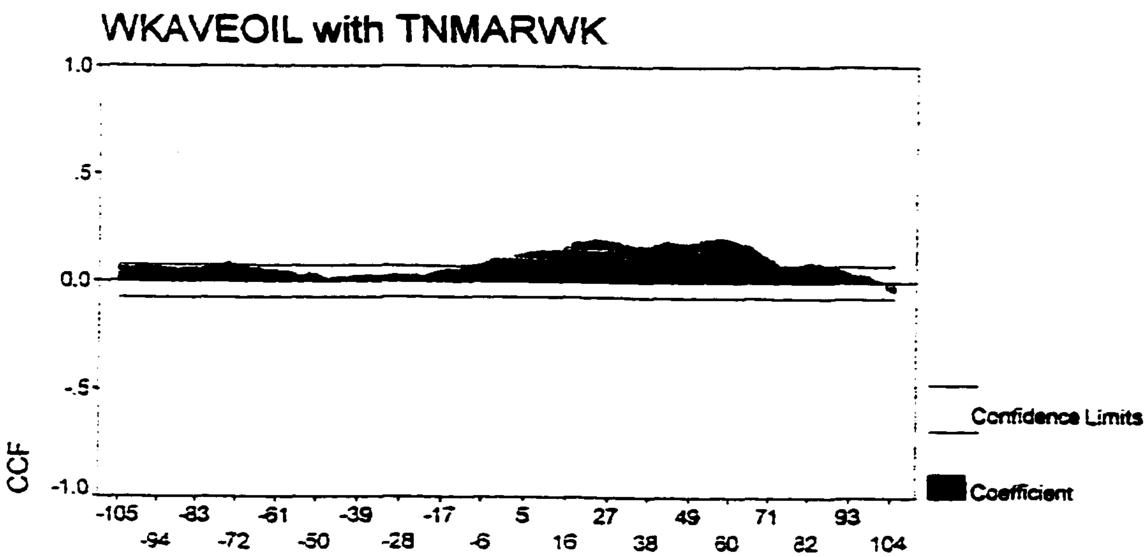

Figure 47. Crosscorrelation of Oil Price and Number of Married Teen Births

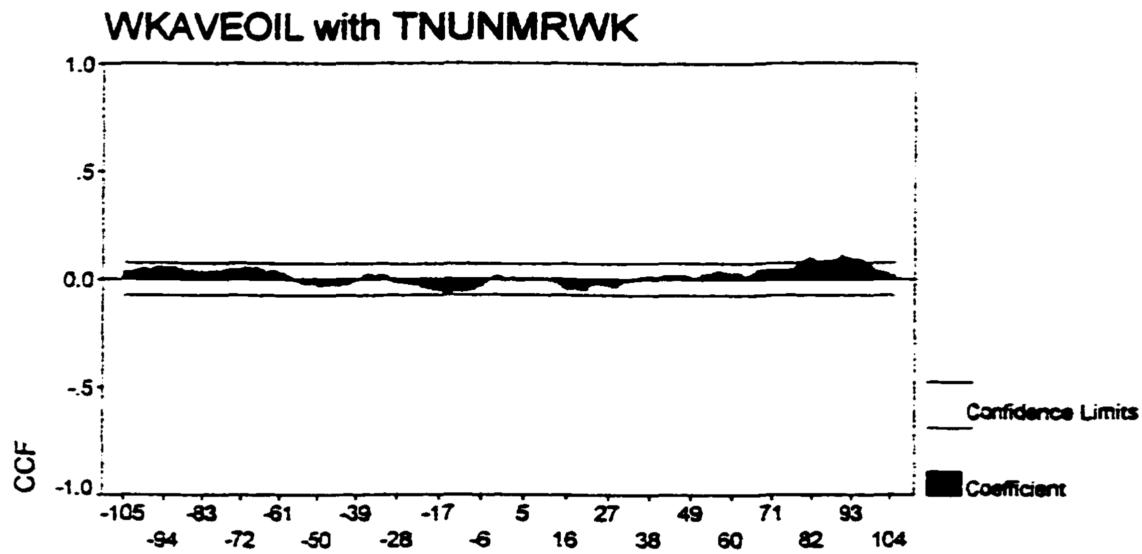

Figure 48. Crosscorrelation of Oil Price and Number of Unmarried Teen Births

Crosscorrelation of Young Teens and Older Teens with Oil Price. The CCF is a procedure that can be performed only on series that are stationary. This was determined through the same procedures described for the entire teen birth series. Completion of the identified transformations removed the cyclical nature of the data, reducing the series to white noise. The CCFs were performed to examine the correlation between the two pairs of series (young teen births with oil price and older teen births with oil price) for the purpose of determining if a relationship exists between the two variables and the nature of that relationship. Young teens were teens 15 years old and younger while the older teens comprised a group of teens 16 years and older. Using SPSS 8.0, the crosscorrelation procedure was used to calculate the crosscorrelation coefficients for the two series. Figure 49 provides a graphic representation of the relationship of the average weekly oil price and the number of young teen births per week. Figure 50 provides a graphic representation of the relationship of the average weekly oil price and the number of older teen births per week. The plot of the older teens displays correlations that are weakly positive, $r = .162$, $p = .05$, reaching peak correlations at a lag of one year very similar to the crosscorrelation of the entire teen birth series with weekly average oil price seen in Figure 39. The plot of the young teens however, displays a weak correlation with oil price at a lag of 70 to 80 weeks $r = .111$, $p = .05$. This interesting finding suggests that young teens either are impacted by the economy in a delayed fashion (ie. the impact of the economy on their parents eventually affects the young teen) or there is no relationship and another process is creating this correlation.

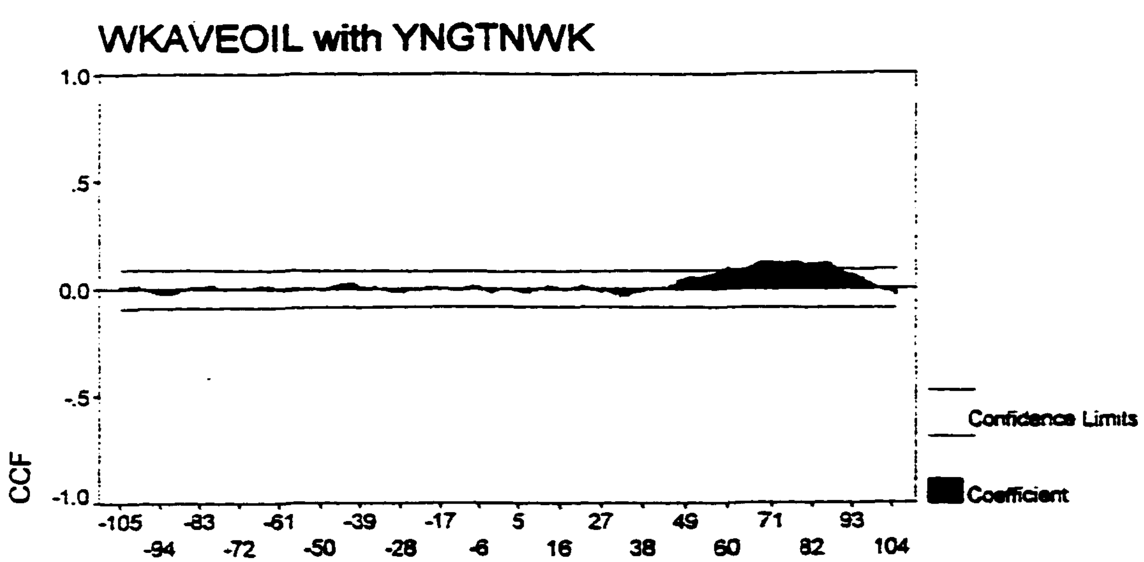

Figure 49. Crosscorrelation of Oil Price and Number of Young Teen Births

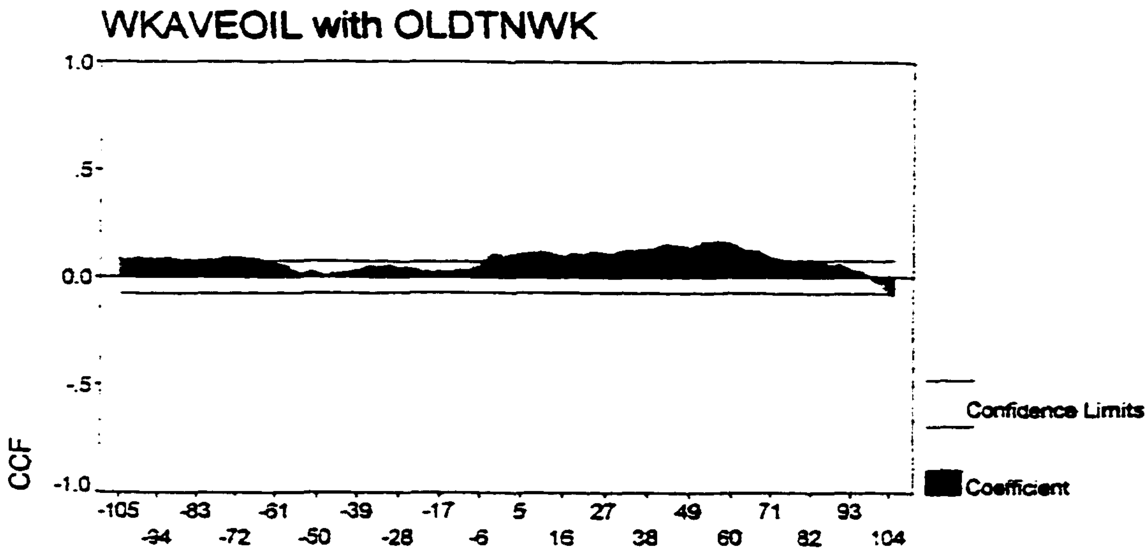

Figure 50. Crosscorrelation of Oil Price and Number of Older Teen Births

Conclusions. A number of differences between teen and adult births were identified by the descriptive analysis and CCF of these two data sets. In regard to marital status, 83.9% of adult mothers identified themselves as married whereas only 51.9% of teen mothers placed themselves in this same category. A greater percentage of teen mothers were non-white (28%) when compared to adult mothers (18%). More teen mothers (44.2%) were from rural areas than were adult mothers (36.8%). It was difficult to compare data regarding the fathers involved in the births during this sixteen-year period due to the large amount of missing information on birth certificates recording teen births. The CCF of teen births with adult births indicated the teen births led adult births and there seemed to be an inverse relationship of the number of teen births when compared to the number of adult births. The CCF of rural and urban teens and adults with oil price indicated that rurality had little impact on the relationship of births with the economy in either group. The CCF of married and unmarried teens and adults with oil price suggested that marriage is a factor in strengthening the relationship between births and the economy in both groups, although the strength of the association is greater in adults than in teens. The CCF of young teens and older teens with oil price indicated that increasing age also strengthens the correlation of births and the economy.

Hypothesis #3: There are differences in seasonal patterns between teen births and adult births in Oklahoma.

Teen and adult birth series were compared in regard to seasonal variation using chi-square analysis. First, chi-square goodness of fit was used with each age group, teen births and adult births, to determine if there was a significant seasonal difference or pattern within each group. Secondly, chi-square test of independence was used to determine if there was a significant difference between the teen birth group and the adult birth group in regard to seasonality. In each test, the actual frequency of the number of births occurring in each season was compared with the expected number of births for that season. The null hypothesis that the number of births was NOT related to season of the year was tested using chi-square analysis. The following assumptions of chi-square were met before the analysis commenced: (a) all cells had an expected frequency greater than five, (b) subjects represented the entire population for the years being studied and were independent of each other, (c) categories were mutually exclusive and exhaustive, and (d) the data was in the form of frequencies (actual number of births). To indicate season, the months of January, February, and March indicated winter; the months of April, May, and

June indicated spring; the months of July, August, and September indicated summer; and the months of October, November, and December indicated fall.

Examination of teen births as a single sample revealed there were 136,788 teen births during the sixteen-year period of time under investigation. If all teen births were distributed equally over the four seasons, it could be expected that 34,197 births would occur during each season. Actual frequencies were: winter 33,691; spring 32,651; summer 36,965; and fall 33,481. Use of the formula $\chi^2 = \Sigma (o - e)^2 / e$ yielded χ^2 (3, N = 136,788) = 316.42, p = .001. Because the calculated value is greater than the critical value (16.266), the null hypothesis is rejected indicating there is a significant seasonal difference in teen births. Post hoc testing shows a significantly higher rate of teen births during the summer months of July, August, and September than any of the other seasons.

Adult births were analyzed using the same techniques described above in the discussion of teen births. There were 663,418 adult births during the years of 1980-1995. Divided equally into four seasons, the expected number of adult births per season would be 165,854.5. Actual frequencies were: winter 160,075; spring 160,898; summer 177,298; and fall 165,156. Use of the formula $\chi^2 = \Sigma (o - e)^2 / e$ yielded χ^2 (3, N = 663,418) = 1140.79, p = .001. Because the calculated value is greater than the critical value (16.266), the null hypothesis is rejected indicating there is a significant seasonal difference in adult births. Post hoc testing shows a significantly higher rate of adult births during the summer months of July, August, and September than any of the other seasons.

To determine if there was a difference in the seasonality of teen births and the seasonality of adult births, the chi-square test of independence was used. Accessing the crosstabs function in SPSS 8.0, the significance of the relationship between the number of births for each age group in regard to the four season categories was crosstabulated in a contingency table. The following results were produced:

Table 7

Chi-Square Test of Independence for Age Group by Season

	Winter	Spring	Summer	Fall
Teen Births	33,691 (o) 33,123 (e)	32,651 (o) 33,085 (e)	36,965 (o) 36,625 (e)	33,481 (o) 33,955 (e)
Adult Births	160,075 (o) 160,643 (e)	160,898 (o) 160,464 (e)	177,289 (o) 177,629 (e)	165,156 (o) 164,682 (e)

	Value	DF	Significance
Pearson Chi-Square	30.44838	3	.00000
Likelihood Ratio	30.43991	3	.00000

The Chi-Square Test of Independence indicated there is NO difference in seasonal patterns between teen births and adult births in Oklahoma during the study period.

Summary of Findings

Findings of the study are summarized as follows:

Research Question #1: Which model best fits the Oklahoma birth data?

1. The daily birth data and the daily oil price data exhibited a 'weekend effect' which produced a seven-day dominant cycle. To address this problem, all data sets were aggregated to weekly data.

2. All four data sets (teen births, adult births, all births, and oil price) were not normally distributed nor were they stationary. To meet the assumptions of normality and stationarity, the data were transformed using a natural log transformation and differencing.

3. Univariate time series analysis revealed that the (0, 1, 1) model with a seasonal (0, 1, 1) component was the model that most accurately represented the birth data and the oil price data in this study.

Hypothesis #1: A procyclic model of economics and fertility better fits the Oklahoma birth data (all births) than a countercyclic model.

4. Crosscorrelation (CCF) of oil price and all births produced positive correlation coefficients greater than .35 for weeks 38 through 55, indicating that there is a procyclic relationship between economic condition and the number of births in Oklahoma. The positive lag indicated that the first series led the second, suggesting that oil price led births.

5. When the transformed series of total number of births was regressed on the transformed oil price series (lagged for one year), the total $\underline{R}^2 = .62$, $\underline{p} = .0001$ confirmed

there is a significant relationship between oil price and all births in Oklahoma during the sixteen-year period of time under investigation for this study.

Hypothesis #2: Fluctuations in economic conditions have a stronger relationship to the pattern of adult births than to the pattern of teen births.

6. CCF of weekly average oil price and number of adult births revealed positive correlation coefficients greater than .35 for weeks 34 through 56, indicating that there is a significant procyclic relationship between economic condition and the number of adult births in Oklahoma. The positive lag indicated that the first series led the second, suggesting that oil price led adult births.

7. When the transformed series of total number of adult births was regressed on the transformed oil price series (lagged for one year), the total $\underline{R}^2 = .72$, $\underline{p} = .0001$ confirmed there is a significant relationship between oil price and adult births in Oklahoma during the sixteen-year period of time under investigation for this study.

8. The CCF plot of weekly average oil price and number of teen births displays correlations that are positive at both negative and positive lags but were less strongly correlated than the adult data. The peak correlation of number of teen births with oil price was also seen at a lag of one year. The strongest correlation coefficient was .171, seen at week 56. The teen data also displays positive correlations at negative lags indicating that teen births also lead oil price, suggesting other factors were impacting both the price of oil and the number of teen births.

9. When the transformed series of number of teen births was regressed on the transformed oil price series (lagged for one year), the total $\underline{R}^2 = .31$, $\underline{p} = .018$ confirming

there is a significant but weaker relationship between oil price and teen births in Oklahoma during the sixteen-year period of time under investigation for this study.

Research Question #2: What other differences can be found in the patterns of teen and adult births?

10. Descriptive data yielded demographic differences in the teen and adult birth groups in regard to age of the mother and father, mother's marital status, race of mother and father, and rurality.

11. Greater than one third (36%) of certificates of live birth recording births to teens have no information about the father. This is compared to 11% of certificates recording births to adults that have no information about the father.

12. The CCF of number of adult births and number of teen births displayed correlations that were both positive and negative at both negative and positive lags. The strongest correlation of number of teen births with adult births was seen at zero lags, $\underline{r}$ = .279, indicating that neither group is leading the other. The positive and negative correlations at positive and negative lags may indicate that one group is tracking the other due to the influence of a third, or possibly several other variables. It is also possible that the groups are not related and the sporadic significant correlations are random associations.

13. The CCF of rural and urban teens and adults with oil price indicated that rurality had little impact on the relationship of births with the economy in either group.

14. The CCF of married and unmarried teens and adults with oil price suggested that marriage is a factor in strengthening the relationship between births and the economy in both groups, although the strength of the association is greater in adults than in teens.

15. The CCF of young teens and older teens with oil price indicated that increasing age also strengthens the correlation of births and the economy.

Hypothesis #3: There are differences in seasonal patterns between teen births and adult births in Oklahoma.

16. Chi Square analysis revealed a significant seasonal difference within the teen birth data. Post hoc testing shows a significantly higher rate of teen births during the summer months of July, August, and September than any of the other seasons, with August being the month with the highest number of teen births.

17. Chi Square analysis revealed a significant seasonal difference within the adult birth data. Post hoc testing shows a significantly higher rate of adult births during the summer months of July, August, and September than any of the other seasons, with September being the month with the highest number of adult births.

18. Chi-Square Test of Independence for Age Group by Season for adult and teen birth data indicated there is NO difference in seasonal patterns between teen births and adult births in Oklahoma.

CHAPTER V

SUMMARY OF THE STUDY

This chapter presents a summary of the study conducted to determine the influence of the economy on teen and adult birth patterns in Oklahoma for a sixteen-year period of time beginning in 1980 and continuing through 1995. Time series analysis was used to examine the relationship between the daily birth rate for teens and adults and the daily price of oil which was used as an economic indicator for the state of Oklahoma. The findings of the present study are discussed and conclusions based upon analysis of the data are presented. In addition, the implications for nursing practice, women's health care, and society are discussed. The chapter concludes with recommendations for future studies.

Summary

There were three distinct problems addressed in this study. First, the issue of competing economic models was addressed. Currently there are several conflicting models that have attempted to describe fertility as it relates to an economic indicator. Some of these models describe this relationship as procyclic, while others find economy and fertility to be related countercyclically.

Secondly, the traditional use of birth trend data compiled on a monthly or yearly basis and studied over time had the inherent problem of a loss of information by smoothing out the data. Patterns such as weekly cycles or seasonality were lost by using the yearly number of births to examine birth trends. This study examined the number of daily births to allow greater sensitivity in testing the relationship of an economic variable with the number and timing of births, as well as identification of subtle differences in teen and adult birth patterns.

The third problem stemmed from the lack of literature available to describe the differences between teen and adult birth patterns. Teens and adults may not respond to the economy in the same way. By conducting separate data analyses for teens and adults, differences in the two age groups were identified.

The stated problems raised the following questions from which the research questions and hypotheses were constructed: (a) which ARIMA model best fits the Oklahoma birth data, (b) what is the relationship between Oklahoma birth trend and the economy, and (c) what differences can be found in the patterns of teen and adult births?

The purpose of this study was to conduct separate rigorous tests using daily birth data for teens and adults to identify the best fitting model of Oklahoma births. The dynamics of the time series of births to teen and adult women in Oklahoma from 1980 through 1995 were examined and compared. The impact of the economy on birth trend in Oklahoma was also evaluated.

The rationale for undertaking this study was to examine birth records for dynamic patterns that occur over time in order to facilitate identification of community needs and characteristics. Defining a model that is a good predictor of the timing and patterns of births is useful to nursing and other health professions in the development of public health policy, planning programs intended to serve women and newborns, and designing women's health care facilities.

The Pennsylvania Model of contemporary economic theory of fertility, a procyclic model, served as the theoretical framework for this study because it best reflects the sociological and demographic nature of the Western family and fertility during the 1980s. The economic principles of supply and demand are applied to the desired number and cost of raising children in today's society. The Pennsylvania Model builds on the sociological premise that economic socialization experience early in life plays an important role in fertility decisions.

This study supports the Pennsylvania Model, a procyclic economic theory of fertility. The first factor considered to be a fertility determinant in the Pennsylvania Model is the potential supply of children defined by Behrman and Wolfe (1984) as the number of surviving children parents would have if they did not deliberately limit fertility. During times of economic well-being, there are several factors which improve fertility. Nutritional status, access to health care, and general health of women is better during periods of economic growth supporting the opportunity for conception. It has been noted that the average age of menarche today is lower than it was twenty years ago, especially for women of color. The high percentage of Native Americans and other persons of color residing in Oklahoma may contribute to a higher fertility rate through increased number of years of fertility. While women may be delaying pregnancy to pursue educational and career goals, women are also continuing to bear children well into their 50s, also a phenomenon partially supported by economic well-being and resultant health outcomes. Because technologicical advances in fertility such as in vitro fertilization and other artificial reproductive techniques, treatments for infertility, surrogate parenting, and cloning are very expensive they contribute to increased fertility when there are periods of economic well-being.

The other fertility determinant presented by the Pennsylvania Model is the cost of fertility regulation in terms of the subjective or psychic drawbacks and the objective cost in terms of time and money required to learn about and use contraceptive techniques (Easterlin, 1989). Fertility behaviors are influenced by culture and societal expectations. The social climate in Oklahoma supports large families eliminating some of the subjective drawbacks identified in other populations such postponing childbearing in lieu of extending educational or career opportunities.

The results of this study do not support the countercyclic views of fertility and economics. Milio (1976) maintains that during periods of poor economic condition, access to health care services such as birth control methods and abortion decrease and birth rates increase. In Oklahoma there are a number of Federal programs such as Indian Health Service and Title XIX that provide contraceptive and sterilization services free of charge. Therefore, during times of economic hardship, access to health care and these services is available. The strong Southern Baptist and non-denominational Christian influence in the state of Oklahoma discourages abortion as a method of fertility control.

The Theory of the Value of Children – Uncertainty Reduction (Friedman, Hechter, & Kanazawa, 1994) predicts economics and fertility to be countercyclic. This prediction was not supported by this study. However, this theory identifies rational choice by a single individual to choose pregnancy as a means to reduce uncertainty in the life of that individual. The uncertainty individual's experience in life may stem from sources other than economic conditions. Therefore, while this theory offers an interesting and valid explanation for fertility behavior at the individual level, it does not entirely explain decision-making processes of communities or large populations regarding childbearing.

The study was designed to address the following research questions and hypotheses:

Research Question #1: Which model best fits the Oklahoma birth data?

Hypothesis #1: A procyclic model of economics and fertility better fits the Oklahoma birth data (all births) than a countercyclic model.

Hypothesis #2: Fluctuations in economic conditions have a stronger relationship to the pattern of adult births than to the pattern of teen births.

Research Question #2: What other differences can be found in the patterns of teen and adult births?

Hypothesis #3: There are differences in seasonal patterns between teen births and adult births in Oklahoma.

The literature review identified that economic conditions have historically had an impact on fertility rates. The research that has been done in this area is conflicting, some resulting in evidence of a procyclic relationship between fertility and economic cycles and others indicating the relationship is countercyclic. The trend may change over time or at different time intervals. The likelihood of multiple confounding or extraneous variables exists, influencing the results of the cyclic nature of the relationship between economics and fertility. Studies have also shown that seasonality plays a role in determining birth patterns.

The setting for this study was the state of Oklahoma, a leader in the oil industry, located in the south-central United States. The sample for this study consisted of the 800,206 live births that occurred in Oklahoma from January 1, 1980 through December 31, 1995. The birth count for all births, teen births, and adult births for each of the 5,844 days during the specified sixteen-year time period created the time-series plots analyzed in this study. The data for this study were derived from birth records obtained from the Maternal Child Health Division of the Oklahoma State Department of Health. Standardized forms provided by the Oklahoma State Department of Health were used to record information about each birth that occurred in the state of Oklahoma. Daily oil price was the economic indicator used in this study and was obtained from the crude oil price bulletin supplied by the Phillips Petroleum Company.

The linear data analysis techniques used to address the research questions and the hypotheses in the study included descriptive and exploratory statistics, time series analysis that included autocorrelation function, partial autocorrelation function, and crosscorrelation function, ARIMA modeling, and chi-square analysis. Several tables, figures, and graphs were used to illustrate the findings.

Discussion of Findings

In this section, the findings for each research question and hypothesis are discussed.

Research Question #1: Which model best fits the Oklahoma birth data?

Univariate time series analysis has been used to model data in the disciplines of economics, mathematics, physical, and social sciences. To account for patterns in data, the history of a single variable is examined in an effort to uncover the internal processes responsible for its behavior (Cromwell, Labys, & Terraza, 1994). Using this technique to examine Oklahoma birth patterns, the similarities and differences in teen births, adult births, and all births were identified.

The three birth data sets (teens, adults, and all) were derived from the same general population of childbearing women in the state of Oklahoma who shared similar environmental and sociopolitical conditions such as climate, altitude, economy, governmental policies, availability of services, and to some degree, beliefs and values. Therefore a cyclic nature of the data was common to all three groups.

Fewer numbers of births occurred on weekend days (Saturday and Sunday) most likely due to the decreased number of scheduled medical interventions such as routine inductions and Cesarean sections on those days. This created a strong seven-day cycle that dominated the entire series of all three data sets. To eliminate this influence, all three files were aggregated to weekly data points in which a weekly sum of births was used.

Another similarity found in the three birth data sets was the seasonal pattern associated with climate and leisure activities (discussed further under Hypothesis number three). To address the problem of seasonal cycles, the data for each set was assigned a periodicity of 52, a seasonal difference of one, and a moving average of one. Because the seasonal nontrend variation was so pronounced in each of the data sets, this manipulation provided a suitable remedy for the problem but did not remove the influence of the annual cycle entirely. Another spike, seen at the 24^{th} lag in the residuals of the transformed teen, adult, and combined birth data correlates with the second highest seasonal birth time. The slightly higher number of births that occur in the early spring coincides with the leisure time of summer vacations and is secondary to the high number of births during the summer attributed to the 'Christmas effect' and its associated leisure time. This correlation appears to be stronger in the adult data than in the teen data, but may be incidental due to the large difference in the numbers of teen and adult births that occur on any given day.

The third similarity of the teen, adult, and combined birth data illuminated by the univariate time series analysis was the lack of normality of the data distribution. While each file appeared to approximate a normal curve, the teen data had a slight positive skew and the adult data had a slight negative skew. To meet the assumption that the data is normally distributed, a natural log transformation was done to normalize each data set.

Finally, all three files displayed a lack of stationarity. Application of an ARIMA (0, 1, 1) model with the seasonal (0, 1, 1) component described above reduced the residuals to white noise and was deemed a suitable model for teen, adult, and all births which occurred in Oklahoma during the study period.

<u>Hypothesis #1: A procyclic model of economics and fertility better fits the Oklahoma birth data (all births) than a countercyclic model.</u>

Competing theories and conceptual frameworks currently exist to describe the cyclic patterns found in fertility behavior. The majority of economic theories describe fertility as being procyclic when compared to business or economic patterns or cycles (ie., as the economy improves, fertility increases). Other theorists, however, describe fertility behavior as being countercyclic (ie., as the economy improves, fertility decreases). The crosscorrelation and autoreggressive techniques employed in this study to test Hypothesis number one support the procyclic model of economics and fertility.

Crosscorrelation (CCF) of oil price and all births produced positive correlation coefficients greater than .35 for weeks 38 through 55, indicating that there is a procyclic relationship between economic condition and the number of births in Oklahoma. The positive lag indicated that the first series led the second, suggesting that oil price led births. The period of gestation required to produce a full term human infant is 37 to 42 weeks. Allowing for variance in each woman's fertility cycle to achieve a pregnancy, the number of births appears to increase or decrease in relation to the economic cycles as determined by oil price. When the transformed series of total number of births was regressed on the transformed oil price series (lagged for one year), the total $\underline{R}^2 = .62$, $\underline{p} = .0001$ confirming there is a significant relationship between oil price and all births in Oklahoma during the sixteen-year period of time under investigation for this study.

<u>Hypothesis #2: Fluctuations in economic conditions have a stronger relationship to the pattern of adult births than to the pattern of teen births.</u>

Multivariate time series analysis using the CCF and autoregression described in the discussion of Hypothesis number one was also used to address Hypothesis number two. The testing of Hypothesis number one established there was a relationship between the price of oil and all births in Oklahoma for the years of 1985 through 1990. For this hypothesis, the variables under examination were the time series of teen births as compared to the time series of oil prices and the time series of adult births as compared to the oil price time series. After each test was run, the values of the correlation coefficients were examined to determine the strength of the relationships between teen births with oil price and adult births with oil price.

CCF of weekly average oil price and number of adult births revealed positive correlation coefficients greater than .35 for weeks 34 through 56, indicating that there is a significant procyclic relationship between economic condition and the number of adult births in Oklahoma. The positive lag indicated that the first series led the second, thus, oil price led adult births. When the transformed series of total number of adult births was regressed on the transformed oil price series (lagged for one year), the total $\underline{R}^2 = .72$, $\underline{p} = .0001$ confirming there is a significant relationship between oil price and adult births in Oklahoma during the sixteen-year period of time under investigation for this study.

The CCF plot of weekly average oil price and number of teen births displayed correlations that are positive at both negative and positive lags with a significance less than the significance seen in the adult data. The peak correlation of number of teen births with oil price was also seen at a lag of one year. The strongest correlation coefficient was .171, seen at week 56. The teen data also displayed positive correlations at negative lags indicating that teen births led oil price, suggesting other factors were impacting both the price of oil and the number of teen births. When the transformed series of number of teen births was regressed on the transformed oil price series (lagged for one year), the total $R^2 = .31$, $p = .018$ confirming there is a significant but weaker relationship between oil price and teen births in Oklahoma during the sixteen-year period of time under investigation for this study. With only 31% of the variance accounted for, the data suggest that factors other than the economy play a larger role in determining teen birth patterns.

These tests demonstrate that economic conditions have a greater impact on adult births than on teen births. The stronger correlations of the CCF and the total $R^2 = 0.72$, $p = .0001$ for adult births compared with the weakly significant correlations of the CCF and the total $R^2 = .31$, $p = .018$ for teen births indicate economic conditions have a stronger relationship to the pattern of adult births than to the pattern of teen births.

Research Question #2: What other differences can be found in the patterns of teen and adult births?

A number of differences between teen and adult births were identified by the descriptive analysis and CCF of these two data sets. In regard to marital status, 83.9% of adult mothers identified themselves as married whereas only 51.9% of teen mothers placed themselves in this same category. This information was extracted from birth certificate information that was obtained by self-report and may have varying degrees of accuracy.

A greater percentage of teen mothers were non-white (28%) when compared to adult mothers (18%). The increase appears to be among Black and Indian teens which is consistent with national trends and cultural acceptance of teen parenting in these groups. Because race only (not ethnicity) was recorded in the state of Oklahoma until late 1990, this study cannot address Hispanic births.

More teen mothers (44.2%) were from rural areas than were adult mothers (36.8%). It was difficult to compare data regarding the fathers involved in the births during this sixteen-year period due to the large amount of missing information on birth certificates recording teen births.

Crosscorrelation of the number of adult births and the number of teen births displayed correlations that were both positive and negative at both negative and positive lags. The strongest correlation of number of teen births with adult births was seen at zero lags $\underline{r} = .279$ indicating that neither group is leading the other. The positive and negative correlations at positive and negative lags may indicate that one group is tracking the other due to the influence of a third, or possibly several other variables. It is also possible that the groups are not related and the sporadic significant correlations are random associations.

The positive correlations at negative lags give the appearance that teen births led adult births. Teens have a higher rate of preterm labor and delivery which could account for an earlier increase in number of births in that age group. It has already been established that the economy may explain a large portion of the variance of adult births, but only about one third of the variance of teen births suggesting that other factors play a role in determining the patterns of teen births. Because the economy is the only variable tested in this study, it cannot account for the affect of other variables on teen birth patterns. Possible contributing factors could be educational level, availability of resources including information, personal and peer values, and age (younger teens may have different birth patterns than older teens).

Crosscorrelation function was also used to examine the relationship between rural and urban teens and adults with oil price. Findings indicated that rurality had little impact on the relationship of births with the economy in any of the groups. This finding may be explained by the use of oil price as the economic indicator for this study. Oil price was selected as the economic indicator because of the great influence it has on the people of Oklahoma. Its impact is felt in rural communities where the drilling takes place, as well as in urban centers where the corporate offices and refineries are located. The use of a different economic indicator may yield different results.

The CCF of married and unmarried teens and adults with oil price suggested that marriage is a factor in strengthening the relationship between births and the economy in both groups, although the strength of the association is greater in adults than in teens. The strongest association was births to married adults and oil price. A weaker but positive association was seen with both the unmarried adult births and oil price as well as married teen births and oil price. These similar resulting CCFs support the research of Hoffman and Foster (1997) who found that the socioeconomic status of women who have had nonmarital birth as an adult is similar to that of women who had a birth as an older adolescent. The CCF of young teens and older teens with oil price indicated that increasing age also strengthens the correlation of births and the economy. Older teenagers are more likely to use economic reasoning in fertility decisions.

Hypothesis #3: There are differences in seasonal patterns between teen births and adult births in Oklahoma.

While both single samples (teen births and adult births) showed a significantly higher number of births during the months of July, August, and September (summer), there was no difference in seasonal patterns between teen births and adult births in Oklahoma. Even when the average number of births per month were corrected for the number of days in the month, summer was the season during which the largest number of births occurred in both the teen and adult groups. The only difference noted, following correction for the number of days in the month, was that August had the highest average daily rate of births for teens, while the month with the highest average daily rate of births for adults was September. This difference was small and not significant.

χ

Table 8

Average Daily Rate of Summer Births

	July	August	September
Teen Births	396	410*	398
Adult Births	1907	1925	1949*

The SPSS 8.0 crosstabulation function of the chi-square test of independence was used to determine if the number of teen births was independent of the number of adult births in regard to seasonality. The Pearson chi-square is the statistic used to determine if the row and column variables are independent. As reported in Chapter IV, χ^2 (3, N = 800, 206) = 30.45, p = .00001. Therefore, the hypothesis that teen birth patterns and adult birth patterns are independent is rejected.

Use of the SPSS 8.0 crosstabulation also yields a likelihood ratio chi-square. Based on maximum-likelihood theory, the test yielded the same result as the Pearson chi-square due to the large sample size. Although this indicates the two samples are related, the chi-square is a test of independence and provides little information regarding the strength of the association between two variables (Polit, 1996).

Conclusions and Implications

This section addresses the conclusions of the study based upon the findings and relates them to the underlying theoretical framework and previous studies. The implications for nursing practice are also discussed.

Model of Birth Patterns in Oklahoma

Nationally, the birth rate displayed an upward trend from the mid 1970s until 1990 when the total number of births began a slow decline (United States Department of Health and Human Services, 1993). This study revealed that the pattern of births in Oklahoma is quite different than the national birth trend during the sixteen-year period of time examined, 1980 through 1995. Reaching the peak number of births in 1982, the Oklahoma birth trend began a steady decline eight years earlier than what is shown with national statistics. In the current study, actual numbers of births were used, not a rate based on the population. According to census figures, the change in population in Oklahoma was minimal during the time of the study. Less than a four percent increase in state population from the 1980 census figures to the 1990 census figures (United States Bureau of the Census, 1993). If rates were used, they would have magnified the drop in the number of births in Oklahoma because of the inverse relationship of a decrease in the numbers of births and an increase in population.

Mocan (1990) described the growth of non-marital childbearing among women greater than twenty years of age as a national phenomenon where women in this age group now account for a greater percentage of non-marital births than do women in their teen years. This finding was not consistent with the results of the current study. A higher percentage of teen women in each year of the Oklahoma study reported being unmarried when compared with the responses of adult women. Overall, 48% of teen mothers indicated they were unmarried, while only 16% of adult women reported the same.

Mocan (1990) also suggested that United States fertility is not governed by a deterministic trend as concluded by the early studies, but evolves around a stochastic trend supporting his countercyclic viewpoint. It may appear this way when data from a wide variety of geographical and sociopolitically diverse areas of the country are aggregated to large yearly totals. However, when data from a more homogeneous population in a smaller geographical area is examined with data compiled on a daily or weekly basis, the trend may very well be deterministic and procyclic as was shown in the current study.

Univariate time series analysis revealed that the ARIMA (0, 1, 1) model with a (0, 1, 1) seasonal component was the model that most accurately represented the birth data in this study. Because all three of the birth data sets were drawn from the general population of childbearing women in Oklahoma, it is reasonable that the model for each set would be similar. The teen model with fewer numbers of daily or weekly births than the adult model may also account for some of the differences in study results.

The recognition of the uniqueness of birth patterns or trends of a specific geographic area has important implications for health care providers. In order to meet the needs of local populations, the provider must be able to accurately assess and interpret the pattern for their area which may be very different from the national trend or figures.

Interventions should then be based on the individualized needs and values of each community. Time series analysis provides a relatively new approach for making such assessments and meeting those needs.

Economic Conditions and Birth Patterns

Numerous early studies examining the correlation between economic conditions and birth rates found a positive association between economic activity and fertility (Thomas, 1927; Galbraith & Thomas, 1941; Kirk, 1960; Silver, 1965). Using aggregate time-series data, these analyses were conducted by regressing fertility rates on a business cycle indicator or correlating trend deviations of the two series to identify the procyclicality of fertility (i.e., the positive association between economic activity and fertility). Studies of the association of fertility and business cycles conducted during the 1970s and 1980s found a countercyclic relationship between the two variables (Butz & Ward, 1979; Kelley & Schmidt, 1995). The current study replicated these studies by regressing the number of births on the price of oil as an economic indicator to obtain procyclic results similar to the earlier studies.

It has been observed that the relationship between economic conditions and birth rates is a cyclic process. This phenomenon is supported by this study. Just as economic conditions are believed to account for the number and timing of births in a given population, the birth rate has an impact on economic growth. Fertility is a dynamic process and decisions surrounding it are multifaceted. This study indicated the economic conditions make a substantial contribution to adult birth patterns, but are less significant in the decision making process of teen women. Many teen women have not yet entered the work force and are not financially independent, therefore they have a decreased awareness of the economy on which to make decisions. There may also be a difference in the relationship between economy and number of pregnancies based on the age of the teenager. Older teenagers would be more likely to use economic reasoning and be aware of economic conditions associated with childbearing than would a younger teenager.

In drawing conclusions about the relationships between fertility and economics, it is important to examine the relationship between correlation and causality. Granger (1988) maintains that when a pair of series are co-integrated (such as oil price and births), there must be causation in at least one direction. There is, however, the implication that some tests of causation based on a different series may have missed and another source of the causation. Because of the nature of fertility decisions, it is certain that other factors besides the economy played a role in determining the birth pattern for any age group in any geographical location.

The implications for nurses and other health care providers are, once again, using the methods available to accurately and thoroughly assess the population being served to assure individualized community, quality care. Continued research to identify factors impacting birth trends in the local population will contribute to the body of nursing knowledge and provide information for informed decision making by health care professionals, clients, and individuals in related disciplines.

<u>Seasonality of Births</u>

Seasonality is an important source of nontrend variation in births in virtually all populations. Even though it is well documented that there are significant differences between geographic regions and time periods in the pattern of seasonal variation (Lam & Miron, 1991), little is known about the differences in age groups of the same regions. In this study, there was not a significant difference in the birth patterns of teens and adults in Oklahoma. The "Christmas effect" discussed frequently in explanations of the peak in births during September is supported by this study (Rosenberg, 1966; Wrigley & Schofield, 1981). On an average, the highest number of births to adults occurred in September. For teens, whose highest number of births appears to occur in August, this phenomenon might be explained by the higher number of preterm births to teen mothers or their vacation or leisure time begins earlier than adults in December.

Seasonal variation in the timing and number of births has also been attributed to the influence of weather and climate. The results of this study support the findings of Macfarlane (1974) that there is an increased release of thyroxin and cortisol when cooling of the body occurs during colder weather, thereby increasing pituitary activity and raising conception rates. Perhaps the endocrine system of teenagers is more sensitive to the change in weather to lower temperatures or the type of clothing a teenager wears may contribute to greater cooling of the body, thereby shifting the onset of a higher rate of conception to a few weeks earlier than that of adult women. A similar phenomenon could occur in the summer when high heat can be attributed to an increase in preterm births, ultimately contributing to the birth pattern.

Recognition of seasonality in birth trends of a specific geographical area has important implications for nurses and other health care providers. Staffing of obstetrical units can be increased during the periods of time associated with the highest birth rates.

Greater efforts could be made to teach women about contraception and to make contraceptive devices more readily available during the times known to be periods of high conception such as holiday and vacation times. Data from this study could be used to examine long term patterns to determine the needs of communities within the geographical area studied. Increased understanding of reasoning regarding the relationship between economic opportunity and childbearing could be used to support the development of programs, construction of facilities, and the formation of health care policies intended to serve women and newborns.

Recommendations for Future Research

As a result of the findings of this study, the following recommendations are offered:

1. Replication of the study of Oklahoma births using a broader general business index that accounts for other economic factors such as unemployment, inflation, and consumer spending.
2. Replication of the study in other geographic regions. Diversity of population demographics and variety in economic indicators will enhance the generalizability of the results.
3. Replication of the study in other states where oil price has had a significant impact on the economy.
4. Design and conduct a qualitative research study to determine the effect of personal preference and cultural or religious influence in determining number and timing of pregnancies.

5. Design and conduct research which investigates the relationship between the number of *pregnancies* (not births) and an economic indicator. Accurate records of elective and spontaneous abortions would be necessary to carry out such a study.
6. Replication of the study using a different, possibly longer, time period to determine if longer cycles exist that were not identified by the present study. Also, it would be interesting to explore the "seesaw" effect of economic theory as it has evolved historically.
7. Design and conduct qualitative research to describe personal beliefs and definitions of "economic well-being" and the role it plays in the decision-making process regarding childbearing.
8. Future studies could include the use of nonlinear data analysis techniques to determine if the relationship between the number of births and economic conditions is something other than linear.
9. Inclusion of economic status/income on the form used to collect birth information would be helpful in investigating the association between economic wellbeing and births.
10. Utilize the forecasting capabilities of time series analysis to predict future birth patterns in specified populations to anticipate the health care needs of entire populations in a cost-effective manner.

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APPENDIX A

Frameworks and Research Foundations

Addressing the Relationship Between Fertility and Economics

Frameworks and Research Foundations
Addressing the Relationship Between Fertility and Economics

Researcher & Date	Discipline	Frameworks/ Foundations	Brief Description	Findings
Friedman, Hechter, & Kamazawa (1994)	Public Health	Theory of the Value of Children-Uncertainty Reduction	Rational choice explanation of contemporary fertility behavior. During times of uncertainty, the decision to have children is a means to increase certainty.	Countercyclic
Milio (1976)	Nursing	Framework for Prevention	Availability of resources influences the "choice-making" of significant numbers of people. During periods of poor economic condition, access to health care services such as birth control methods & abortion decrease & birth rates increase.	Countercyclic
Leibenstein (1957); Becker (1960); Kelley (1975)	Economics	Contemporary Economic Theory of Fertility	Fertility behavior is explained by the economic theory of household demand.	Procyclic
Becker (1965); Lancaster (1971); Nerlove (1974); T. P. Schultz (1976, 1981); Ben-Porath (1982)	Economics	Chicago-Columbia Approach	Incorporates the concept of allocation of time into household production theory. As more women enter the work force, family income increases as number of children decreases due to time constraints of mothers.	Countercyclic
Sanderson (1976, 1980); Behrman & Wolfe (1984)	Economics	Pennsylvania Model	Builds on the Chicago-Columbia approach. A broader model that incorporates social & demographic aspects of fertility.	Procyclic
Silver (1965)	Economics	Time Series Analysis of Births, Marriage Rate & Business Cycle	Procyclicality of fertility exists even after controlling the marriage rate although the response of the birth rate was substantially lower when the marriage rate was held constant.	Procyclic

Frameworks and Research Foundations
Addressing the Relationship Between Fertility and Economics

Researcher & Date	Discipline	Frameworks/ Foundations	Brief Description	Findings
Mocan (1990)	Economics	Vector Auto-regressive Model of Business Cycles & Fertility Dynamics	When models include divorce rate & the proportion of young marriages as additional regressors, fertility is countercyclic to the business cycle.	Countercyclic
Easterlin, Pollak & Wachter (1980) Bulato & Lee (1983)	Economics	Supply-Demand Framework	Formal statement adapted by the inter-disciplinary National Academy of Services panel as the basis for determining fertility in developing countries.	Procyclic
Becker (1991)	Economics	Reformulation of Economic Theory of Fertility	Based on economic theory of fertility, fertility rate is based on dynastic utility functions and descendents in different generations. The importance of altruism within families is stressed.	Procyclic

APPENDIX B

Permission to Conduct the Study

Human Subjects Review Committee

Graduate School

TEXAS WOMAN'S
UNIVERSITY
DENTON/DALLAS/HOUSTON

HUMAN SUBJECTS
REVIEW COMMITTEE
P.O. Box 425619
Denton, TX 76204-5619
Phone: 940/898-3377
Fax: 940/898-3416

October 14, 1998

Ms. Sandra Cesario
[redacted]

Dear Ms. Cesario: Social Security # [redacted]

Your study entitled "Influence of the Economy on Teen and Adult Birth Patterns in Oklahoma 1980 through 1995: A Time-Series Analysis" has been reviewed by a committee of the Human Subjects Review Committee and appears to meet our requirements in regard to protection of individuals' rights.

Be reminded that both the University and the Department of Health and Human Services (HHS) regulations typically require that agency approval letters and signatures indicating informed consent be obtained from all human subjects in your study. **These consent forms and agency approval letters are to be filed with the Human Subjects Review Committee at the completion of the study. However, because you do not utilize a signed consent form for your study, the filing of signatures of subjects with the Human Subjects Review Committee is not required.**

Your study was determined to be exempt from further TWU HSRC review. However, another review by the Committee is required if your project changes. If you have any questions, please feel free to call the Human Subjects Review Committee at the phone number listed above.

Sincerely,

[redacted]
Chair
Human Subjects Review Committee

cc. Graduate School
Dr. Patti Hamilton, College of Nursing
Dr. Carolyn Gunning, College of Nursing

TEXAS WOMAN'S
UNIVERSITY
DENTON / DALLAS / HOUSTON

390-58-3185
THE GRADUATE SCHOOL
[redacted]

November 17,1998

Ms. Sandra K. Cesario
[redacted]

Dear Ms. Cesario:

I have received and approved the prospectus entitled **"Influence of the Economy on Teen and Adult Birth Patterns in Oklahoma 1980 through 1995: A Time-Series Analysis"** for your *Dissertation* research project.

Best wishes to you in the research and writing of your project.

Sincerely yours,

[redacted]

Leslie M. Thompson
Associate Vice President for Research and
Dean of the Graduate School

LMT/sgm

cc Dr. Patti Hamilton, Nursing
Dr. Maisie Kashka, Nursing

APPENDIX C

Request for Birth Certificate Information

Oklahoma State Department of Health

OKLAHOMA STATE DEPARTMENT OF HEALTH
REQUEST FOR CONFIDENTIAL INFORMATION

Date 4-28-97

I. Type of Data Requested:
Describe: (i.e. type of certificate - birth or death, years needed, information needed from record, etc.)

BIRTH CERTIFICATE INFORMATION 1980-1995

II. Attach Protocol of Research Proposal. (Requests will not be considered without Protocol.)

III. Assurance of Confidentiality:
If provided with the above information, I agree that the information will be used for the research stated in the protocol and that I will release no information to any other person or agency. I assure that the information concerning the identity of persons named in the records will be strictly confidential.

IV. Signature of Applicant [redacted] + TWU Research Team
Title & Organization Doctoral Student
Address Texas Woman's University
Denton TX

APPENDIX D

Certificate of Live Birth

Information Collection Form Used from July 1, 1968 through August 31, 1990

Oklahoma State Department of Health

CERTIFICATE OF LIVE BIRTH

STATE OF OKLAHOMA – DEPARTMENT OF HEALTH

LOCAL REG. NO. STATE FILE NO. 135 -

Type or print with black permanent ink. THIS IS A PERMANENT RECORD.

1. CHILD NAME First Middle Last (Type or print)
2. DATE OF BIRTH Month Day Year
4. SEX
5a. THIS BIRTH SINGLE ☐ TWIN ☐ TRIPLET ☐
5b. IF TWIN OR TRIPLET, WAS CHILD BORN 1st ☐ 2d ☐ 3d ☐
6a. COUNTY OF BIRTH
6b. CITY, TOWN, OR LOCATION OF BIRTH
6c. INSIDE CITY LIMIT Yes ☐ No ☐
6d. HOSPITAL – NAME
7. MOTHER MAIDEN NAME First Middle Last
8. AGE
9. BIRTHPLACE
10a. RESIDENCE – STATE
10b. COUNTY
10c. CITY, TOWN, OR LOCATION
10d. INSIDE CITY LIMIT Yes ☐ No ☐
10e. STREET ADDRESS
11. FATHER NAME First Middle Last
12. AGE
13. BIRTHPLACE
14a. INFORMANT – SIGNATURE OF EITHER PARENT
14b. IF UNABLE TO OBTAIN PARENTS SIGNATURE, STATE REASON THEREFORE.
15. MOTHER'S MAILING ADDRESS STREET or R.F.D. NO. POSTOFFICE STATE ZIP
16a. WAS BLOOD OF THIS CHILD'S MOTHER TESTED FOR SYPHILIS? Yes ☐ No ☐
16b. DATE TEST MADE
16c. IF NO TEST, STATE REASON THEREFORE
17. WEIGHT OF CHILD AT BIRTH LBS. OZS.
18. WAS PROPHYLACTIC DRUG USED IN BABY'S EYES? Yes ☐ No ☐
19a. SIGNATURE OF ATTENDANT
19b. DATE SIGNED
19c. NAME OF ATTENDANT (Print or Type)
19d. ATTENDANT AT BIRTH M.D. ☐ D.O. ☐ D.C. ☐ Midwife ☐ Other ☐
19e. ADDRESS OF ATTENDANT STREET or R.F.D NO. POSTOFFICE STATE ZIP CODE
20a. DATE REC'D. BY LOCAL REG.
20b. LOCAL REGISTRAR'S SIGNATURE
21. DATE RECEIVED BY STATE REGISTRAR
THIS LINE FOR USE OF STATE REGISTRAR
22a. DATE CORRECTIONS MADE
22b. ITEMS CORRECTED
22c. AUTHORITY
22d. CLERK

DO NOT WRITE BELOW

CODES

Race

Hospital

Oklahoma Residence

Out of State Residence

Legitimacy

Attendant

Birth Weight

VS 152 7-68

DO NOT WRITE BELOW

CODES

TO BE DETACHED BY STATE REGISTRAR ONLY

CONFIDENTIAL INFORMATION FOR MEDICAL AND HEALTH USE ONLY

RACE – FATHER

RACE – MOTHER

ELEMENTARY HIGH SCHOOL COLLEGE

Marital Status

Comp. Relat. to Preg.

Comp. Not Relat.

Comp. Labor

Birth Injury

Cong. Mal.

COMPLICATIONS RELATED TO PREGNANCY

BIRTH INJURIES TO CHILD

COMPLICATIONS NOT RELATED TO PREGNANCY

CONGENITAL MALFORMATIONS OR ANOMALIES OF CHILD

COMPLICATIONS OF LABOR

THIS LINE FOR USE OF STATE REGISTRAR

CLERK

VS 152 7-68

APPENDIX E

Certificate of Live Birth

Information Collection Form Used from September 1, 1990 through Present

Oklahoma State Department of Health

CERTIFICATE OF LIVE BIRTH

STATE OF OKLAHOMA-DEPARTMENT OF HEALTH

LOCAL FILE NO

STATE FILE NO. 135-

1. CHILD'S NAME | 2. DATE OF BIRTH | 3. TIME OF BIRTH

4. SEX | 5. CITY, TOWN, OR LOCATION OF BIRTH | 6. COUNTY OF BIRTH

7. PLACE OF BIRTH ☐ Hospital ☐ Freestanding Birthing Center ☐ Clinic/Doctor's Office ☐ Residence ☐ Other (Specify)

8. FACILITY NAME

9. I certify that this child was born alive at the place and time on the date stated. Signature

10. DATE SIGNED

11. ATTENDANT'S NAME AND TITLE — Name ☐ M.D. ☐ D.O. ☐ C.N.M. ☐ Other Midwife ☐ Other (Specify)

12. CERTIFIER'S NAME AND TITLE — Name ☐ M.D. ☐ D.O. ☐ Hospital Admin. ☐ C.N.M. ☐ Other Midwife ☐ Other (Specify)

13. ATTENDANT'S MAILING ADDRESS — Street and Number or Rural Route; City or Town; State

14. DATE RECEIVED BY LOCAL REGISTRAR | 15a. STATE REGISTRAR'S SIGNATURE | 15b. DATE FILED BY STATE REGISTRAR

16a. MOTHER'S NAME | 16b. MAIDEN SURNAME | 17. DATE OF BIRTH

18. BIRTHPLACE | 19a. RESIDENCE-STATE | 19b. COUNTY | 19c. CITY, TOWN, OR LOCATION

19d. STREET AND NUMBER | 19e. INSIDE CITY LIMITS? | 20. MOTHER'S MAILING ADDRESS

21. FATHER'S NAME | 22. DATE OF BIRTH | 23. BIRTHPLACE

24. Permission given to provide Social Security Administration with the necessary birth information to issue a Social Security Number. Yes ☐ No ☐ Initials

25. I certify that the personal information provided on this certificate is correct to the best of my knowledge and belief. Signature of Parent

THIS LINE FOR USE OF STATE REGISTRAR | DATE CORRECTIONS MADE | ITEMS CORRECTED | AUTHORITY | CLERK

CONFIDENTIAL INFORMATION
FOR MEDICAL AND HEALTH USE ONLY

To Be Detached By State Registrar Only

Do Not Write in This Space

APPENDIX F

Sample Page of the Crude Oil Price Bulletin (1980-1)

Phillips Petroleum Company

This Crude Oil Price Bulletin supersedes all previous Phillips Petroleum Company Crude Oil Price Bulletins.

PHILLIPS PETROLEUM COMPANY

CRUDE OIL PRICE BULLETIN 1980-1

Effective 7 a. m. January 1, 1980, subject to change without notice, and subject to the applicable rules and regulations of all governmental authorities and to the provisions of its Division Order and/or contract agreements, Phillips Petroleum Company will pay the following prices per barrel of 42 U.S. Gallons for marketable crude oil not in excess of 8# Reid Vapor Pressure purchased by it from the areas designated below and delivered for its account into the custody of an authorized receiving agency; provided, however, that any transportation charges required or imposed to move said crude oil from lease tanks to a pipeline terminal or a final destination (including common carrier, contract carrier or Phillips Petroleum Company's charges for its own transportation equipment), other than common carrier pipe line tariffs, may be deducted. The prices posted below for crude petroleum are based upon computation of volume by the use of 100% tank tables or mutually acceptable automatic measuring equipment with deductions in full for all B.S. & W. and corrected for temperatures to 60° F, in accordance with usual industry practice.

ALL PRICES SHOWN ARE APPLICABLE FOR 40.0° GRAVITY & ABOVE. IN ALL AREAS, FOR EACH FULL DEGREE A.P.I. GRAVITY BELOW 40.9° DOWN TO 19.9°, $0.02/BBL. SHALL BE DEDUCTED. NO FURTHER ADJUSTMENT SHALL BE MADE BELOW 19.9°.

STATE & FIELD	LOWER TIER *	UPPER TIER *
ALABAMA & FLORIDA PANHANDLE	---	$13.99
COLORADO: Rangely	$6.34	14.14
KANSAS: Barton, Cowley, Ellsworth, Harvey, McPherson, Reno, Rice, Rooks, Russell, Sedgwick, and Sumner Counties	6.39	14.29
ALL OTHER COUNTIES	6.34	14.29
MONTANA: Cut Bank	6.02	13.92
Pondera	5.99	13.92
OKLAHOMA: Panhandle, All fields	6.34	14.34
All fields in Osage and Kay Counties	6.34	14.34
All other fields (Sweet Crude)	6.34	14.34
TEXAS (West) and NEW MEXICO Sour	6.34	13.74
TEXAS (West) and NEW MEXICO Intermediate Sweet	6.45	14.49
TEXAS (West) Segregated Lube	6.42	14.61
TEXAS (Panhandle) All fields	6.34	14.09
TEXAS (Gulf Coast)	6.49	13.99

UNCONTROLLED OIL: CRUDE OIL THAT IS NOT SUBJECT TO A DOE CEILING PRICE, SUCH AS STRIPPER OR NEWLY-DISCOVERED OIL, WILL BE THE PRICE FOR THAT GRADE AND QUALITY WHICH, IN THE JUDGEMENT OF PHILLIPS, IS COMPETITIVE FOR THE FIELD INVOLVED.

NOTICE: Each seller of crude oil and condensate to Phillips Petroleum Company under terms of division order or contract at prices posted in this Bulletin certifies to Phillips Petroleum Company by acceptance of payment made by Phillips Petroleum Company that these prices do not exceed maximum prices permitted under the statutes, orders, regulations and rulings applicable thereto. In the event a seller is unable to accept the prices posted in this Bulletin, it shall be his responsibility to certify to Phillips Petroleum Company in writing the price he is permitted to accept. In the event the Federal Government retroactively limits the lawful price that can be paid or limits the effective date of these prices, Phillips Petroleum Company reserves the right to amend this Crude Oil Price Bulletin to comply with such limitation. Phillips Petroleum Company further reserves the right to recover any payments made in excess of those allowed in such price limitation, either by withholding an amount equal to such excess payment from future purchases or by directly invoicing for such payment.

* Denotes Change

PHILLIPS PETROLEUM COMPANY - PETROLEUM PRODUCTS GROUP
896 ADAMS BUILDING - BARTLESVILLE, OKLAHOMA 74004 (RC)
PHONE: 918 661-4141

AREA	ADDRESS	PHONE
OKLA. & TEXAS PANHANDLE, WEST TEXAS & NEW MEXICO	P.O. BOX 791 910 BLANKS BUILDING-MIDLAND, TEXAS-79702	AC 915 682-8241
S.E. STATES, EAST TEXAS & TEXAS GULF COAST	P.O. BOX 1967 ADAMS PETROLEUM CENTER-HOUSTON, TEXAS-77001	AC 713 790-7669
OKLA. (EXCLUDING PANHANDLE), AND KANSAS	8 F 11 ADAMS BUILDING BARTLESVILLE, OKLA.-74004	AC 918 661-4145
ROCKY MOUNTAIN	WOODSIDE II 7800 EAST DORADO PLACE ENGLEWOOD, CO. 80111 ROOM # 107 D	AC 303 779-8963

APPENDIX G

Flow Sheet of Data Analysis

Flow Sheet of Data Analysis

Purpose	Hypothesis/Research Question	Planned Comparison	Statistical Test
Identification of the best fitting model of Oklahoma birth data.	RQ $_1$: Which model best fits the Oklahoma birth data?	Adult births Teen births All births	Univariate Time Series Analysis ACF, PACF, and ARIMA modeling
Identification of the best fitting model of OK births as related to economic trend.	H $_1$: A procyclic model of economics & fertility better fits the OK birth data (all births) than a countercyclic model.	Economic indicator and all births	Multivariate Time Series Analysis Cross - correlation
Evaluate the impact of the economy on 2 different age groups.	H $_2$: Fluctuations in economic conditions have a stronger relationship to the pattern of adult births than to the pattern of teen births.	Economic indicator & adult births	Multivariate Time Series Analysis Cross-correlation Autoregression
		Economic indicator & teen births	Multivariate Time Series Analysis Cross-correlation Autoregression
Examine the birth patterns of 2 age groups to identify differences that may exist.	RQ $_2$: What other differences can be found in the patterns of teen and adult births?	Adult births and teen births	Descriptive statistics, graphing
			Multivariate Time Series Analysis Cross-correlation
Compare birth trends of 2 different age groups in regard to seasonal variation.	H $_3$: There are differences in seasonal patterns between teen births and adult births in Oklahoma.	Teen births and adult births	Chi Square

APPENDIX H

Number of Births by Mother's County of Residence

Mother's County of Residence

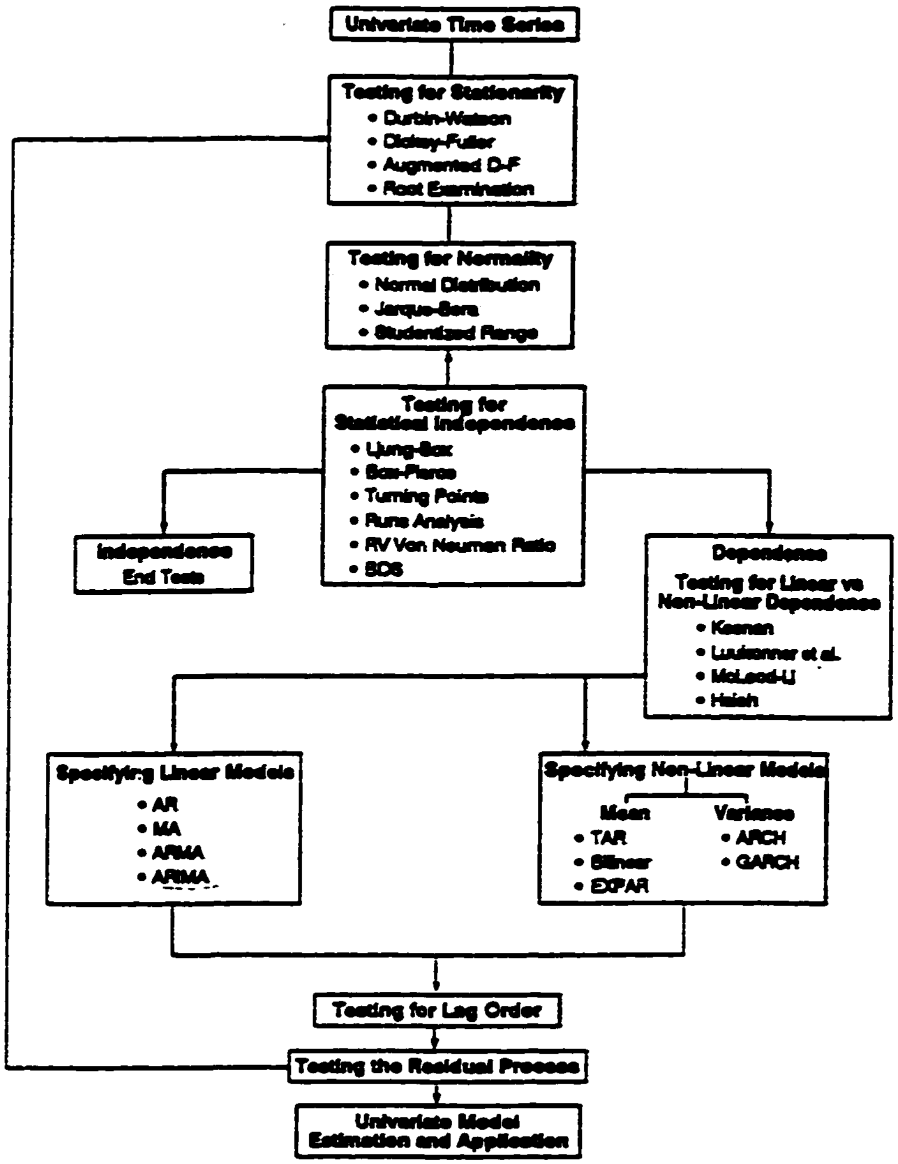
	Teen Births	Adult Births	All Births
Adair	1,412	4,108	5,520
Alfalfa	155	1,004	1,159
Atoka	646	1,985	2,631
Beaver	223	1,114	1,337
Beckham	1,109	4,384	5,493
Blaine	658	2,634	3,292
Bryan	1,555	5,505	7,060
Caddo	1,886	6,530	8,416
Canadian	2,082	15,387	17,469
Carter	2,227	8,289	10,516
Cherokee	1,695	6,473	8,168
Choctaw	936	2,778	3,714
Cimarron	123	635	758
Cleveland	4,094	32,112	36,206
Coal	318	971	1,289
Comanche	6,345	31,521	37,866
Cotton	275	1,137	1,412
Craig	564	2,383	2,947
Creek	2,873	11,952	14,825
Custer	1,223	6,082	7,305
Delaware	1,321	4,510	5,831
Dewey	205	1,085	1,290
Ellis	157	806	963
Garfield	2,260	12,960	15,220
Garvin	1,287	5,054	6,341
Grady	1,828	8,253	10,081
Grant	135	1,098	1,233
Greer	284	882	1,166
Harrison	208	673	881
Harper	131	691	822
Haskell	517	1,767	2,284
Hughes	618	2,102	2,720
Jackson	1,772	7,927	9,699
Jefferson	271	1,141	1,412
Johnston	460	1,613	2,073
Kay	1,857	10,294	12,151
Kingfisher	536	3,169	3,705
Kiowa	598	2,046	2,644
Latimer	498	1,641	2,139
Leflore	2,192	7,404	9,596
Lincoln	1,271	5,106	6,377

	Teen Births	Adult Births	All Births
Logan	1,084	5,443	6,527
Love	347	1,325	1,672
McClain	855	4,338	5,193
McCurtain	2,289	6,556	8,845
McIntosh	724	2,474	3,198
Major	260	1,521	1,781
Marshall	483	1,621	2,104
Mayes	1,629	6,250	7,879
Murray	560	1,969	2,529
Muskogee	3,814	13,578	17,392
Noble	384	2,194	2,578
Nowata	460	1,781	2,241
Okfuskee	618	1,923	2,541
Oklahoma	27,576	143,626	171,202
Okmulgee	2,059	6,991	9,050
Osage	1,357	6,891	8,248
Ottawa	1,364	5,488	6,852
Pawnee	662	2,890	3,552
Payne	1,542	11,918	13,460
Pittsburg	1,993	6,433	8,426
Ponotoc	1,280	6,371	7,651
Pottawatomie	2,609	11,307	13,916
Pushmataha	577	1,807	2,384
Roger Mills	164	842	1,006
Rogers	1,958	10,986	12,944
Seminole	1,455	4,897	6,352
Sequoyah	1,832	6,152	7,984
Stephens	1,733	7,901	9,634
Texas	762	3,600	4,362
Tillman	666	1,979	2,645
Tulsa	19,589	118,215	137,804
Wagoner	1,783	8,689	10,472
Washington	1,404	9,540	10,944
Washita	534	2,562	3,096
Woods	238	1,619	1,857
Woodward	931	4,531	5,462
Unknown/Out of state	408	4	412
Total Births	136,788	663,418	800,206
	17.1%	82.9%	

APPENDIX I

Test Procedure for Univariate Model Identification

Test Procedure for Univariate Model Identification

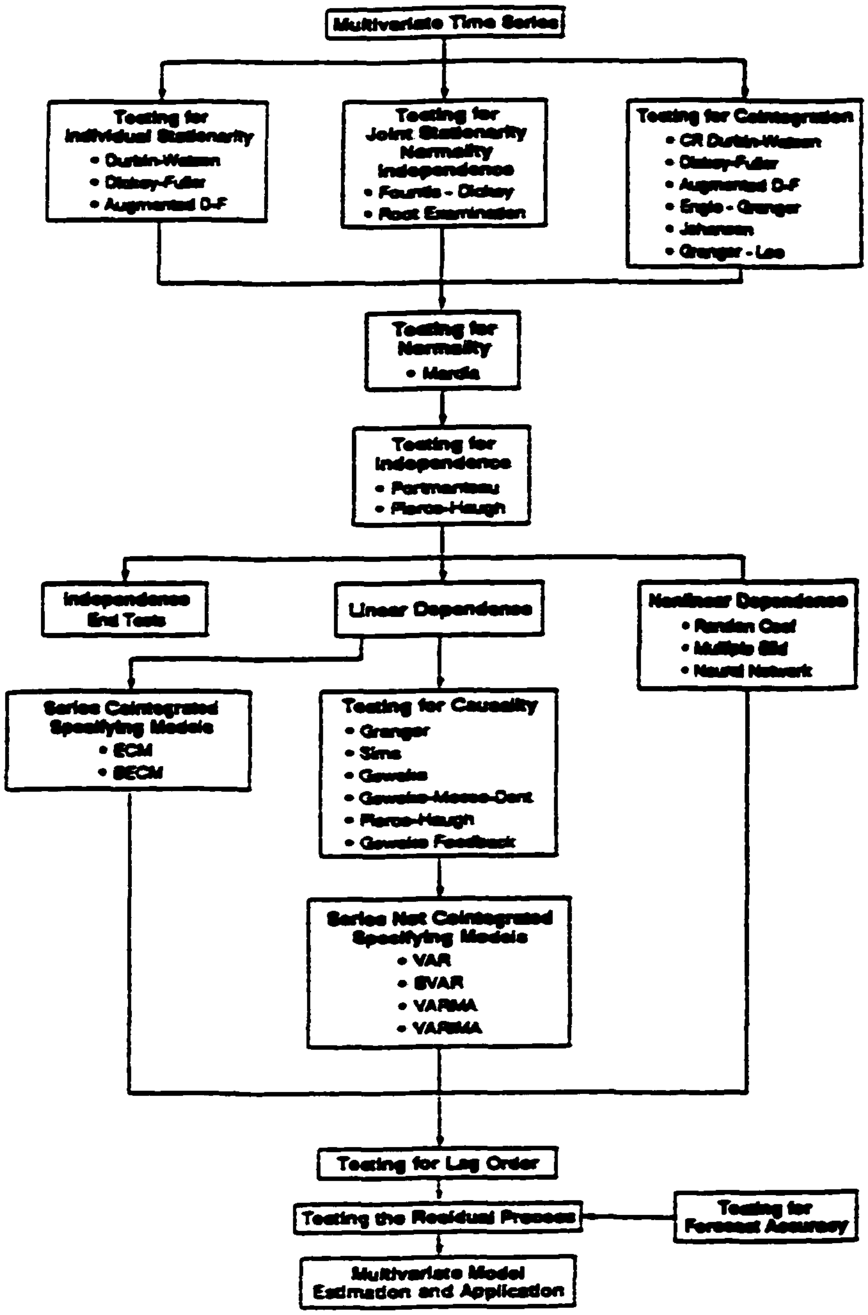


Cromwell, J., Labys, W., & Terraza, M. (1994). Univariate tests for time series models. Thousand Oaks, CA: Sage Publications, p. 9.

APPENDIX J

Test Procedure for Multivariate Model Identification

Test Procedure for Multivariate Model Identification



Cromwell, J., Hannan, M., Labys, W., & Terraza, M. (1994). Multivariate tests for time series models. Thousand Oaks, CA: Sage Publications, p. 7.

APPENDIX K

Summary of Study Findings

Summary of Study Findings

Hypothesis/Research Question	Variables Examined/Compared	Statistical Test Employed	Findings
RQ 1: Which model best fits the Oklahoma birth data?	Adult births Teen Births All births	Univariate Time Series Analysis ACF, PACF, and ARIMA modeling	Transformations included natural log, weekly aggregation, & assigning a periodicity of 52. (0,1,1) (0,1,1) Model for all 3 data sets
H 1: A procyclic model of economics & fertility better fits the OK birth data (all births) than a countercyclic model.	Economic indicator and all births	Multivariate Time Series Analysis Cross-correlation	Findings support the hypothesis & suggest the relationship between economics & births in Oklahoma is procyclic
H 2: Fluctuations in economic conditions have a stronger relationship to the pattern of adult births than to the pattern of teen births.	Economic indicator & adult births	Multivariate Time Series Analysis Cross-correlation Autoregression	Findings support the hypothesis & suggest the fluctuations in economic conditions have a greater impact on adult birth patterns
	Economic indicator & teen births	Multivariate Time Series Analysis Cross-correlation Autoregression	
RQ 2: What other differences can be found in the patterns of teen and adult births?	Adult births and teen births	Descriptive statistics, graphing	There are differences in marital status, ethnicity, & rurality between groups. The CCF indicates that teen births lead adult births & there may be an inverse relationship between teen & adult birth patterns at times
		Multivariate Time Series Analysis Cross-correlation	
H 3: There are differences in seasonal patterns between teen births and adult births in Oklahoma.	Teen births and adult births	Chi Square	Significantly more births occur during summer months for both teens & adults. The hypothesis is NOT supported however, as there is NO difference in seasonal patterns of adults & teens

RESUME

SANDRA K. CESARIO, RNC, PhD

[redacted]

Business Address:
College of Nursing
[redacted]

Education:

Doctor of Philosophy in nursing, Texas Woman's University, Denton, Texas, 1999

Master of Science with a nursing major and a leadership pathway in education, University of Oklahoma, Health Sciences Center, Oklahoma City, Oklahoma, 1989

Bachelor of Science in Nursing, Fort Hays State University, Hays, Kansas, 1985

RN Diploma, St. Luke's Hospital School of Nursing, Racine, Wisconsin, 1976

Institute for Advanced Musical Studies, Crans, Valais, Switzerland, 1973

Experience:

Assistant Professor
College of Nursing
Texas Woman's University
Houston, Texas, 1999 - present

Clinical Assistant Professor and Research Associate,
Graduate and Undergraduate Faculties
University of Oklahoma, College of Nursing,
Tulsa, Oklahoma, 1992 – 1999

Adjunct Clinical Faculty, Langston University
Tulsa, Oklahoma Spring and Fall 1995

RN, Per Diem Staff Nurse, Obstetrics, Claremore Regional Hospital, Claremore, Oklahoma, 1994 – 1998

Coordinator, OB Nurse Residency Program, Indian Health Service, USPHS Indian Hospital, Claremore, Oklahoma, 1989-1992 (Assistant Coordinator, 1992-1994)

RN, Per Diem Staff Nurse, Obstetrics, USPHS Indian Hospital, Claremore, Oklahoma, 1983-1989 and 1992-1994

Nursing Instructor (PT), Medical-Surgical, Northeast Area Vocational-Technical Institute, Pryor, Oklahoma, 1986-1993

Nursing Instructor (PT), Obstetrics, Rogers State College, Claremore, Oklahoma, 1983-1990

Inservice Coordinator, Obstetrics, Memorial Hospital, Guymon, Oklahoma, 1983

RN, Staff Nurse (PT), Obstetrics, North Colorado Medical Center, Greeley, Colorado, 1981-1982

Nursing Instructor, Obstetrics, Luna Vocational-Technical Institute, Las Vegas, New Mexico, 1980-1981

RN, Staff Nurse (PT), Obstetrics, Northeastern Regional Hospital, Las Vegas, New Mexico. 1980

RN, Staff Nurse, NICU, St. Joseph's Hospital, Milwaukee, Wisconsin, 1977-1978

GN/RN, Staff and Charge Nurse, Newborn Nurseries, Kirksville Osteopathic Hospital, Kirksville, Missouri, 1976-1977

Nursing Assistant (PT), Obstetrics, St. Luke's Hospital, Racine, Wisconsin, 1974-1975

Ward Clerk (PT), Pediatrics, St. Luke's Hospital, Racine, Wisconsin, 1971-1973

Organizations:

Midwest Nursing Research Society, 1997-

Southern Nursing Research Society, 1997-

Oklahoma Nurses Foundation, Board of Trustees, 1996-1999

Sigma Theta Tau International, dual membership Beta Delta (1988) and Zeta Delta (1996) Chapters

N-Stat – Nurses Strategic Action Team, 1996-

American Nurses Association, 1988-

Oklahoma Nurses Association, 1988-

Association of Women's Health, Obstetric, and Neonatal Nurses (formerly NAACOG), 1988-

Oklahoma Coalition for Women's Health, 1991-1992

Graduate Nurses Association, 1987-1989

Tulsa Junior College Community Band and Orchestra, 1983-

Claremore Community Concerts Association, 1983-1994

Rogers State College Community Band, 1983-1990

Student Nurses Association, 1973-1976
(First Vice President, 1974-1975)

Certifications:

Certified Breastfeeding Educator, 1992

Neonatal Resuscitation Instructor, American Academy of Pediatrics, 1990-1996

Inpatient Obstetrical Nurse, AWHONN (formerly NAACOG), 1989-

Neonatal Resuscitation Provider, American Academy of Pediatrics, 1989-1996

Reliable in the administration of the NCAST Tool, Assessment of Infants and Children, University of Washington, Seattle, Washington, 1988

Basic Life Support Instructor, American Heart Association, 1985-1989

High Risk Newborn Care, St. Joseph's Hospital Perinatal Center, Milwaukee, Wisconsin, 1978

Basic Life Support Provider, American Heart Association, 1975-1998

Publications:	"Recognizing Fetal Alcohol Syndrome," Sandra Cesario, Baby Care Forum, Summer 1999.
	"Positive Outcomes: What Should the Nurse Do When the News is Good?" Sandra Cesario, submitted for publication in Lifelines, 1999.
	"Should Cameras be Allowed in the Delivery Room?" Sandra Cesario, MCN, March/April 1998
	"The Impact of the Electronic Domain on Theory Construction," Sandra Cesario, The Journal of Theory Construction and Testing, Fall 1997
	Book Review of Ammerman and Hersen's Assessment of Family Violence: A Clinical and Legal Sourcebook (1992) appeared in Family and Community Health Vol. 15, No. 4, January 1993 pp. 83-84
Research:	"Influence of the Economy on Teen and Adult Birth Patterns in Oklahoma 1980 through 1995: A Time-Series Analysis," Dissertation, Texas Woman's University, Denton, Texas
	Pilot study "Instrument Development: Cesario Comprehensive Labor Support Questionnaire" 1996-1997. Approval granted by Texas Woman's University
	Research Technician, "Smoking Practices Among American Indian Pregnant Women," Principal Researcher Paulette Burns, RN, PhD
	Research Assistant, "Increasing the Initiation and Longevity of Breastfeeding Among Native American Mothers," Principal Researcher Kathy Holcroft, RN
	Data Collection for Indian Parenting Study, Ruth Seideman, Graduate Nursing Faculty, University of Oklahoma, published in Western Journal of Nursing Research, 1992, 14(3), pp. 308-321
Grants:	Dissertation Grant, Sigma Theta Tau, Beta Delta Chapter, 1997
Honors:	Graduate Education Scholarship, Association of Women's Health, Obstetric, and Neonatal Nurses, 1999
	Graduate Education Scholarship, Sigma Theta Tau, Beta Delta Chapter, 1996

Graduate Nursing Traineeship, Texas Woman's University, 1995-1996

Who's Who in Medicine and Healthcare, 1997-1998

Who's Who of American Women, 1997-1998

Who's Who Among Human Service Professionals, 1992-1993

Who's Who in American Nursing, 1990-1991 and 1996-1997

USPHS Surgeon General's Certificate of Recognition for Professional Development, 1990

Nurse of the Day, Oklahoma State Capital, 1990

Graduate Nursing Traineeship, University of Oklahoma, 1987-1989

Continuing Education Scholarship, St. Luke's Hospital School of Nursing, 1976

Consultations:

Team Leader, Second Stage Labor Management Evidence-Based Practice Guideline Development Team, Association of Women's Health, Obstetric, and Neonatal Nurses, 1999 -

Book reviews for Lippincott, Williams and Wilkins, 1999

Member Practice Committee, Association of Women's Health, Obstetric, and Neonatal Nurses, 1998 - Present

NCLEX Item Writer, 1996- Present

Member Editorial Board, Journal of Theory Construction and Testing, 1996-1998

Chapter Reviews for Addison Wesley Publishing Co., 1991- Present

Chart and Fetal Monitor Strip Review, Various Law Firms, Oklahoma and Texas, 1989-Present

OB Policy and Procedures Review, Application of NAACOG Standards, Indian Health Service, Service units in the Albuquerque, Navajo, and Oklahoma City Areas, 1990-1992

Presentations:

Poster Presentation, "Influences of the Economy on Oklahoma Birth Patterns 1980-1995," Oklahoma Nursing Research Consortium, Norman, Oklahoma, April 1999

Panel Presentation, "Evidence-Based Practice," AWHONN National Conference, San Antonio, Texas, June, 1998

Poster Presentation, Cesario, S., "Oklahoma Birth Trends: A Time-Series Analysis," Midwest Nursing Research Society, Columbus, OH, March 1998

Poster Presentation, Cesario, S., "Oklahoma Birth Trends: A Time-Series Analysis," Southern Nursing Research Society, Fort Worth, TX, February 1998

Poster Presentation, Cesario, S., "Oklahoma Birth Trends: A Time-Series Analysis," Sigma Theta Tau, International Conference, Indianapolis, Indiana, December, 1997

Poster Presentation, Beard, M., Althaus, B., Cesario, S., et al. "Major Theories of Selected Disciplines" Texas Woman's University Research Days, Denton, Texas, March, 1996

Poster Presentation, Burns, P., Cesario, S., and DeVito-Thomas, P. "Cigarette Smoking Practices of American Indian Pregnant Women" Sigma Theta Tau, Zeta Delta Chapter, Research Day, Tulsa, Oklahoma, September 1995

Innovative Program Poster, Cesario, S. and Holcroft, K. "OB Nurse Residency: Preparing RNs to Provide Rural Maternity Care". AWHONN Annual Meeting, Cincinnati, Ohio, June, 1994 (Received Outstanding Poster Award)

Poster Presentation, Burns, P., Cesario, S., and DeVito-Thomas, P. "Cigarette Smoking Practices of Native American Pregnant Women – Instrument Development," Midwest Nursing Research Society, Cleveland, Ohio, March, 1993

"Breastfeeding, Legal Issues, Labor Care, and Newborn Resuscitation" Faculty for IHS/ACOG Annual Postgraduate Obstetrical Course, Aurora, Colorado, 1992-1994

Post-Partum Care, Basic Life Support, and Newborn Nursery Procedures and Equipment Series, Indian Health Service, Oklahoma, 1984-1994

Fetal Monitoring, Various Hospitals and Educational Institutions, Oklahoma, 1989-Present