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The Effect of Road Investment on Economic Development: A Case Study of the Oregon Counties

Ameer Mohammed Al-Alwan
Portland State University

THE EFFECT OF ROAD INVESTMENT ON ECONOMIC DEVELOPMENT:

A CASE STUDY OF THE OREGON COUNTIES

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AMEER MOHAMMED AL-ALWAN

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TO THE OFFICE OF GRADUATE STUDIES:

The members of the Committee approve the thesis of Ameer Mohammed Al-Alwan presented February 5, 1991.

[redacted]

James G. Strathman, Chair

[redacted]

Kenneth J. Dueker

[redacted]

Nohad A. Toulan

[redacted]

Carl Abbott

[redacted]

Thomas P. Potiowsky

APPROVED:

[redacted]

Nohad A. Toulan, Dean, School of Urban and Public Affairs

[redacted]

C. William Savery, Vice Provost for Graduate Studies and Research

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APPROVED BY MEMBERS OF THE DISSERTATION COMMITTEE:

[redacted]

James G. Strathman, Chair

[redacted]

Kenneth J. Dueker

[redacted]

Nohad A. Toulan

[redacted]

Carl Abbott

[redacted]

Thomas P. Potiowsky

Despite its significance and frequent mentioning in the literature, the relationship between road investment and economic development has never been clearly understood. A significant number of scholars in this field have always emphasized the need for further research to examine this complex and dynamic relationship.

Historically, investment in transportation networks has played a great role in the development of cities, regions, and nations. This positive view is attributed to the indispensable role that water transportation, and then rail transport, played in the early development of Europe and the United States. In recent years, many scholars, as well as policy makers, have disputed that investment in transportation, and in particular roads, in the regions of a highly developed country like the United States will have a great impact on economic development.

This disagreement and speculation about the role of transportation investment, especially roads which constitute a large portion of the transportation network, on economic development has made justification for roads funding difficult. This is coupled with the recent decline in federal funding for many civilian programs, and in particular, regional economic development program, that include investment in road systems. Furthermore, rising construction and maintenance costs for major highway systems have substantially out-paced the current funding levels. As a result of the shortage of roads funding and the lack of federal support, individual states have started to take on more responsibility for keeping their road network intact. In almost all the states in the nation, and Oregon is no exception, the state Departments of Transportation have started to use economic development as a criterion for roads funding.

Therefore, it is the objective of this dissertation to examine the longitudinal impact of the various types of roads investments on economic development in Oregon in order to better understand this dynamic relationship. Total road expenditures, capital expenditures in the three types of roads (primary, secondary, and local), total maintenance expenditures, and maintenance expenditures in the three types of roads are used as a measure of road investments. Total employment to growth and employment to growth in manufacturing and service sectors are used as a measure of economic development.

In order to achieve the above objective, the Granger Causality test at different level of aggregation is used to examine this relationship. First, the state as a single aggregate unit is used to examine the effect of the various road investments on the three employment to growth sectors. Second, different spatial groupings, such as Portland Metropolitan Counties vs. the rest of the state Counties, Urban Counties, vs. Rural Counties, Interstate Counties vs. Non-Interstate Counties, Coastal Counties vs. Non-Coastal Counties, and the Department of Transportation's five designated regions are used to examine this relationship. Finally, the county level as a single disaggregate unit is also used.

The results highlighted the complexity of the relationship between road investments and economic development. The nature of this relationship varies from one region to another, and mainly depends on the level of aggregation in determining the direction of this relationship. At the aggregate level, the state as one geographic unit, the various road investments have a positive impact on the employment to growth in this region. In particular, total road expenditure and capital expenditure on primary and secondary roads have a one-way directional relationship runs from the various road expenditures to employment to growth, and the effect of this investment is long-term. This analysis also indicates that the different spatial groupings have demonstrated different relationships. Nevertheless, the general pattern for most spatial groupings tends to suggest either a one-way directional relationship runs from the various road expenditures to employment to growth or a bi-directional relationship. No findings support the hypothesis that employment to growth in the three economic sectors causes road expenditures, with the exception of very few cases, especially at the lower end of the analysis at the county level, where the results are highly discrepant and mixed.

In addition, this research indicates that the time-lag effect measured by lag-length and accumulative lag effect changes as the level of aggregation changes. However, the general pattern seems to indicate that total road expenditures and capital expenditures for the three types of roads, particularly primary and secondary roads, have a long-term effect on employment to growth. Also, the relative magnitude effect of total road expenditures and capital expenditures on primary and secondary roads is greater on the employment to growth than is the comparable effect of maintenance expenditures in most spatial groupings. Furthermore, the effect of the various road expenditures on the type of employment (manufacturing and service) depends greatly on the level of aggregation and the type of road investment.

Finally, this study provides public policy makers, transportation planners, and regional economic developers a better understanding of the complex relationship between road investment and economic development. A better understanding of this highly complex and dynamic relationship can guide decision makers to best utilize their limited resources. In addition, this research offers insight into the theories and works in the field of transportation and economic development.

DEDICATION

I dedicate this dissertation in memory of my late father, to whom God did not give life long enough to witness my completion of this final product, for his love and encouragement during my first two years of study at Portland State University. I also dedicate this work to my mother, who has always encouraged me to live up to my potential and who has been so very supportive of my study.

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CHAPTER I

INTRODUCTION

The relationship between transportation investment and economic development has been frequently documented (Zwick, 1963). Historically, transportation has played a major role in the development of countries, regions, and cities. From his earliest days, man has been dependent on transportation for movement from one point to another. This dependence has forced him to invest substantially in transportation facilities.

In the early development of the U.S., water transportation was the dominant mode of travel. Economic and industrial activities developed around seaports and along sea-lanes. Later, in the 1800s and early 1900s, railroads came to play a more substantial role in the developmental process of the country (Barloon, 1965; Zwick, 1963).

In a highly developed country such as the United States, highway systems have become the most common mode of transporting people and goods within as well as between regions (Small, 1983; Preston, 1973). The great importance of highways as the most common form of communication and travel led Congress in 1940 to propose a national network of four-lane highways. However, at that time, Congress was concerned that a freeway system would not generate a return on its investment.

Eisenhower, upon becoming president, argued convincingly that federally built freeways were an economic as well as a military necessity. On June 29, 1956, the National System of Interstate and Defense Highways Act was signed into law. This law authorized the expenditure of more than $40 billion for the construction of 41,000 miles of an integrated highway network (Altshuter, 1981; Dickinson, 1964).

The financing of this huge project relied heavily on a three-cent-per-gallon gasoline tax and on truck and bus levies proposed by Congress. The cost of the new system was to be paid on a matching basis, with the federal government covering 90 percent of the construction cost and the individual states the remaining 10 percent, as well as 100 percent of the maintenance (Preston, 1973; Rao and Larson, 1982).

Historically, scholars in the field of regional economics and development have frequently emphasized the importance of the physical infrastructure in regional development. Transportation planners also have argued that investment in transportation infrastructure represents a key component of a region's economic potential Straszheim (1972) pointed out the dominant role of transportation investment in the classic theory of firm and household location, as well as in the theory of interregional comparative advantage and trade. The historic importance that transportation had in the past has led many regional economists and planners to explore the possibilities of highway investment as a tool for regional development. It is also important to point out that direct or indirect decisions that involve transportation investment provide a practical means for implementing regional economic development.

THE GENERAL SCOPE OF THE PROBLEM

In recent years federal funding for many civilian programs, and in particular for regional economic development programs that include investment in highway systems, has declined drastically. Rising construction and maintenance costs for major highway systems have substantially outpaced the current funding level. There is general agreement among transportation planners, policy makers, and regional developers that the traditional sources of highway funding might not be sufficient to meet funding needs in the future (Schoppert and Herald, 1983).

Fox and Smith (1990) noted that public expenditure has slowed in the past 25 years. Most of the decline is greatly noticed in the most important sector, i.e., highways. In their conclusion they pointed out that:

> While most other major spending categories – health and hospitals, sewerage, and water – have maintained their share of total infrastructure spending, the share accounted for by highways has declined from 57 percent in 1964 to 39 percent in 1987 (p.51).

Figure 1 illustrates spending in the different economic sectors.

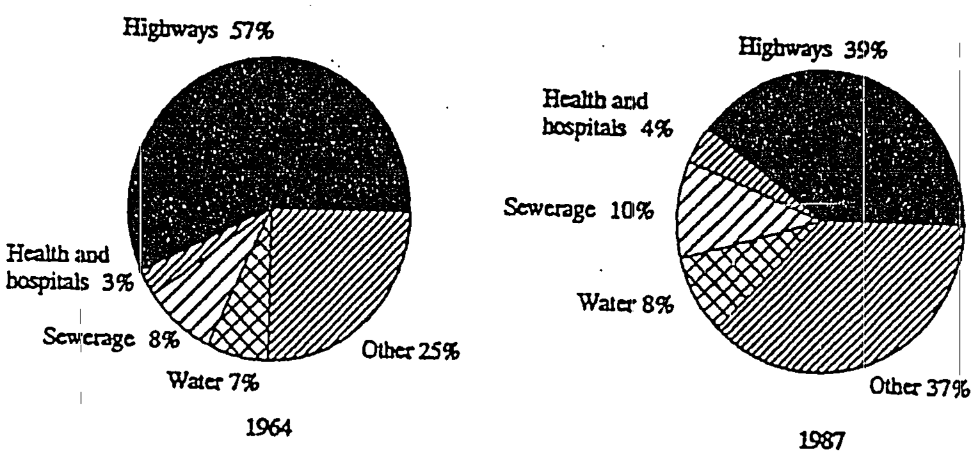


Figure 1. Share of highway spending in relation to other categories. Source: Fox and Smith, 1990, P. 54.

As a result of the shortage of highway funding and the lack of federal support, individual states have started to take on more responsibility for keeping their road networks intact. In almost all of the states in the Nation, the state departments of transportation have started to use economic development as a criterion for highway funding.

However, the great disagreement and speculation about the role of highway investment for economic development have made justification for highway funding difficult. Scholars such as Colwell (1963), Dodge(1965) and others have indicated that transportation investment has been a major stimulus for economic development. They further contend that this investment has shaped the pattern of development in this country. Others have argued that transportation investment can have not only a positive effect, but also a negative and a permissive effect (Gauthier, 1970; Wilson, et al. 1966). Gauthier (1970) and Wilson, et al. (1966), also indicate that a negative effect can occur whenever investment in transportation reduces the potential growth in activities which are directly productive, while the permissive effect occurs because transportation investment alone will not lead to economic development.

The evidence is clear that the impact of highway investment on regional economic development is still debated and further research is highly needed. This conclusion is clearly stated by Isserman, et al. (1989):

> However, in no instance has the case been convincingly made that feasible alterations in the transportation system in the United States have the potential to markedly affect regional development. . . . The interaction of transportation and economic development requires much additional research (p.1).

THE OBJECTIVE OF THE STUDY

The primary objective of this dissertation is to examine the longitudinal impact of various types of road investments on economic development in Oregon in order to better understand this dynamic relationship. Beneath this broad statement of intent are three more specific goals. First, a current examination of the dynamic relationship between road investments and economic development should fill a void in transportation and economic development literature. Second, any conclusion generated by this analysis could be utilized as a planning tool when no current clear guideline on this phenomenon is available. Finally, a set of research questions put forth as conceptual targets would strengthen the empirical and theoretical aspects of this relationship.

Such a study will be significant because it could possibly help public policy makers and transportation planners understand the complexity of the relationship between road investment and economic development. It will also enhance their abilities to best utilize their limited resources. In addition, this research will offer additional insight into the theories and empirical works in the field of transportation and economic development.

ORGANIZATION OF THE STUDY

The remaining chapters are organized as follows: Chapter II presents a brief discussion of the debate over the causal relationship between transportation investment and economic development. This is followed by a discussion of the theoretical perspective, and then a review of the empirical works on transportation investment and its impact on regional economic development. A conclusion of the literature review follows, and several key issues are raised.

Chapter III presents a description of highway systems and economic development in Oregon. Included in this chapter is a discussion about the development of the highway network and its impact on economic development in Oregon.

Chapter IV presents the methodology used for the analysis in this study. Included in this chapter are the research questions, the research design and models, and the data sources.

Chapter V presents the empirical analysis. Included in this chapter are a discussion of the relationship between road investment and economics at a different level of spatial aggregation, the major research finding, and a formal summary conclusion.

Chapter VI presents the conclusion of discussions of major research findings and their implications.

CHAPTER II

REVIEW OF THE LITERATURE

THEORETICAL PERSPECTIVES ON THE EFFECTS OF HIGHWAY INVESTMENT ON ECONOMIC DEVELOPMENT

This chapter will present the theoretical perspectives that affect the relationship between highway investment and economic development. First and foremost, the issue of cause and effect in the relationship between highway investment and economic development will be addressed. Second, the effect of road investments on the nation's economy will be explored. Third, the historical role of transportation investment in the development process will be discussed. Fourth, more recent views regarding transportation investment and its impact on economic development, and the resulting policy implications, will be addressed. Fifth, the previous empirical works in the field are discussed, followed by a summary of the literature review.

THE CAUSALITY CONCEPT

As previously stated,the interrelationship between transportation investment and economic development is complex and very hotly debated in the transportation and economic development literature. Previous theoretical as well as empirical works have had different views regarding the issue of cause and effect and the direction of the relationship between transportation investment and economic development.

Transportation Investment is a Cause of Economic Development

Some scholars in this field, such as Colwell (1963), argue not only that transportation investment has a major effect on a region's economic development, but that this relationship is very direct. Colwell argues that small settlements gave way to small towns and small towns to cities, with growth patterns changing and population dispersing all over the region as a result of advancements in transportation technology.

The precise nature of the relationship between transportation investment and economic development is not always clear in the literature, but Dodge (1965) contends that the development of transportation technology accelerated advancement during the Industrial Revolution and that this in turn greatly contributed to economic development in this country.

Wilson, et al. (1966), in his study of the effects of highway investment in some developing countries, found that in countries such as Bolivia, Guatemala, and India, road buildup initiated development that would not have occurred otherwise. In the cases of Thailand, Peru, and El Salvador, highway buildup was more of a response to development that was already underway in these regions. Even in these areas, though, highway investment facilitated dynamism and further enhanced economic development. Hunter (1965) found a close link between low-cost transportation and industrial development in the two communist giants, China and the Soviet Union.

Economic Development is a Cause of Transportation Investment

Other scholars argue that economic development and the demand for transportation were the real causes behind transportation investment, rather than the other way around. Barloon (1965) contends that changes in industrial structure and in locational needs have dictated the structure of transportation; in other words, transportation investment was a response to the shipping and locational needs of the various industries in the region.

Cootner (1963), in his study of the role of railroads in the development of this country, indicated that railroads have followed development rather than the other way around. Some scholars argue that in a developed country like the U.S., the relationship between transportation investment and economic development has been reversed and that the transportation network in this country has reached a stage of maturity (Zwick, 1963). In essence, any further investment in transportation networks may not lead to further economic development.

Simultaneous Relationship

The final point regarding the issue of causality is that it runs both ways and each factor reinforces the other. In essence, transportation investment will cause development in a region, but as the region develops, more transportation investment will be needed (Payne-Maxie, 1980; Straszheim, 1972). Payne-Maxie points out that highway investment has a lesser effect than it once had on overall mobility and locational decisions. However, once a region develops, investment in roads will be necessary in order for the region to keep up with the mechanism of development. Small (1983) adds that development in this country has dominated travel patterns. As this transportation network has developed, it has determined the location of households and firms, which in turn affects a region's development.

THE EFFECT OF ROAD INVESTMENTS ON THE NATION'S ECONOMY

Aggregate Level

The effect of transportation investment, particularly the effect of road investments on the nation's economy and development, is highlighted in this section. Smith (1967) sums up the impact of road investments on GNP growth throughout the 1958-1965 period. He contends that transportation's share of GNP growth at this period is approximately 20 percent, if not greater. Of this 20 percent, road investment accounted for about 83 percent. In other words, road investment's share of the GNP is approximately 17 percent. In a report published by the U.S. Department of Transportation (1980) clearly stated that the national economy will operate more efficiently with an improved, highly integrated highway network

In another study, Wheat (1969) indicates that at the national level, as well as the regional level, freeway cities grew faster than non-freeway cities, and the impact of freeways on employment, especially manufacturing employment growth, is substantial.

The positive impact of transportation investment on the nation's economic development makes spending on public works programs such as roads favorable. Based on this argument additional infrastructure investment is highly recommended to sustain and/or increase the level of economic development in this country. This conclusion is based on a top-down approach in analyzing this relationship. In other words, this approach emphasizes the usage of aggregate economic relationships such as the nation as a whole, or a region as one unit, to set desired infrastructure investment levels.

Disaggregate Level

Aschauer (1990) and Montgomery, Deich, and Pinkston (1989) argued against the aggregate approach. They point out the difficulties in using aggregate economic relationships as a precise guide for infrastructure spending. Their criticism was based on the fact that this approach gives no indication of the extent to which current infrastructure programs could be more efficient, besides the fact that it creates the wrong political incentives. Their arguments were that the bottom-up, or the disaggregate, approach is more appropriate in setting up infrastructure spending targets. Such an approach would evaluate separately the desirability of individual projects (or classes of projects) much more efficiently.

The fact of the matter is that the level of aggregation is very important in determining the efficiency and directionality of this relationship. Straszheim (1972) emphasized this point very strongly and pointed out the significance of the level of aggregation on this dynamic relationship. He concluded that road investment tends to lead to or cause economic development at the disaggregate level of the analysis, such as the county level or project level. On the other hand, when counties are grouped, the direction of the causal relationships tends to run both ways. Further more, Eberts (1991) clearly pointed out that the unit of analysis is the most important determining factor in studying the linkage between transportation investment and local economic development.

THE TRADITIONAL VIEW OF TRANSPORTATION AND ITS IMPACT ON ECONOMIC DEVELOPMENT

Transportation Investment is a Tool to Economic Development

There is a general agreement among scholars regarding the common historical view of transportation investment as an essential element in any region's development. Mohring and Harwitz (1962) indicate that a highway's impact on an economy will be greater than that of, say, a steel mill.

This strong positive view of the impact of highway investment on economic development is attributed to the indispensable role that water transportation, and then rail transport, played in the early development and success of the Industrial Revolution in Europe and in the United States (Dodgson, 1974; Hart, 1983). Gauthier (1970) stresses the prominent historic role of transportation investment in the development process, and particularly in this country (Colwell, 1963).

Scholars such as Gauthier (1970) and others contend that transportation investment is a prerequisite for economic development. Forkenbrock and Plazak (1986) point out that accessibility is critical to any region's economic development. Rostow, in his study of the stages of economic growth (1964), identifies the railroads as the most critical investment in this country's early development. Hunter (1965) points to the clear relationship between low-cost transportation and economic development, and he attributes the early success of the Industrial Revolution to advances in transportation technology. Throughout history, the developmental process of cities has been dependent on transportation, and changes in transportation technology have changed the pattern and distribution of cities. Early railroad buildup resulted in railroad cities and, more recently, the development of highway systems has resulted in a more even distribution of cities (Harris and Ullman, 1945).

Wilson, et al. (1966) traces the historical view of transportation investment back to Adam Smith's famous thesis that the division of labor is limited by the extent of the market, but Wilson adds that the extent of the market is limited by the transportation technology. Wilson also indicates that transportation investment will lead to the division of labor, that this labor division will extend the market and consequently raise productivity, and that the productivity increase will in turn enhance economic development.

Transportation and Location Theory

The other traditional theoretical view is that low-cost transportation was a primary determining factor in industrial location. Among all the other factors industries consider when locating to a certain region, transportation cost is the most important, since it lowers shipment costs and reduces the time and resources required to move input into and output out of the area (Kuehn and West, 1971). Any changes in this service can result in expansion or contraction of industry in the region (Wilson, et al. 1966).

Smith (1971) considers transportation investment as the single most important element in plant location. This vital role of transportation investment, and in particular low-cost transportation, can be traced back to the early works of Frederich and Weber (1929). Dodgson (1974) indicates that low-cost transportation has traditionally been emphasized in location theory. Indeed, it was a major determinant, and regions with lower transportation costs have a relative advantage and hence a better chance of economic development.

Traditionally, the choice of a plant location is determined by transportation costs as a function of distance. This is well documented in the early classic location theories of Isard (1956), and others. Dodgson (1974) indicates that the low-cost transportation which has been emphasized in the conventional location theory has a great impact on the pattern and distribution of activities in space. Kuehn and West (1971) add that the recent interest of economic theorists in highway investment as a tool of economic development is not of recent origin, since it can be traced back to the early classic location theories. There is a strong relationship between beltways and industrial development, and accessibility has resulted in greater industrial dispersal (Payne-Maxie, 1980). Also, transportation investment affects household and firm location, thereby affecting regional development (Small, 1983; Straszheim, 1972).

THE CONTEMPORARY VIEW

Recent Controversial View of Transportation Investment

Recent theoretical views of transportation investment in a developed economy, such as that of the United States, have changed. Many believe that transportation investment will have a lesser effect than it once had and that transportation network has reached the stage of maturity (Eagle and Stephanedes,1987; Zwick 1963). Also, there is a general agreement that the impacts of transportation investment on the region will change over time, and that recently the impacts of transportation investment on the U.S. economy have become more subtle (Straszheim, 1972).

This recent change in the view of transportation investment may be attributed to the general shift in the economy from raw materials-oriented industries to more highly valued goods-and-services-oriented industries, which are less dependent on transportation (Zwick, 1963; Straszheim, 1972).

Also, other factors such as the shift from a lower grade to a higher grade of goods, the changes in production technology which reduce requirements for raw materials, and the shift to newly developed and highly processed goods have all lessened the role of transportation (Barloon, 1965; Heilbrun, 1981).

Transportation Investment Benefits

Transportation investment benefits are enormous on economic development. Highway investment has a dramatic effect on the functioning of the economy and, more broadly, on the society as a whole (Mohring and Harwitz, 1962). Forkenbrock and Plazak (1986) contend that rich and well-maintained transportation networks provide a high degree of accessibility to markets, resources, and goods and that accessibility has proven to be critical to any region's development. It is also stated that transportation investment is an essential element of capital formation and leads to more capital investment in the region (Gauthier, 1970; Hawkins, 1962; Hart, 1983; Cole, 1968).

Cole (1968) adds that improved transportation reduces the costs of movement, thus releasing working capital that can be used more productively as fixed capital elsewhere in the economy, resulting in greater economic development. integrated transportation networks have provided safe, cheap, speedy, and more dependable travel(Zwick, 1963; Kuehn and West, 1971). Harris (1974) indicate that construction of new highways reduces trucking costs and thus stimulates interregional shipments. This cost reduction may cause industries to relocate from one region to another. Highway investment also reduces transportation costs, makes land more accessible, increases the value of property adjacent to the highway, and encourages industrial and commercial activities in the neighboring areas (Mohring and Harwitz, 1962).

Amano and Fujita (1970) contend that improving the transportation system reduces transportation costs and time for passenger and commodity movement, thus increasing the system's total capacity. In a report to the U.S. Department of Transportation, Curtis C. Harris Associates (1976) summarized the economic benefits of highways as follows: First, the local economy will benefit from the large construction expenditure, which they suggest will create more employment and income in the region with a multiplier effect as it is spent in the region. Second, improvement and/or expansion of road networks result in a reduction of interregional transportation costs, thus inducing industries to relocate from one region to another. Third, well-maintained highway networks reduce traffic congestion, therefore making the region more attractive for both goods and people.

In addition, Grossman and Levin (1963) and Payne-Maxie (1980) have pointed out that highly integrated highway networks will improve the competitive advantage of a region. Yet, not all regions will share the same positive economic gains from transportation investment (U.S. Department of Transportation, 1980).

The external effects of highway investment lead to changes in the production of goods, which result in increased production capability in the region (Brown, et al. 1972). Barloon (1965) and Cameron (1971) summarized the direct benefit of highway investment on the users of the system as follows: reduction in operating costs, reduction in time costs, reduction in accident costs, and reduction in the strains and discomforts of driving.

In urban areas, highway investment can provide better property access, reduce urban congestion, and enhance urban efficiency (Pyers, Cichy, and Stein, 1979). It also encourages mobility, thus leading to a greater decentralization of population, services, and industries (Dickinson, 1964).

Transportation Investment in Third World Regions and Remote Regions of the Developed World

Transportation investment is still vital in third-world regions and in regions that lack accessibility in highly developed countries. In areas where development potential is still high, transportation investment is evident, and we would expect to find development patterns similar to those in the highly developed regions in western countries (Hart, 1983).

Owens (1966) indicated that the lack of transportation investment in some third-world countries was the main obstacle to economic and social development, particularly in the larger cities. And the lack of these strongly needed facilities can cause serious problems in these regions' regional as well as national development (Dodgson, 1974). Wilson et al. (1966) pointed out the significance of transportation investment in these regions' development and the barriers to development that result when there is a lack of such investment.

In their study of selected developing countries in South America and Africa, Wilson et al. (1966) indicate that investment in the form of building, expanding, and improving roads and railroads has led to positive economic results. Investment in roads has opened up markets for agricultural products, has increased the efficiency of the production and distribution of goods and services, and has made available new untapped resources.

Transportation investment in third-world countries is large and comprises 30 to 40 percent of the national budget in some countries, compared to 15 percent or less in developed countries. However, the magnitude of this investment, coupled with other types of physical and economic infrastructures, is greatly needed, since it contributes substantially to capital formation and thus to development in these regions (Wilson, et al., 1966; Gauthier, 1970). Brown, et al. (1972) point out that the significance of transportation investment in the underdeveloped regions is its immediate effect on production increase and expansion of the market, both of which are essential for economic development.

Some believe that the impact of transportation investment in a highly developed country is very limited. However, in areas of the developed world where lack of accessibility is evident, such as in the Atlantic region of Canada, transportation investment is essential. It has been argued that lack of accessibility in this region was the major barrier to the region's economic and industrial development (Wilson, Stevens, and Holyoke, 1977).

Furthermore, transportation investment is vital in remote areas of developed countries and in areas that lack ready access, such as is the case with the Appalachian region, in order to raise the economic standards through increasing income and employment in such regions (Grimm and Wegmann, 1976). Kuehn and West (1971) have also shown how good roads played a major role in the expansion of economic activities and the location of industry and new firms in the Ozarks.

Transportation Investment is Necessary but not Sufficient

The fact that transportation investment is a necessary but not sufficient condition for economic development is well documented in the transportation and economic development literature. However, scholars in this field such as Forkenbrock and Plazak (1986) contend that there are many factors that contribute to economic development in any region. Factors such as the cost and availability of land, labor, and capital, relative tax rates, and availability of services and infrastructure are all essential for regional economic development.

Piet (1989) concluded that: "Improvement of infrastructure is not a sufficient condition for regional development. Many other intermediary factors play a role" (p.272).

Highways alone cannot create miracles; however, a good network of highways is necessary for a region's competitive advantage. Highly improved highway systems can insure the attractiveness of a region to new industries and the ability of the region to maintain existing industries, and they can also increase the overall efficiency of the region as a good place to work and live (Grossman and Levin, 1963; Eberts, 1991). Dickinson (1964) adds that, good highway networks will have a tremendous impact on regions whenever the other conditions for development are available.

Several local-impact studies have indicated that transportation investment can have a direct effect on regional economic development in areas where other prerequisites for development -- availability of labor, natural resources, etc. -- also exist (Grimm and Wegmann, 1976). Furthermore, Munro pointed out (1969) that a lack of accessibility was not the main barrier to development in the Appalachian region, but that other factors are as important, or more so, for this region's development.

Wilson, Stevens, and Holoyke (1977) have indicated that the lack of transportation investment was a major deterrent to industrial location in particular areas. However, they point out that the development and attractiveness of any region will require many other factors that are as important, as or more important than, transportation investment. Munro (1969) blamed the lack of development in the Appalachian region on the unavailability of the other important factors of development, rather than on the inadequacy of the transportation system in the region.

The flexibility of highway systems has increased their accessibility by opening up areas and markets that were beyond reach before (Smith, 1971). Mckain (1965) contends that highway investment can have certain desired economic consequences. He claims that investment in road networks leads to changes in land-use patterns, extends trade centers, and expands a region's resources. However, he adds that investment itself is an external stimulus for change, and that the response to be made to this stimulus depends on the capacity for change in the region. Factors such as the availability of community leaders, a plan of action, and public motivation are necessary for social and economic change to take place in any area.

<u>Transportation Investment is a Safe Political Investment</u>

Politicians, regional officials, and local citizens have consistently supported investment in roads. Transportation investment is a high political priority in the development process (Hansen, 1973). It also proves that someone is doing something in the region to initiate growth (Munro, 1969). Highway expenditure is often supported since it is used as a means of generating employment for construction and maintenance workers and facilitates business investments desired by state and local officials (Altshuter, 1981).

Bottiny (1975) went a step further to indicate that highway spending not only creates employment in the region, but it also influences the final demand for goods in the region, and the construction workers' income will increase the income of the region as a whole. In particular, industries that provide construction materials and consumer expenditures will benefit greatly from this investment. Curtis C. Harris Associates (1976) added that the impact of road investment varies from region to region. They also indicated that construction expenditures will benefit the region in the short run especially if a large number of the local people are employed in the construction activity. Others, such as Curtis C. Harris Associates (1976) and Wheat (1969), contend that the long-term effect of highway investment on overall efficiency in the economy and on increased productivity in the region is long-lasting.

The notion that transportation investment is politically safe has been challenged recently. Wilson et al. (1966) and Hansen (1973) maintain that the durability, longevity, externalities, and indivisibility of this investment have troubled public officials in calculating and specifying future costs and benefits.

Lee (1990) adds that transportation investment is implicitly thought of as a good tool for economic development, and more transportation would be better. However, he was skeptical of this argument, since transportation investment is costly, and more often than not, that other sectors of the economy will suffer in order to get more transportation investment.

Highway Investment Impact in Urban Areas

The argument that highway investment in urban areas can have negative consequences on the people who are affected by the construction is well supported, and local opposition can be very strong. Highway investment in urban areas can create noise and air pollution caused by the heavy traffic, neighborhood destruction, and dislocation of local people (Cameron,1971; Cline,1963, Thiel,1964). In addition, Thiel (1964) asserts that these negative consequences will outweigh the positive consequences of flexibility and accessibility.

Highway Investment and Regional Economic Development Policies

European communities reach the conclusion that it is hard to draw a clear-cut policy regarding the use of highway investment as an instrument of regional development (Dodgson, 1974). This confusion is attributed to the lack of a clear theory and evidence to guide policy makers in formulating their policies. However, policy makers in England and in other European countries formulate their policies to achieve the following goals. First, building a national highway network will improve the rate of national economic development. Second, highway investment improves communication and travel and, ultimately, the national economy. Third, highway investment in depressed and isolated areas will attract new firms and industries to the region, thus increasing the competitive advantage of these regions. Fourth, investment in road and highway buildup is needed since it supports actual, as well as expected, development in the region (Judge, 1983).

One issue European policy makers have to deal with is whether highway investment should take place before or after development takes place in the region, or simultaneously. Another concern facing policy makers in these countries is the distribution of these services and the adoption of a policy that deals with the core-periphery problem (Button and Gillingwater, 1983).

Previously, the dominant policy was the concentration of highway investment in metropolitan and urban areas, since this brings the highest return on investment (Hart, 1983; Button and Gillingwater, 1983). However, more recently European policy makers adopted a policy that favors more equitable allocation of highway investment. Thus, less-advantaged, depressed, and isolated areas should get a fair share of the investment so that their present and future needs are met. Also, these isolated regions will be linked to metropolitan centers by a highway network which overcomes the distance barriers between the two regions (Button and Gillingwater, 1983).

In the U.S., policy makers and transportation planners have followed a path similar to that which has been taken by the English and European community in allocating highway investments. Earlier, highway systems were built to connect major urban centers and to enhance accessibility and travel between urban areas. Also, a large portion of highway investment moneys were spent in metropolitan areas to increase movement within urban regions (Altshuter, 1981).

Fox and Smith (1990) highlighted the impact of infrastructure on economic development in three types of regions: intermediate, congested, and lagging. This criteria is based on their current level of development and presence of ingredients for further development. First, they noted that intermediate regions are in a position for further economic development because most ingredients for development were in place. Second, congested regions were not in a good position for further development because additional growth might cause bottlenecks in transportation and production. Third, lagging regions were in no position for economic development because they lacked many of the necessary ingredients for development. They concluded that:

> Given the uncertainty surrounding the use of public infrastructure as a development tool, policy makers should carefully identify the locations most likely to benefit from infrastructure. . . Intermediate type regions, where other economic development ingredients are in place, will probably benefit most from enhanced infrastructure. But all regions, even lagging regions that stand little chance of raising their levels of economic development, can find more effective ways to spend their limited development budgets (p.58).

In addition, Eberts (1991) indicated that the state of the region is very important in determining the effect of transportation infrastructure on regional economic development He further adds that booming regions where congestion and other inefficiencies are present transportation investment would have a great and immediate effect on regional economic development.

However, there has recently been more emphasis on an equitable allocation of resources. This new emphasis should benefit rural, isolated, and depressed areas more than before. For instance, the 1965 Appalachian Regional Development Act was one of the acts that were designed to stimulate economic development in this depressed region (Grimm and Wegmann, 1976). This act proposed the spending of $1.2 billion, with 63 percent of this amount to be spent on the construction of not more than 2,350 miles of highway in Appalachia (Munro, 1969). The main goal of this investment was to facilitate the flow of people and goods throughout the region, particularly in remote and isolated areas that had growth potential.

The stated goal of the act was to increase accessibility in the region and make it more attractive for industries and economic activity. However, in the case of West Virginia, the lack of highway improvement and poor highway design have hampered development potential in this area (Shafran and Wegmann, 1969).

Forkenbrock and Plazak (1968) examined the role of the state Department of Transportation in using highway investment as a tool to enhance economic development. They surveyed the fifty states' departments of transportation and found that thirty-six states explicitly use highway investment to help facilitate economic development in the state.

Oregon is one of the thirty-six states that use highway investment as a tool to enhance economic development. Of these thirty-six states, twenty-two have special funds to foster economic development. Iowa's Project RISE (Restore Iowa's Sound Economy) is one of the few successful programs that have used highway investment to foster economic development.

In the U.S., policy makers and transportation planners have wrestled with three policy concerns in allocating highway resources. First, there is the issue of balanced development or equity in allocating resources, which implies that highway investment resources should be allocated equally throughout the region. This issue in essence will lead policy makers to the important question of where to spend highway investment moneys -- should they go to areas where more efficiency will result, i.e., metropolitan areas, or should they go to rural areas where the need is greater (Pyers, Cichy, and Stein, 1979; Forkenbrock and Plazak, 1986; Payne-Maxie, 1980)?

The second policy concern is: What type of industry will this investment serve? Should it target local industries such as retailing and service industries, which would generate less income locally? Or should the investment target nonlocal industry or export-oriented industry such as manufacturing, since such an investment would have a greater multiplier effect and thus increase income in the region (Forkenbrock and Plazak, 1986)?

Third, there is the policy issue of involvement of the private sector in financing highway development. Since public funds for road improvements and/or expansion have shrunk in recent years, several approaches to generating private funds have been developed. Some of the approaches that have been tried and seem to be working include land use regulation, special tax assessments, service charges, and public land acquisition (Schoppert and Herald, 1983; Forkenbrock and Plazak, 1986).

EMPIRICAL STUDIES

Previous empirical works have focused on four areas: first, an examination of the general relationship between highway investment and economic development, emphasizing accessibility; second, an examination of the causality concept; third, the effects of highway investment on the various industries in a region; and fourth, an examination of the effects of accessibility on economic development, holding the effects of some development variables constant.

General Highway Investment Impact on Economic Development

Geagler, March, and Wenier (1979), in their study of the long-term social and economic effects of the turnpike on the eastern Connecticut region, found that towns located along the turnpike experienced increases in population, manufacturing employment, retail sales, and land values.

Although the whole region's population grew, towns with greater accessibility experienced greater population growth. Gaegler et al. found that the entire region benefited from the accessibility offered by the turnpike, but that development was not equally distributed among all towns in the region.

In another study, on the effects of transportation improvements on the economic development of Appalachia, Shafran and Wegmann (1969) found that overall employment in the area increased above the national rate. In their analysis of West Virginia networks, using graph theory for three time periods (1950, 1965, and 1975), they found that improved highway networks had a major impact on the region's accessibility patterns, which in turn impacted economic development. However, the final finding was not clear on whether development could be attributed to improved highway networks or to renewed interest and a greater demand for natural resources in the region.

Two studies centered on the state of Ohio, one conducted by the Ohio Department of Transportation (1971) in order to examine the impact of Interstate Route 71 on the northeastern Ohio region. This study found that Interstate Route 71 had no clear impact on population changes in that region, although population changes were observed along the access and interchange zones. The second study by William and Koohal (1970) reached a some what contradictory conclusion. This study found that there was a strong relationship between highway capacity and income in the area and that improved highway networks reduced disparities in per-capita income. All of these studies, however, suffered from leaving too many variables uncontrolled. Also, some studies focused on one region or a part of the region and ignored the interregional effects of economic development:

investment in one region could cause industry and people to relocate, thus changing economic development patterns (U.S. Department of Transportation, 1980).

Examination of Causality

A study by Eagle and Stephanedes (1987) examined the causal relationship between highway investment and economic development in Minnesota. Counties were divided into different groupings: urban, next-to-urban, regional centers, next-to-regional-centers, and rural. Their finding was that the direction of the causality from highway construction expenditures to employment growth was weak. However, there were indications that long-term effects from investment in regional-center counties were well supported. This study also indicated that in the short run, construction expenditures benefit the local economy. One criticism this study raises is that previous studies use cross-sectional data that does not capture the long-term effect which highway investment has on economic development.

A study by Stephanedes and Eagle (1980) tested causality in the relationship between highway investment and manufacturing and retail employment. Thirty Minnesota nonmetropolitan counties were selected, and cross-sectional data as well as time-series data were used for this analysis. The finding was in agreement with those of the previous studies. The cross-sectional data indicated no significant relationship between highway expenditures and manufacturing and retail employment. However, the time-series data indicated that there was a two-way causal relationship: highway expenditures affect manufacturing and retail employment, and employment growth affects highway expenditures. In counties that are twenty-five miles or farther from large metropolitan areas, causality was not very apparent.

In another study, Balvir and Balbir (1984) examined the casual relationship between public expenditure and national income for the period 1950 – 1981. They used Granger-Sims method to test the direction of causality between public expenditure and national income. Their findings indicate that on a aggregate level, causality between public expenditure and national income is neither Keynesian nor Wagnerian. On the disaggregate level, namely by functions of public expenditures (such as administration, social service and development, and defence service), and by region (such as different sub-regional levels) causality is mixed, and the relationship between public expenditure and development is bi-directional and instantaneous.

Also, a more recent study by Eberts (1991) examined the casual relationship between transportation investment and regional economic development strongly support the linkage between the two.

Highway Investment Impacts on the Various Industries

In a time-series study of the relationship between highway investment and employment changes in the nonmetropolitan counties of the U.S. in the period between 1950 and 1975, Briggs (1981) found that tourism is one industry which can benefit the most from highway investment. Contrary to common belief, manufacturing and wholesaling employment, which is believed to be associated with accessibility, did not show a strong relationship with highway investment.

In a similar study, Briggs (1983) controlled for exogenous variables that affect development in these counties, such as population size, proximity to metropolitan areas, and net migration prior to highway buildup. His findings were similar to those of the previous study, in which service industries, and in particular tourism, were the industries that were highly related to the interstate system, while wholesaling and manufacturing industries did not show a strong relationship.

Stephanedes and Eagle (1980) conducted a time-series study investigating the relationship between highway expenditures and manufacturing and retail employment for the thirty counties in the state of Minnesota. They found that highway expenditures do have an impact on manufacturing and retail employment. They also suggested that other industrial sectors of the economy should be investigated in future studies.

Carlino and Mills (1987) conducted a study of the determinants of population and employment growth in 3000 counties in the U.S., controlling for some economic and demographic factors that affect growth in the counties. Their finding was that in the 1970's interstate highways had an impact on manufacturing and total employment growth. Also, investment in highways did alter population growth in the counties.

Kuehn and West (1971) carried out a study of the relationship between highway types and regional development in the Ozark region over the three time periods of 1954, 1959, and 1963. They found that highways have little impact on total employment growth; however, local roads are moderately correlated with total employment in the counties. They also found that local roads and access networks were clearly associated with manufacturing employment, while primary federal highways were not associated with manufacturing employment. Finally, they found that trade and service industries were moderately correlated with all types of roads, primarily federal highways, local roads, and access networks.

The general conclusion resulting from the above empirical studies regarding which industries benefit the most from highway investment was that the service industry, particularly tourism, benefits greatly from highway investment. Results regarding other industries, particularly manufacturing and wholesaling, were conflicting.

Transportation Investment Impact on Economic Development Holding the Effect of Other Development Variables Constant

Other empirical studies have tried to examine the effects of transportation investment, in particular highway investment, on economic development, holding the effects of some development variables constant. The results of these studies have given transportation a secondary role. Carlino and Mills (1987) have indicated that interstate density is positively related to total employment, manufacturing employment, and population density in counties. However, the strength of this relationship among other factors that determine development in the counties was not clear.

Briggs (1981), in his study of the impact of the interstate system on the development of the nonmetropolitan U.S. counties, concluded that interstate counties as a group have a higher growth rate and that total employment and net migration were affected. However, interstate development alone in any single county is no guarantee of greater economic development or demographic change, especially if variables such as population size and proximity to metropolitan areas have been controlled.

In their analysis of thirteen factors that affect industrial location in the Atlantic region of Canada, Wilson, Stevens, and Holoyke (1977) pointed out that transportation-related variables do have an impact on industrial location in this region. Transportation factors ended up being ranked differently among the other factors (e.g., roads ranked fourth, railroads sixth, shipping eighth, and air thirteenth). However, when transportation-related variables were taken together, they ranked sixth among the nine remaining factors that affect the location decisions of industries.

In a study of the effects that investment in motorways has on regional economic development in northern England, Dodgson (1974) found that when other variables are held constant, motorway investment does not increase employment in the areas through which motorways pass.

Some empirical studies have pointed out the importance of population size and proximity to metropolitan areas as determinants of economic development in nonmetropolitan areas. Briggs (1981) pinpointed the importance that both city size and proximity to metropolitan areas had on employment changes in a given county. Eagle and Stephanedes (1987) indicated that regional-center counties that have populations of 28,000 or more, and counties adjacent to regional centers have higher total increases in employment. In the long run these counties are expected to grow faster than others.

Lichter and Fuguitt (1980) added that rural-remote counties are the least affected by highway investment. However, rural-remote counties with city populations of 2,500 or more and locations fewer than 100 miles from the nearest SMSAs have experienced greater employment and population growth. In another study, Fuguitt and Beale (1976) found that interstate counties that are fewer than 100 miles from the nearest SMSAs and that have population sizes of from 2,500 to 10,000 will experience higher development in general than will those interstate counties which are remote and have populations of fewer than 2,500. Hansen (1973) pointed out that proximity to SMSAs and the existence of a well-developed highway network can partially influence a county's development.

SUMMARY

This chapter's review of studies examining the relationship between transportation investment and economic development highlighted the complexity of this relationship and the need for more rigorous investigation. For example, Isserman et al. (1989) clearly stated that regional science and other related fields have not done enough in providing the needed research in this area.

Other scholars (Colwell, 1963; Dodge, 1965; Cootner, 1963; Zwick, 1963; Straszheim, 1972) have greatly debated and speculated on the directionality in the relationship between transportation investment and economic development. Their discussions clearly point out the complexity of this phenomenon and the lack of clear understanding of its dynamics.

However, the level of aggregation is very important in determining the direction of this relationship. On the national level or aggregate level previous theoretical as well as empirical studies have supported the conclusion that public expenditures lead to regional economic development (Balvir and Balbir, 1984; Smith, 1967; Wheat, 1969; U.S. Department of Transportation 1980). On the other hand, on a regional and local level or disaggregate level previous works have given a mixed conclusions (Aschauer, 1990; Eagle and Stephanedes, 1987; Fox and Smith, 1990; Montgomery, Deich, and Pinkston, 1989; Stephanedes and Eagle, 1980; Straszheim, 1972)

The traditional role of transportation has a strong positive view of the impact of transportation investment on economic development. Studies such as those by Gauthier (1970), Forkenbrock and Plazak (1986), and Wilson, et al. (1966) provided clear evidence of the historically dominant role of transportation in economic development. For example, Wilson, Stevens, and Holyoke (1977); Payne-Maxie (1980); and Dodgson (1974) traced back the vital role of low-cost transportation to the early classic location theories of Hoover, Losch, and Isard.

Recent theoretical views of the impact of transportation investment on economic development in a highly developed economy such as that of the United States is changing. This change is attributed to the arrival of transportation networks at the maturity stage, the shift in the U.S. economy from goods-producing (manufacturing industries) to service-producing (non-manufacturing industries), and changes in product technology which have minimized the role of transportation (Barloon, 1965; Heilbrun, 1981; Zwick, 1963; Straszheim, 1972).

Therotical as well as empirical studies on the issue of causality in the relationship between road investment and economic development is not settled yet. Previous works have given conflicting conclusions depending on the level of aggregation.

The debate among policy makers and regional planners is still lingering over the concentration of highway investment. Some policy makers favor concentration of highway investment in metropolitan areas (Hart, 1983; Button and Gillingwater, 1983). Recently, policy makers have been pushing for even distribution of this investment over the entire region.

Another debated issue in the literature is the types of industries this investment will service. Numerous empirical studies have wrestled with this issue with little success. Stephanedes and Eagle (1980), Carlino and Mills (1987), and Wheat (1969) found that total and manufacturing employment benefit greatly from road investment. In other empirical studies, Briggs (1981;

1983) and Keuhn and West (1971) indicated that service employment is the biggest beneficiary of this investment.

Other empirical studies have tried to investigate the effects of transportation investment on economic development, holding the effects of some development variables constant. The results of these studies have clearly demonstrated that transportation maintains a secondary role when other development variables are held constant (Carlino and Mills, 1987; Wilson, Stevens, and Holyoke, 1977; Dodgson, 1974).

In summary, the issues that have been discussed in this chapter are critical to understanding the dynamic relationship between road investment and economic development, since it is implicitly assumed that highway investment, which constitutes the largest share of public infrastructure spending, is a key ingredient in the support of long-term economic development. However the debate and speculation on the linkage and relationship between transportation investment and economic development is still going. Thus, the need to understand and explain the linkage between transportation investment and economic development is certainly more than just an academic exercise.

CHAPTER III

HIGHWAY INVESTMENT AND ECONOMIC DEVELOPMENT IN OREGON

This chapter discusses the historical development of the highway network as well as its link to economic development in Oregon. This discussion incorporates the following three areas. First, the evolution of highway networks, sources of highway funding, and highway conditions. Second, the link between highway investment and economic development. The third area is a discussion of the state of economic conditions followed by a summary conclusion.

HISTORY OF HIGHWAY DEVELOPMENT

Network Evolution

Oregon's economy, with severely limited public funds in recent years, has affected the ability of the Oregon Department of Transportation to build and maintain its transportation network. Despite the impacts of the troubled economy, Oregon's Department of Transportation, particularly its highway program, is one with a history of early leadership and accomplishments.

Prior to the 1900s, county governments were responsible for the construction, layout, and repair of county roads under their jurisdiction. Funds to pay for the construction and repair of roads were collected through a general road tax, and voters were required to pay a poll tax of $3 or do actual work on the road equivalent to that amount (Klaboe, 1974; Moore, et al., 1984).

The state first recognized the road problems in 1913, when the legislature created a state highway commission, composed of the governor, the secretary of state, and the state treasurer. The legislature also authorized the construction of 2,900 miles of roads (1,070 miles of primary roads and 1,830 miles of secondary roads). To finance its organization, the state highway commission received $10,000, plus a property tax of a quarter of a million dollars for highway purposes (Klaboe, 1974).

In July 1919, Oregon was the first state to adopt a gasoline tax as its main source of revenue to finance its roads. The initial rate, authorized in 1919, was one cent per gallon. Later on, the success of the gasoline tax and the increased demand for more revenue to finance road construction and/or improvement, raised the rate to seven cents per gallon in 1967 (Yturri, 1983). Oregon was followed by other states within a few years, and the gasoline tax became the main source of revenue for highway construction and/or development in most states in the country.

Oregon had a commanding lead in highway development, ranking among the top ten states in highway developments; in the early days, highway construction progressed very rapidly (Yturri, 1983). In 1923 the completion of the Pacific Highway was one of the state's greatest achievements. It made Oregon the first state west of the Mississippi to construct a paved highway from border to border.

During World War II, highway construction came to a halt and the focus shifted mainly to highway maintenance. An increased need for highway construction and the lack of sufficient revenue to carry on highway programs led the state in 1951 to authorize the sale of $72 million in general revenue bonds to finance highway construction programs.

After World War II, and in particular in the late 1960s, the construction of the interstate highway system accelerated. Oregon has 735 miles of this huge interstate highway system, and a total of 123,393 miles of highways and road networks (Yturri, 1983).

By 1973 the growing energy crisis, the fuel shortages, and the reduction of income from motor revenue sources created uncertainties for Oregon's highway development program. The reduction in revenue sources directly affected the state's capability of keeping up with its construction needs. This reduction of income was coupled with a high inflation rate that caused major cutbacks in program budgets. Also, the increased costs of labor, materials, and equipment have made it necessary for the state to consider different methods of contracting and to reschedule major highway construction projects.

In the early 1980s, increased fuel prices decreased motor fuel consumption in Oregon from a recent high of 1.4 billion gallons in 1978 to an average annual level of 1.25 billion. In the 1980s, state collected revenues for roads were depressed, at around $200 million annually between 1978 - 1982. To help increase revenues in 1982, the U.S. Congress approved a five cent per gallon federal fuel tax. This federal tax was designed to enable the state to deal with its deteriorating highways and bridges and to construct new ones. This has been very helpful but the state must raise additional revenues to carry out its highway projects and to match federal funds available to Oregon. The legislature recognized the growing need and authorized a fuel tax increase, moving up from seven cents to twelve cents per gallon. In addition, total local revenues raised at the county and city level have increased dramatically (Price Waterhouse, 1986).

While several recent increases in road, fuel, and weight-mile taxes authorized by the legislature have helped, the system is deteriorating very rapidly from age and increased usage. Backlogs of deferred repair and preservation work are expanding to major proportions, and many segments of the road system are in urgent need of modernization. To modestly improve the backlog of substandard roads and bridges, $6 billion is required (Barney & Worth, Inc., 1989). A backlog of essential maintenance and reconstruction work, deferred because of inadequate funding is reaching significant proportions, and is projected to exceed $19 billion over the next 20 years (Price Waterhouse, 1986).

Sources of Highway Funding

Oregon relies on two sources to finance highway investment. One source of highway revenue is federal fees, which come from federal fuel taxes (gasoline tax of nine cents per gallon and diesel fuel tax of fifteen cents per gallon) and other truck taxes. The state pays the federal government the federal highway tax it collects, then receives a share of this money back. The share is based on a federal formula which considers, among other things, the amount of federal-aid road mileage in each state. In addition, Oregon has succeeded in capturing federal discretionary funds over the past several years. These funds are specific federal funds targeted for special projects, not allocated to the state by formula (Oregon State Highway Division, 1990a).

The second source is state fees, which include motor fuel taxes, weight distance fees, and vehicle registration fees. The state also receives minor revenue from truck load violation fees, bridge tolls, billboard permits, sales of highway bonds, property and equipment, and others. State fees account for approximately 65% of the highway funds, with the rest coming from federal sources (Oregon State Highway Division, 1990b).

Highway Conditions

With the major highway construction completed and the state recovering from its difficult economic times, the challenge is to preserve and maintain the existing highway network. A study conducted in 1976 revealed that about 50% of the highway miles on the state system were in poor or very poor condition (see Figure 2).

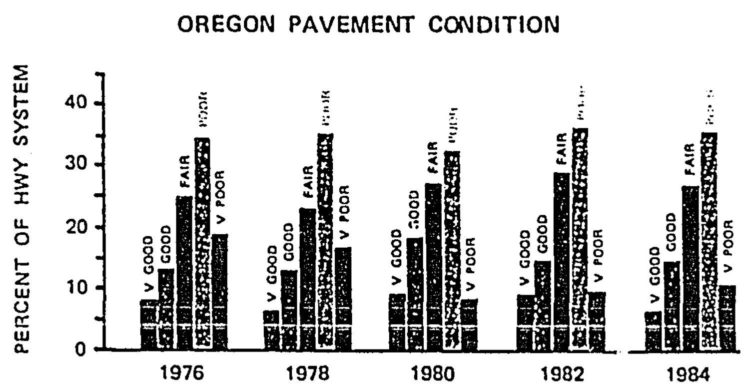


Figure 2. Oregon highway conditions over different periods of time. Source: Oregon State Highway Division, 1990a, P. 6.

Another study by Yturri for the Oregon Department of Transportation (1983) indicated that highway conditions in Oregon are deteriorating and that over half of the total highway system requires major maintenance. A more recent study by the Oregon Department of Transportation (1990) indicated that only 42% of Oregon highways are in fair condition or better. This percent has changed over time depending on the availability of funds and the amount of dollars spent on road repairs and maintenance work. In the 1980s, the percent of roads in the Oregon highway system rated as being in fair or better condition has improved to reach 67% in 1988. This percentage has remained constant since 1988 (see Figure 3).

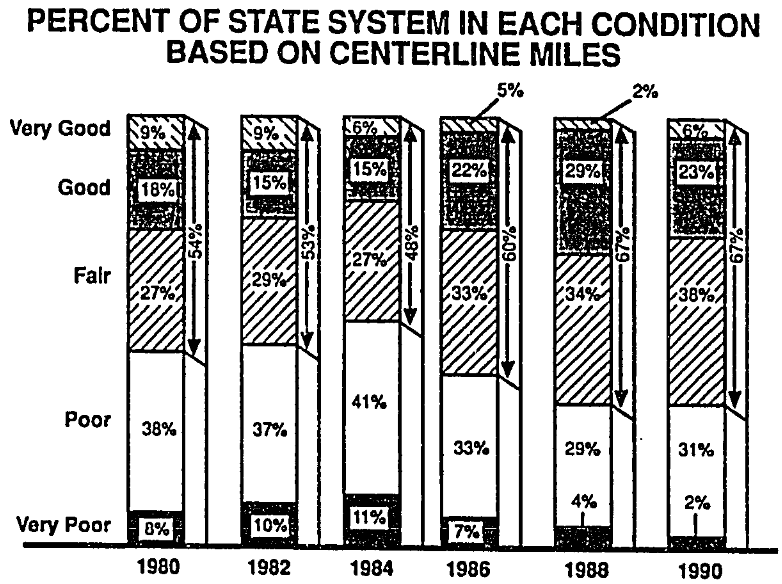


Figure 3. Changes in roadway conditions over the last ten years.
Source: Oregon Department of Transportation, 1990, P. 16.

The condition of the state highway system is of great concern to the state transportation officials. The concern results from a revenue-cost squeeze that for the past several years has crippled the ability of the department's construction programs to keep pace with the deterioration (from age, exposure, and use) of the exisiting system. Major reconstruction and new construction has become increasingly costly if not prohibitive. Increased costs of maintenance have reduced the state construction program to zero. The accelerating road deterioration and shrinking revenue sources put the state in a serious delimma. The state must decide whether to spend these limited funds on maintenance and repair of existing roads, or the construction of new ones. The state's present and future policy approach is to preserve and maintain the existing highway network first, then construct new ones where required. In addition, the state's long-term plans are considering other facets of highway programs (Oregon Department of Transportation, 1990).

HIGHWAY INVESTMENT AND ECONOMIC DEVELOPMENT

The use of transportation investment to stiumlate economic development has been one of the primary factors in Oregon's development from pioneer days to the present (Oregon Department of Transportation, September,1977). One of the primary goals of the Oregon highway system is to provide for economic development by: moving through traffic safely and efficiently between geographic and major economic areas within Oregon; moving through traffic between Oregon and adjacent states; and moving traffic to and through major metropolitan areas (Oregon State Highway Division, 1990a). In pursuing this goal, the state has built a highly integrated highway network that is safe, cost-effective, and provides efficient access throught the state. In addition, this network has provided good linkage among most areas and regions in the state (see Figure 4).

Many state, as well as local, officials and transportation planners have argued that highway investment is essential for economic development in this region. This link is clearly stated in a report published by the Oregon State Highway Division (1990b) which describes the mission of the Highway Division as to design, build, and maintain quality highways that complement Oregon's natural beauty and help spur economic development.

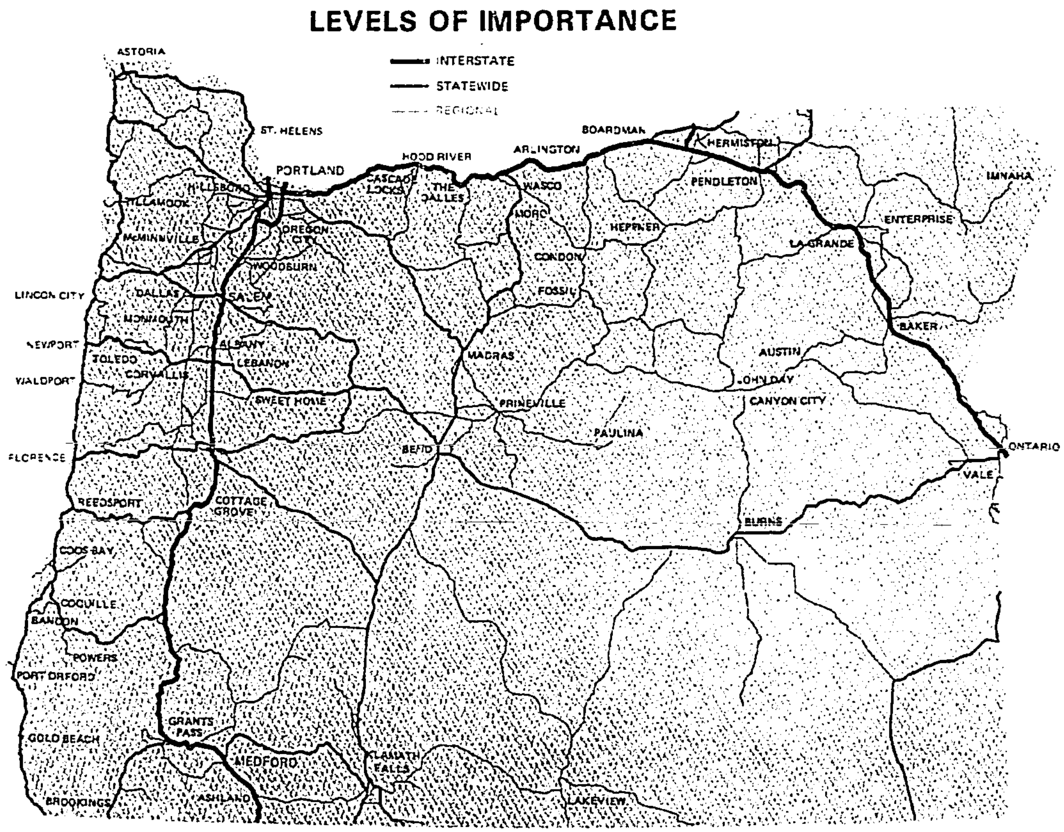


Figure 4. The state integrated highway system. Source: Oregon Department of Transportation 1990. p. 10.

A report published by the City Club of Portland (1987) indicated that investment in all road types, in the form of construction and/or maintenance, and other infrastructure underlies economic development in this region. The report further added that highly integrated transportation networks, partiuclarly well-built roads, will enhance movement and travel of people and goods in the region. Furthermore, the attractiveness of the region for business and new industries is highly enhanced as a result of the investment in road networks.

A discussion with Oregon's transportation director, Fred Miller, in Yturri's *Challenge for the 80s* (1983), pointed out the necessity of transportation networks for economic development to take place in this region. These transportation investments, particularly highway construction, provide badly needed jobs and reduce transportation costs for the movement of both people and freight.

In recent years, the problem is that highways and bridges are aging, and decling revenue sources are no longer able to deal with the rapidly deteriorating roads and bridges. State officials are aware of this problem and are exploring all avenues available to involve the local, federal, and private sector and to provide the needed funds to keep highway networks in good and usable condition. In spite of this, the gap between revenue required to keep the network intact, and the revenue generated is widening over time (see Figure 5).

OREGON'S ECONOMIC CONDITIONS

Oregon's economy is in a process of transition. Traditionally, the economy has relied heavily on its natural resources as a source of jobs , income, and wealth. Most of these natural resources are renewable and will continue to be an important source of economic activity. However, new trends are emerging and to maintain levels of employment and raise incomes of Oregonians, the state must diversify its economic activity (Goldschmidt, 1989).

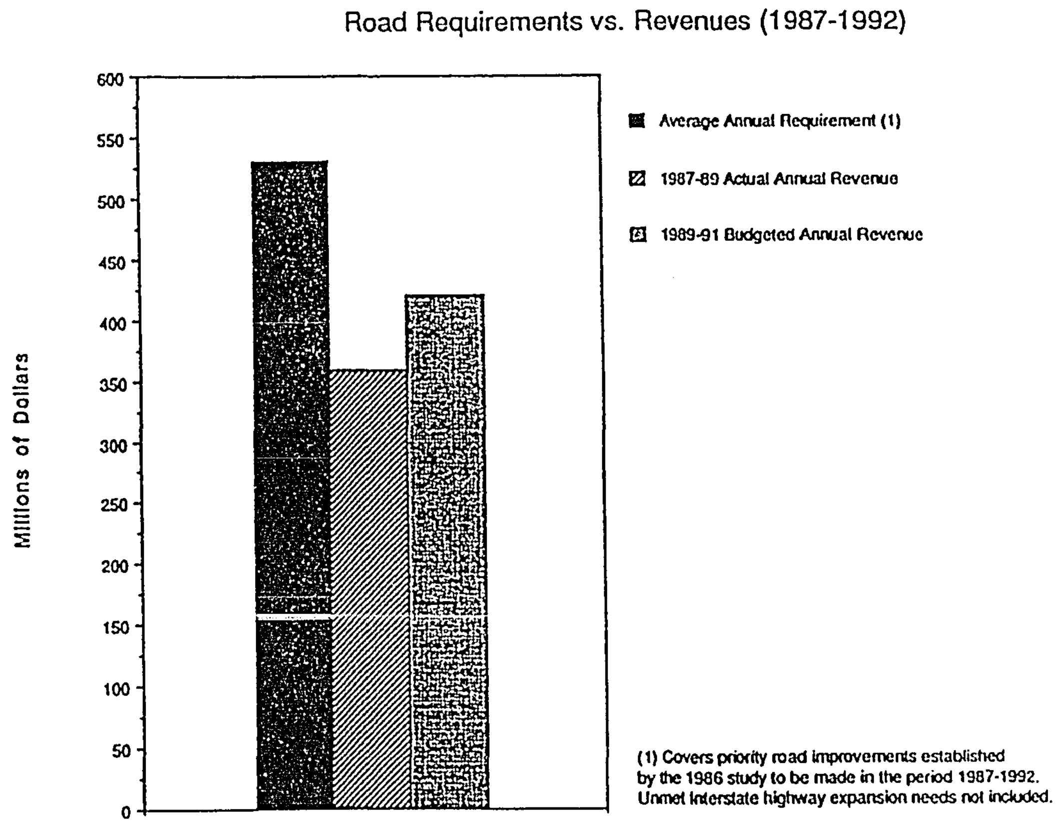


Figure 5. Oregon road requirements vs. revenue generated (1987 - 1992). Source: Oregon Department of Transportation, 1989, p. 3.

Fortunately, since World War II, Oregon has been gradually diversifying its economic activity. This diversification is clearly noted in the continuous decline of manufacturing employment in the natural resource industries. Accompanying this decline has been a continuous increase in employment in non-traditional manufacturing industries, such as metals and high technology (see Figure 6).

During most of the post war period, employment in Oregon rose steadily, exceeding the national average. In the 1970s, economic conditions and economic development in the state were relatively good, and in 1979, employment reached its highest point. However, during much of the 1980s, diversification stalled while forest products entered a severe downturn, and the economy entered the worst recession since the great depression. During much of the 1970s, people moved into Oregon in record numbers, attracted by jobs and widely hearalded quality of life. During the first half of the 1980s, however, a large number of the population was lost as jobs disappeared and people moved away (Cortright, 1984; Goldschmidt, 1989).

Oregon, compared to other states, ranked poorly in many key economic indicators. For instance, Oregon unemployment was ranked as tenth highest in the nation. Employment growth from 1980 - 1985 ranked 47th, and per-capita income ranked 31st out of the fifty states. Overall Oregon ranked 43rd in the U.S. in unemployment, employment growth, and duration of employment (City Club of Portland, 1987).

This poor economic performance is greatly attributed to Oregon's traditional reliance on natural resource industries. Coupled with the lack of serious effort at the state and local level to explore new avenues for other industries to develop and prosper, and thereby enhance economic development. The state's historic dependence on natural resource industries, such as agriculture and forest products results in Oregon's economy being directly tied to national economic trends and policies, and is consequently unstable (Oregon Department of Economic Development, 1982).

In recent years, other economic sectors such as tourism, trade, metals, and basic maufacturing, and electronics have experienced some growth. For instance, the tourism industry has grown so rapidly as to become Oregon's third largest industry, after lumber and agriculture, and its largest employer. In addition, the other economic sectors have experience a gradual increase and have the potential to grow (Goldschmidt, 1989).

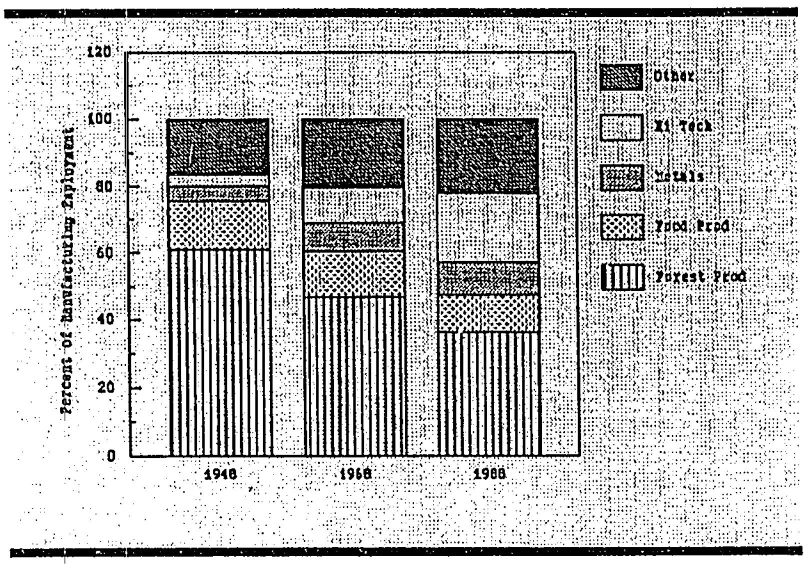


Figure 6. Oregon manufacturing employment changes in the various industries over three periods of time (1948, 1968, 1988). Source: Goldschmidt, 1989, p. 5.

CONCLUSION

Generally, the condition of the state highway system has improved. Recent revenue increases at the state and federal levels have been beneficial to state's highway development. Still, a host of challenges must be confronted. The widening gap between revenues generated and cost to maintain the highway network has to be reduced and further funding for highway programs found. Preservation and modernization activities will have to be enhanced to cope with Oregon's population and economic development needs. As previously stated investment in the state infrastructure, and in particular in its transportation network is crucial for its present and future development.

CHAPTER IV

METHODOLOGY

As indicated in Chapter I, the purposes of this study are to investigate (a) the longitudinal impact of the different road investments on economic development in Oregon, and (b) the temporal effect of this investment on economic development in this region. This chapter consists of a brief description of the approaches used to examine transportation impact on economic development, followed by a summary, research questions, research design, research models, and data sources.

APPROACHES EXAMINING THE IMPACT OF TRANSPORTATION INVESTMENT ON ECONOMIC DEVELOPMENT

Previous approaches investigating the impact of transportation investment on economic development vary and depend on the purpose, period to be studied, and the level of aggregation. Some techniques can be characterized as disaggregate and cross-sectional in nature such as input/output and to certain extent cost/benefit analysis. Others are aggregate in nature and can examine either/or cross-sectional and longitudinal impact of this relationship, such as regression analysis. The following is a brief summary of these different approaches.

Regression Analysis

Regression analysis has been extensively used to examine the impact of transportation investment on economic development. One frequent use is the examination of the impact of one mode or more of transportation on the development process, either holding the impacts of other development factors constant or incorporating them in the analysis (Briggs, 1981; Harris and Mitchell, 1966; Kau, 1977; Pyers, et al., 1979; Payne-Maxie, 1980).

A more recent and common use of this technique is in the examination of the causal relationship between transportation investment and economic development. Eagle and Stephanedes (1987) and Stephanedes and Eagle (1980) used regression analysis with the Sims test to examine the causal relationship between highway investment and economic development. Balvir and Balbir (1984) used regression analysis with the Granger-Sims test to examine the impact of public expenditures on national income. In addition, Eberts (1991) used regression analysis to examine the causal relationship between transportation investment and economic development.

This technique is aggregate in nature and very useful in studying certain aspects of the relationship on national or regional levels. This approach can use either cross-sectional or time-series data to examine this relationship. The regular use of this method in previous research, and in particular its usage in the Granger causality test, makes it the most appropriate technique to use for this research.

Aerial Photography

One of the early methods used to examine the effects of highway investment on economic development was aerial photography. Thung (1972) used aerial photography to measure the impact of highways on rural development in Thailand. Also, Munro (1969) used aerial photography to measure land-use change and development at interchange points in the state of Alabama. Photographs were taken annually during the period from 1964 to 1970 and were supplemented by secondary data to determine development and land-use change a half-mile from the interchange points.

In a study of the impacts of highways on rural life and land-use change in southern New York, Gessaman and Sisler (1976) used aerial photographs as the primary data source for the analysis, although they also employed secondary sources such as ground surveys.

This approach is very primitive and commonly used as a substitute for costly data gathering where data is not available in regions, such as third world and remote, isolated regions of the developed world. However, this approach is aggregate in nature where it provides a precise location identity or a photograph of a certain place without the ability to disaggregate this information. This, in essence, would make it very difficult to pinpoint the economic impact since the information collected is highly aggregated and mostly lumped together. Furthermore, this technique takes a snapshot of an area at one point in time making it very difficult to understand the dynamic effect of this relationship.

Input-Output Models

Input-Output models are used to examine the effect of road investment on economic development. In a study which modeled investment priorities for national road improvements in Korea, Kim, and Rho (1985) used the input-output model. This approach is aggregate in nature since it addresses the interaction between transportation investment and all other economic sectors. However, one of its shortcomings is that it is static in nature, failing to capture the dynamic effects of one road on other roads in the transportation system.

Other scholars have used the either conventional input-output model or the expanded and modified input-output model (Liew and Liew, 1985; Amano and Fujita, 1970; Harris, C.C. , 1974; and Sakashita, 1974). Some modifications of the model have succeeded in capturing the changes in the relationship between transportation investment and economic development over a short period of time. The multi-regional input-output model used by Liew and Liew (1985) was modified to capture changes in output prices, input costs, and transportation costs over a four year period.

The general criticism of these models is that they look at the relationship or try to study the impact of transportation investment and economic development at one point in time and fail to model changes over a period of time. The main shortcoming of the conventional input-output model is that it is static, cross-sectional, and short-term in nature. Nonetheless, they can be very useful in studying inter-industrial and interregional aspect of the relationship over a short period of time.

Cost-Benefit Analysis

This approach is disaggregate in nature and would be very useful in examining the impact of transportation investment on economic development at the lower end of the analysis, such as the project level or class of projects. The U.S. Department of Transportation (1980) has used this technique to examine the effects of highway investment on economic development. One of the main criticisms of this approach is that it is too narrowly focused on user benefit and cost efficiency, rather than economic development in the region.

This approach is quite different than the long-run dynamic economic approaches. One major difference is that in cost-benefit analysis, only a subset of specific alternatives is analyzed. Furthermore, cost-benefit analysis will tend to be more detailed since it looks at a disaggregate and lower end of the analysis.

SUMMARY

The selection of any of the above approaches would greatly depend on the type of question being addressed and the purpose of the particular research. Some might look at the aggregate aspect of the relationship, while others might focus on the disaggregate aspect of the analysis. Also, some are concerned with the snapshot impact of this relationship, while others are interested in examining the dynamic long-term effect. These techniques can be used separately or can be used to complement each other.

Since highways are costly infrastructures, the study of their long-term effects is very important. The significance of this study stems from the fact that a number of previous empirical studies were cross-sectional in nature, thus making it difficult to identify long-term effects. Payne-Maxie (1980) strongly criticized previous studies as being short-term in nature and looking only at the disaggregate level of analysis, thereby resulting in misleading and inaccurate long-term effects. Studying the long-term effect of highway investment on economic development would be more useful and helpful in assisting transportation planners and policy makers to understand past effects and help project the future.

RESEARCH QUESTIONS

There are four general questions in this research:

1. Does there exist a general relationship between highway investment and economic development? Then, if a relationship is established, what is the direction of this relationship and what is the level of significance?

2. What is the relationship between the types of road investments (construction and maintenance expenditures) and types of roads (e.g., primary state highway, secondary state highway, and local roads and streets) and employment growth (total, manufacturing, and service employment), and how significant is this relationship?

3. What is the dynamic effect of the various road investments on growth of the three types of employment?

4. What is the effect of the level of geographic aggregation on the relationship between road investment and employment growth?

RESEARCH DESIGN

In order to address the above questions, this research seeks to investigate the dynamic relationship between road investments (measured by road expenditures) and economic development (measured by employment growth). Road expenditures are measured by total road expenditures (grand total road expenditures, total capital expenditures, total maintenance expenditures), total capital expenditures on the three types of roads (primary, secondary, and local), and total maintenance expenditures on the three types of roads (primary, secondary, and local). Employment growth is measured by total employment, manufacturing employment, and service employment.

These relationships are analyzed from 1955 to 1985 for the state as a whole, for every county in the state, and for different spatial groupings of counties.

The research proceeds on three levels. The first is examination of the relationships between the various road investment and employment growth at the state level. The second is examination of these relationships for different spatial groupings (such as Portland metropolitan counties versus the rest of the state counties, urban counties versus rural counties, interstate counties versus non-interstate counties, coastal counties versus non-coastal counties, and the Oregon Department of Transportation's five designated regions). The third is investigation of these dynamic relationships at the local level or the county level.

It is also worth noting that shazam statistical package was used for the execution of this research. Also annual data for both road expenditures and employments growth was used in this research.

RESEARCH MODEL

Previous empirical research has not clearly determined the direction and strength of the relationship between highway investment and economic development. Therefore, it is prudent to study the causal relationship between road investment and economic development in this region. To study the causal relationship between the various roads expenditures and employment growth, the Granger causality test is used. This test involves the estimation of the two following regressions:

$$1.\ \text{Employment}_t = \sum_{i=1}^{n} \alpha_i \text{Road exp.}_{t-i} + \sum_{i=1}^{n} \beta_i \text{employment}_{t-i} + U_1t$$

$$1.\ \text{Road exp.}_t = \sum_{i=1}^{n} \eta_i \text{Road exp.}_{t-i} + \sum_{i=1}^{n} \delta_i \text{employment}_{t-i} + U_2t$$

where,

Employment_t = Employment at the beginning period

Road exp._t = Road expenditure at the beginning period

n = Lag length

U_1 and U_2 = Uncorrelated disturbance

With the two regression models simplified, the Granger causality test (regression 1) assumes that the current employment growth variable is related to past values of employment itself as well as of road expenditures. Regression 2 postulates a similar behavior for road expenditures where the current road expenditure variable is related to past values of road expenditure itself as well as employment growth (Gujarati, 1988).

To determine the direction of the relationship among the different road expenditures and employment growth, we need to distinguish between four cases:

1. A one-way directional relationship from road expenditures to employment growth is identified if the estimated coefficients on the lagged road expenditure in regression 1 are statistically significant as a group ($\sum \alpha_i \neq 0$), and the set of estimated coefficients on the lagged employment in regression 2 is not statistically significant ($\sum \delta_i = 0$).

2. A one-way directional relationship exists from employment to road expenditures if the set of lagged road expenditures in regression 1 is not statistically significant ($\sum \alpha_i = 0$), and the set of lagged employment coefficients in regression 2 is statistically significant ($\sum \delta_i \neq 0$).

3. A bilateral relationship exists when the sets of both road expenditures and lagged employment coefficients are statistically significant in both regressions.

4. Finally, no relationship exists when the sets of both road expenditures and lagged employment coefficients are not statistically significant in either regression.

The causality test examines the direction of the relationship between the different road expenditures and employment growth for the state as a whole, the different spatial groupings of counties, and individual counties in the state. To test for the causality, a run of the two regression equations is conducted for the period 1955 to 1985.

In addition to the causality test, this research examines the time-lag effect of the different road investments on employment growth. This includes identifying lag length and the cumulative lag effect of the various road expenditures on employment growth. Different lag structures are tested to estimate the appropriate lag length, and a six-year lag is used to estimate the cumulative lag effect of this investment. In order to capture the development impact of the investment, a lag structure of three to five or six years is appropriate, Eagle and Stephanedes (1987) indicated in their study of the State of Minnesota counties.

DATA SOURCES

Secondary data are used for the execution of this research. *The State of Oregon Highway Report* was the source of data for total road expenditures, total construction expenditures, construction expenditures for the three types of roads (primary highway, secondary highway, and local roads and streets), total maintenance expenditures, and maintenance expenditures for the three types of roads. This report is published annually by the State Department of Transportation Programming Section. It presents information pertaining to the State Highway Division revenue, system mileage, construction expenditures, maintenance expenditures, and other miscellaneous data.

Furthermore, construction and maintenance expenditures are classified by the type of road (primary state highway, secondary state highway, and local roads and streets) for each county in the state, and for the state as a whole from 1950 to 1985. All data on road expenditures are adjusted to the 1982 implicit price deflator for the fixed investment non-residential index (U.S. Department of Commerce, 1986).

The source of data for total employment, manufacturing employment, and service employment was the *Oregon State Department of Employment Annual Data Report*. This report is prepared annually by the Research and Statistics Division of the Oregon Department of Employment. It presents information pertaining to state employment classified by the type of employment (total, manufucturing, and service), for each county and city in the state, and for the state as a whole, from 1947 to the present.

Time series data for the various roads expenditures and the three employment sectors is available on a disk at the Center for Urban Studies, School of Urban and Public Affairs, Portland State University.

CHAPTER V

DATA ANALYSIS

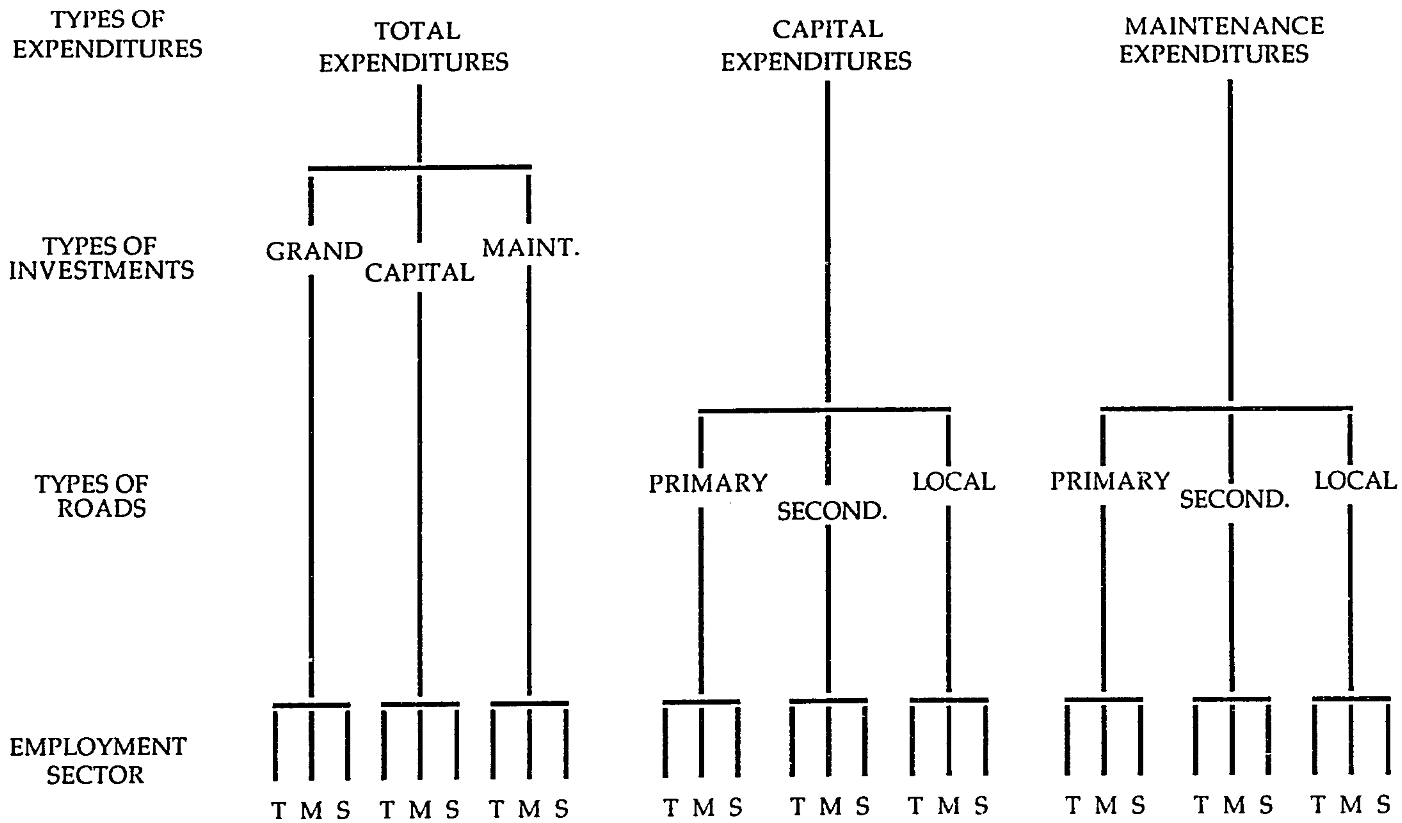
A discussion of the results of the data analysis is presented in this chapter. The four research questions for the study are discussed and analyzed here. This chapter is divided into five sections. The first section includes an outline of the empirical analysis design and the Granger Causality test. Second, the causal relationship between road expenditures and employment growth , and the temporal aspect of this relationship of the state as a single aggregate unit, is examined. Third, the causal relationship between road expenditures and employment growth, and its time-lag effect for the different groupings of counties based on their geographic characteristics and for the five regional groupings identified by the Oregon Department of Transportation, is analyzed. Fourth, the causal relationship between road expenditures and employment growth, and the temporal aspect of this relationship at the local level of the counties is discussed. Finally, a conclusion of the major findings of this research are discussed.

EMPIRICAL ANALYSIS DESIGN

The empirical analysis of the impact of road investment on economic development is measured by two primary measures: road expenditures and employment growth. Road expenditures are measured by the following surrogate measures: total road expenditures, total capital expenditures, capital expenditures for the three types of roads (primary, secondary, and local), total maintenance expenditures, and maintenance expenditures for the three types of roads (primary, secondary, and local). Employment growth is measured by three surrogate measures: total employment, manufacturing employment, and service employment. This research objective is to examine the impact of road investment divided by the type of investment (total, capital, and maintenance) and type of road (primary, secondary, and local) on the three employment sectors (total, manufacturing, and service) (see Figure 7).

THE GRANGER CAUSALITY TEST

The Granger causality test is used to determine the direction of the relationships in this analysis. This test is based on the following premise: Forecasts of some variable y (let's say, total expenditure) obtained using both past values of y and past values of another variable x (let's say, total employment) are more accurate than forecasts obtained using past values of y alone. Based on this criterion, and selection of an economic development indicator and a road investment indicator, the discovery that total road expenditure causes total employment growth indicates that road expenditures are not exogenous to employment growth. However, showing that the lagged expenditure variables are significant as a group does not preclude the possibility of a bi-directional causality. To test for that, a second regression is estimated where road expenditure is the dependent variable and the lagged values of total employment are the independent variables. Thus, the first regression examines the hypothesis that road expenditure causes employment growth, while the second regression examines the hypothesis that employment growth causes road expenditure (Granger, 1969).



Note: T = Total Employment; M = Manufacturing Employment; S = Service Employment.

Figure 7. Direction of the Causal Relationship Between the Various Roads Investments with Employments to Growth.

F-values are examined against the F-critical to determine its statistical significance, thereby determining the direction of the relationship. If the estimated F-value is statistically significant in the first regression, and statistically not significant in the second regression, this result suggests that road expenditures cause employment growth. However, if the estimated F-values are statistically significant in both regressions, this result suggests that road expenditures and employment growth have a bi-directional relationship. In other words, road expenditures cause employment growth, and employment growth causes road expenditures. Finally, if the estimated F-values are statistically not significant in both regressions, this result suggests that road expenditures have no relationship to employment growth.

In addition to the causality aspect of this relationship, this analysis examines the temporal effect of road investment on economic development. Eagle and Stephanedes (1987) contended that the real effect of road investments on the region's economic development may occur beyond the immediate future. They pointed out that a lag structure of three to five or six years will most likely capture the real and dynamic effect of road expenditures on employment growth.

The temporal effect of road investment on economic development examines two factors. The first is lag length, which measures the effectiveness of the investment over a period of time. Different lag structures are tested to estimate the lag length. The estimated T-value is used as a measure of the statistical significance of the investment over the years. Second is the cumulative lag effect, which measures the dynamic impact of the investment on employment growth over a six-year period. The estimated

F-statistic is used to measure the statistical significance of the cumulative lag effect of road investment on employment growth.

The approach to this empirical analysis consists of two components. The first is investigation of the causal relationship between the different road expenditures and employment growth. The second is examination of the dynamic effect of this investment measured by the lag length and cumulative lag effect on employment growth. This analysis proceeds for different levels of spatial aggregation: the state as one single unit, different spatial groupings within the state, and then individual counties.

THE RELATIONSHIP BETWEEN ROAD INVESTMENT AND ECONOMIC DEVELOPMENT AT THE STATE LEVEL

At this aggregate level of analysis or the state as one single unit,, the results of the relationship between road investments and economic development suggest that the total road expenditures (grand total road expenditures, total capital expenditures, and total maintenance expenditures) and capital expenditures for primary and secondary roads have a one-way directional relationship running from those road expenditures to the three employment sectors (total, manufacturing, and service), since the estimated F-values for these road expenditures are statistically significant at the 5-percent and 1-percent levels of significance. On the other hand, there is no reverse causation from the three employment sectors to road expenditures, since the computed F-values are statistically not significant.

Also, maintenance expenditures for the two types of roads (primary and secondary) and capital expenditures for local roads have a bi-directional relationship to the three employment sectors, since the estimated F-values for both road expenditures and the three employment sectors are statistically significant at the 5-percent and 1-percent levels of significance. In addition, maintenance expenditures for local roads have no relationship to the three employment sectors (total, manufacturing, and service), since the estimated F-values for both road expenditures and the three employment sectors are statistically not significant (see Table I and Figure 8).

The temporal aspect of this relationship seems to indicate that the different road expenditures have a long-term effect on the three employment sectors, since the estimated T-values are mostly statistically significant at the five- and six-year lags. However, total maintenance expenditures and maintenance expenditures for the three types of roads tend to have a shorter-term effect on the three employment sectors. On the other hand, the temporal effect of the three employment sectors (total, manufacturing, and service) in triggering the different road expenditures is mostly immediate, since the estimated T-values are statistically significant for the first year. Also, the cumulative lag effect which measures the marginal benefit of our dollars spent for road investment on employment growth is significant, since the estimated F-statistics for the different road expenditures are statistically significant at the 5-percent and 1-percent levels of significance. Furthermore, the cumulative effects of the total road expenditures and capital expenditures are more pronounced on the three employment sectors (see Table II).

In addition, the relative magnitude effect of total capital expenditures is greater than the relative magnitude effect of total maintenance expenditures on the three employment sectors. The relative magnitude effect of the capital expenditures of the three types of roads is clearly greater than that for maintenance expenditures on the three types of roads.

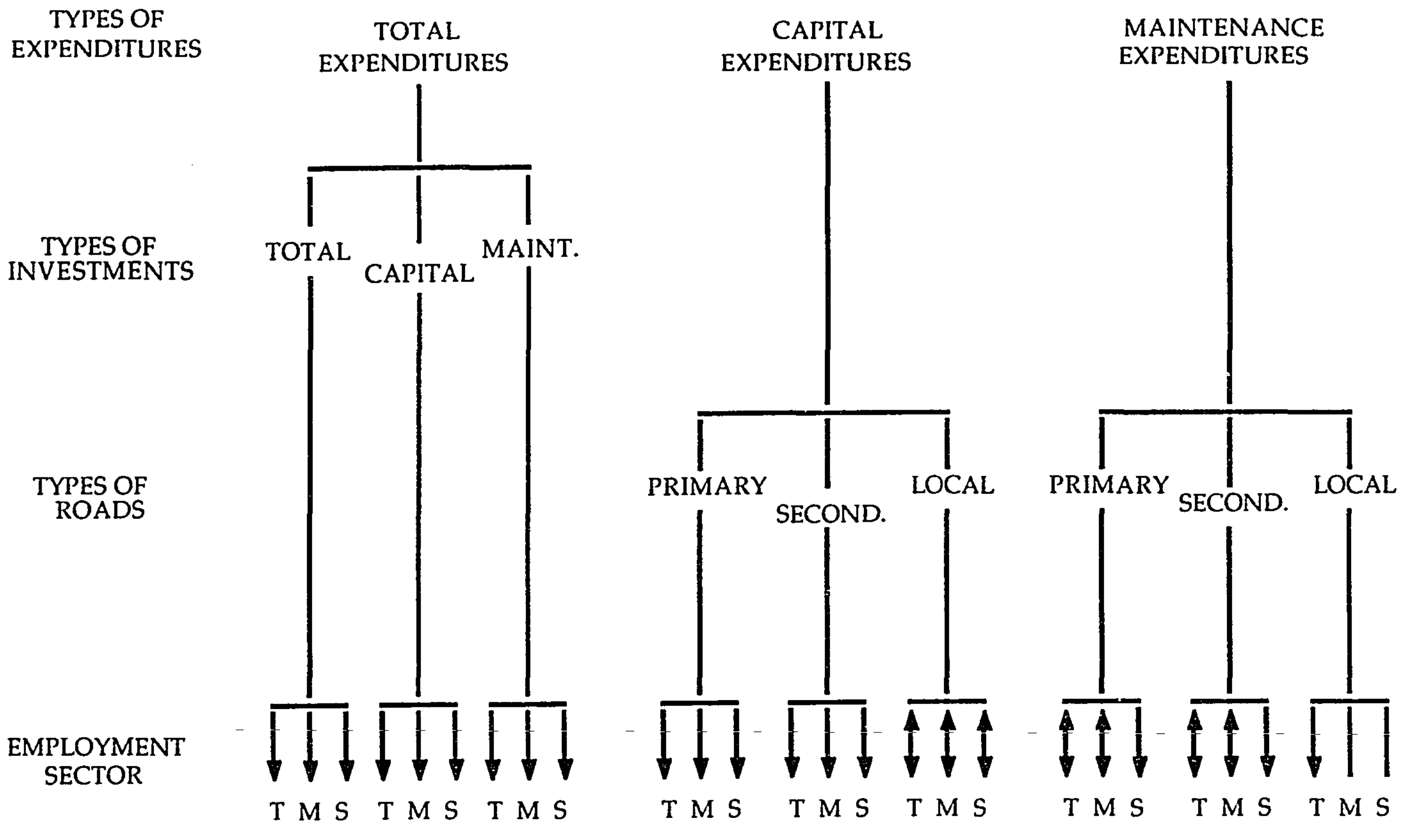
TABLE I

DIRECTION OF THE CASUAL RELATIONSHIP BETWEEN THE VARIOUS ROADS EXPENDITURES AND EMPLOYMENT TO GROWTH AT THE STATE LEVEL

Direction of Causality
Road Expenditures (EX) vs. Employment (EM)

	Total Expenditures						Capital Expenditures						Maintenance Expenditures					
	Grand		Capital		Maint.		Primary		Secondary		Local		Primary		Secondary		Local	
	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.
Tot . Emp.																		
EX ➔ EM	7.09	A	8.19	A	3.70	A	7.90	A	2.74	A	3.36	A	4.20	A	2.26	A	0.11	R
EM ➔ EX	1.10	R	0.98	R	4.87	A	0.74	R	0.90	R	8.03	A	9.28	A	0.48	R	0.44	R
Mfg. Emp.																		
EX ➔ EM	2.34	A	2.70	A	2.87	A	2.30	A	2.53	A	11.96	A	8.37	A	3.33	A	0.37	R
EM ➔ EX	4.01	A	3.71	A	7.74	A	3.23	A	0.67	R	0.31	R	1.37	R	0.46	R	0.44	R
Svc. Emp.																		
EX ➔ EM	10.46	A	12.16	A	6.94	A	12.32	A	5.07	A	7.39	A	6.00	A	0.23	R	0.46	R
EM ➔ EX	0.0003	R	1.04	R	1.68	R	0.42	R	0.73	R	0.04	R	0.80	R	0.36	R	0.37	R

F-critical(10,14) = 2.60
A :: Accept causality hypothesis
R :: Reject causality hypothesis



Note: T = Total Employment; M = Manufacturing Employment; S = Service Employment.

Figure 8. Direction of the Causal Relationship Between the Various Roads Investments with Employments to Growth at the State Level.

TABLE II

TEMPORAL EFFECT OF THE VARIOUS ROADS EXPENDITURES ON EMPLOYMENTS TO GROWTH AT THE STATE LEVEL

Road Expenditures vs. Employment

	Total Expenditures			Capital Expenditures			Maintenance Expenditures		
	Grand	Capital	Maint.	Primary	Secondary	Local	Primary	Secondary	Local
Total									
laglength	(2.7)^{7}	(4.43)^{7}	(12.25)	(2.52)^{7}	(3.74)^{7}	(2.62)^{7}	(2.33)^{4}	(3.16)^{5}	(3.27)^{7}
cuml.lag	(79.02)	(377.07)	(11.20)	(826.40)	(44.64)	(39.75)	(32.71)	(20.63)	(402.89)
Mfg.Em.									
laglength	(2.42)^{2}	(2.64)^{2}	(2.20)^{1}	(2.31)^{2}	(4.93)^{7}	(3.63)^{1}	(5.41)^{1}	(2.83)^{5}	(5.21)^{5}
cuml.lag	(56.67)	(126.32)	(5.01)	(92.89)	(132.14)	(42.10)	(6.89)	(7.84)	(142.39)
Svc.Emp.									
laglength	(4.10)^{7}	(4.30)^{7}	(15.14)	(5.13)^{7}	(3.23)	(4.65)	(2.71)^{4}	(2.98)^{5}	(7.46)^{5}
cuml.lag	(140.52)	(209.03)	(5.88)	(1096.21)	(26.69)	(42.66)	(14.58)	(25.16)	(9.51)

F-critical(10,14) = 2.60
lag length = T-value; T-critical = 2.14
cumulative lag = F-statistics over the lag period.
Exponent = Represent lag length.

DIFFERENT SPATIAL GROUPINGS

The relationship between the different road investments and the three employment sectors, and its temporal effect at a lower level of aggregation, is examined. Certain spatial groupings are analyzed: the Portland metropolitan counties versus the rest of the state's counties, urban counties versus rural counties, interstate counties versus non-interstate counties, coastal counties versus non-coastal counties, Oregon Department of Transportation five designated regions, and the individual counties. Following are the results.

Portland Metropolitan Counties Versus the Rest of the State

At this level of aggregation, the results of the relationship between the different road expenditures and the three employment sectors suggest the following: First, the total road expenditures (grand total, total capital, and total maintenance) have a one-way directional relationship running from each of the three road expenditures to total and service employment growth, and a bi-directional relationship between each of the three total road expenditures and manufacturing employment growth in the Portland metropolitan counties . Second, in the rest of the state's counties, there is a bi-directional relationship between total road expenditures (grand total, total capital expenditures, and total maintenance expenditures) and total and service employment growth, and no relationship between the three road expenditures and service employment growth (see Figure 9).

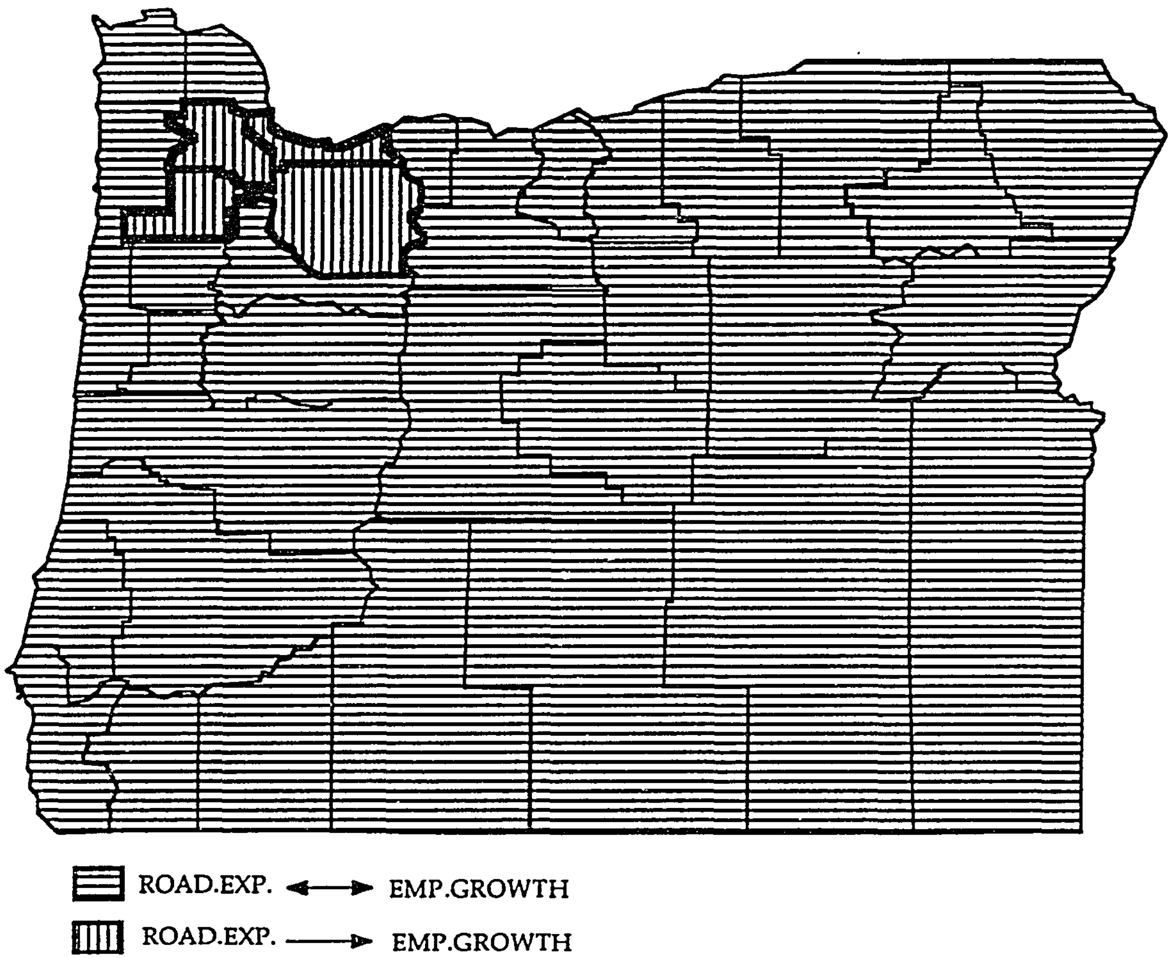


Figure 9. Pattern of the relationship between the various road investments and employment to growth in the Portland Metropolitan counties vs. the rest of the state counties. Source: Author

The results of the relationship between capital investment for the three types of roads (primary, secondary, and local) and the three employment sectors suggest that capital expenditures for the three types of roads have a one-way directional relationship running from each of the three road expenditures to the three employment sectors in the Portland metropolitan counties. The results for the rest of the state's counties suggest a bi-directional relationship between road capital expenditures and total and manufacturing employment growth, and no relationship between road capital expenditures and service employment growth.

The results of the relationship between maintenance expenditures for the three types of roads and the three employment sectors are mixed. But, the general pattern suggests that maintenance expenditures for primary and secondary roads have a one-way directional relationship running from those two road expenditures to the three employment sectors in the Portland metropolitan counties. In the rest of the state's counties, the results suggest a bi-directional relationship between maintenance expenditures on primary and secondary roads and the three employment sectors. In both groups, maintenance expenditures on local roads have no relationship to the three employment sectors (see Figures 15 and 16; and Table III and IV in Appendix).

The temporal aspect of this relationship seems to indicate that the total road expenditures and capital investments on the three types of roads have a long-term effect on the three employment sectors in both groups, while total maintenance expenditures and maintenance expenditures on the three types of roads have a short-term effect on the three employment sectors. In the case where no relationship is identified, then there is no clear temporal effect . On the other hand, the temporal effect of the three employment sectors is mostly immediate in triggering road investments. The cumulative lag effects of the different road expenditures on the three employment sectors are mostly statistically significantly. But, the temporal effect of the total road expenditures and capital expenditures on primary and secondary roads is more pronounced on total employment and service employment growth, and in particular in the Portland metropolitan counties and on the total and manufacturing employment growth in the rest of the state's counties. However, the relative magnitude effect of total road expenditures and capital expenditures in the three types of roads on employment to growth is much greater than that for maintenance expenditures in the Portland metropolitan counties. In the rest of the state counties, it is the other way around, the relative magnitude effect of maintenance expenditures is much more significant than that for capital expenditures (see Tables V and VI in Appendix).

The major finding of this analysis is consistent with the finding of Eagle and Stephanedes (1987), in which they concluded that state regional centers are the biggest beneficiary of road investments, and employment growth will benefit greatly from the various road investments in the state regional centers.

Urban Counties Versus Rural Counties

At this level of aggregation, the results of the relationships between the various road investments and economic development suggest that the total road expenditures and capital expenditures on the three types of roads (primary, secondary, and local) have a bi-directional relationship to total and manufacturing employment growth in both groups. On the other hand, the total road expenditures and capital investment on the three types of roads have a bi-directional relationship to service employment growth, with the exception of the grand total road expenditure and capital investment on primary roads, which have a one-way directional relationship running from the two road expenditures to service employment growth in the urban counties. In the rural counties, the results suggest no relationship between the total road expenditures and capital expenditures on the three types of roads and service employment growth (see Figure 10).

The results of the relationship between maintenance expenditures on the three types of roads (primary, secondary, and local) and the three employment sectors suggest that in both groups, maintenance expenditures on primary roads have a bi-directional relationship to the three employment sectors; however, maintenance expenditures on secondary roads have a one-way directional relationship running from road expenditures to total and service employment growth, and a bi-directional relationship to manufacturing employment growth. Furthermore, maintenance expenditures on local roads have no relationship to the three employment sectors (see Figures 17 and 18; and Tables VII and VIII in Appendix).

The temporal effect of this relationship seems to indicate that the total road expenditures and capital expenditures on the three types of roads have a long-term effect on the three employment sectors, and in particular on the total and service employment sectors in the urban counties; however, the total maintenance expenditures and maintenance expenditures on the three types of roads have a short-term effect on the three employment sectors, with the exception of the cases where there is no relationship between road expenditures and employment growth.

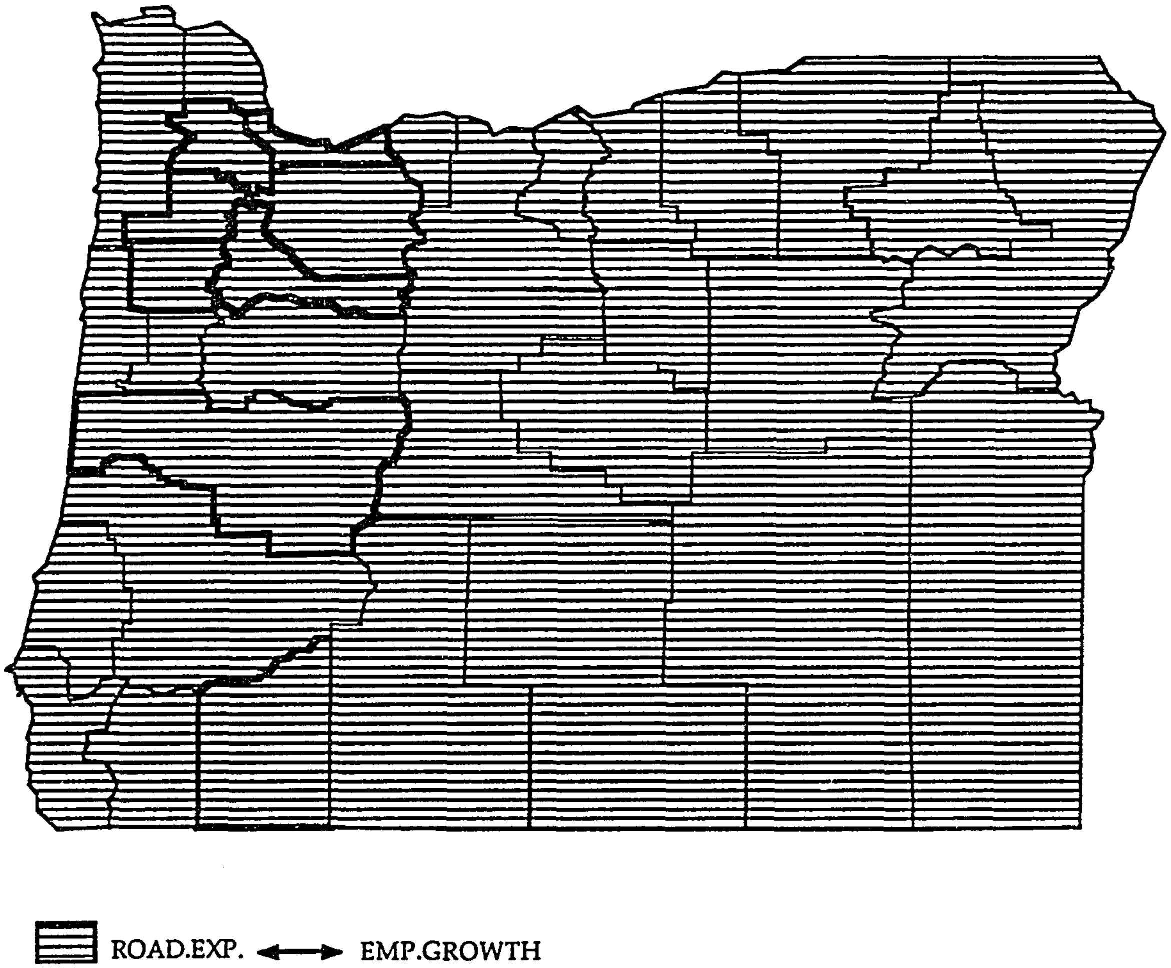


Figure 10. General pattern of the relationship between the various roads investsments and employment to growth in the urban counties vs. rural counties. Source: Author

In these cases, the temporal effect is not very clear, and the estimated T-values are mostly statistically not significant and sometimes have negative signs. It appears that maintenance expenditures have a longer-term effect on total and manufacturing employment growth in rural counties than in urban counties. On the other hand, the temporal effect of the three employment sectors on the different road expenditures is mostly immediate.

The cumulative lag effect of the different road expenditures on the three employment sectors is statistically significant. Nevertheless, the cumulative effect of the total road expenditures and construction expenditures for the three types of roads on total and service employment growth is highly significant in the urban counties. Also, the cumulative effect of the total road expenditures and construction expenditures on the three types of roads is significant on manufacturing employment growth in rural counties. However, the relative magnitude effect of total road expenditures and capital expenditure on the three types of roads on employment growth is much greater than that of maintenance expenditures in urban counties. In the rural counties, on the other hand, the relative magnitude effect of maintenance expenditures on employment growth is much more significant than that for capital expenditures (see Tables IX and X in Appendix).

<u>Interstate Counties Versus Non-Interstate Counties</u>

At this level of aggregation, the results of the relationship between road investment and economic development suggest that in the interstate counties the total road expenditures have a bi-directional relationship to the three employment sectors; however, in the non-interstate counties the total road expenditures have no relationship to total and service employment growth, and a one-way directional relationship runs from the total road expenditures to manufacturing employment growth.

The results of the relationship between capital investment in the three types of roads and the three employment sectors suggest that, in the interstate counties, capital expenditures on the three types of roads have a bi-directional relationship to service employment growth. On the other hand, capital expenditures on primary and local roads have a bi-directional relationship to total employment growth, while capital expenditures on secondary roads have a one-way directional relationship running from secondary road capital expenditures to total employment growth. Also, capital expenditures on primary roads have a bi-directional relationship to manufacturing employment growth, but capital expenditures on secondary and local roads have a one-way directional relationship running from the capital expenditures for the two types of roads to manufacturing employment growth. In the non-interstate counties, capital expenditures on the three types of roads have no relationship to total and service employment growth, and a one-way directional relationship running from capital expenditures on the three types of roads to manufacturing employment growth.

Therefore, the general pattern suggests that the total road expenditures and capital expenditures on the three types of roads have a bi-directional relationship to the three employment sectors in the interstate counties. In the non-interstate counties, the pattern is that the total road expenditures and capital expenditures on the three types of roads have no relationship to total and service employment growth, and a one-way directional relationship running from these road expenditures to manufacturing employment growth (see Figure 11).

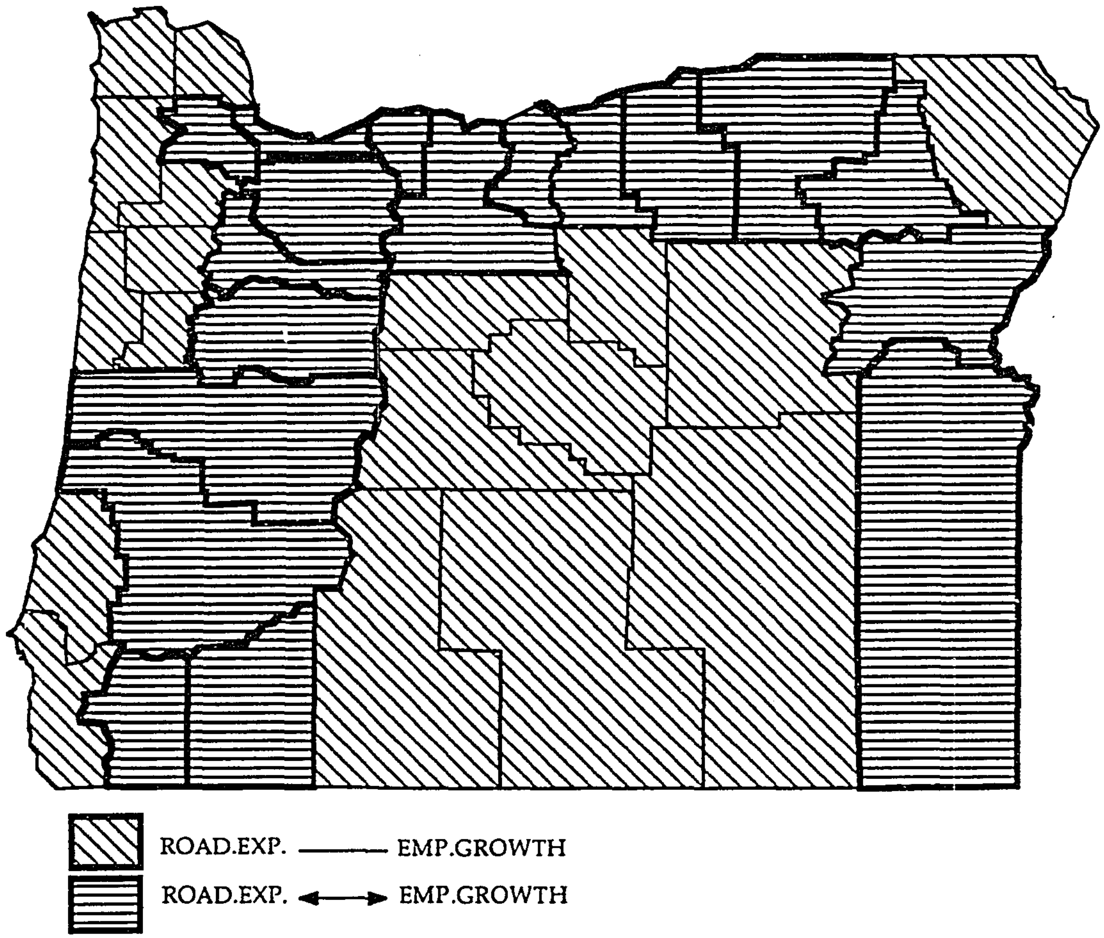


Figure 11. General pattern of the relationship between the various roads investments and employment to growth in interstate counties vs. non-interstate counties. Source: Author

In terms of the relationship between maintenance expenditures on the three types of roads and the three employment sectors, the results suggest the following. First, in the interstate counties, maintenance expenditures on primary roads have a bi-directional relationship to total and manufacturing employment growth. Maintenance expenditures on secondary roads have a one-way directional relationship running from road expenditures to total and manufacturing employment growth. Second, maintenance expenditures on local roads have no relationship to total employment growth, a one-way directional relationship running from maintenance expenditures on local roads to manufacturing employment growth, and a bi-directional relationship to service employment growth in the non-interstate counties. Maintenance expenditures on primary and secondary roads have a bi-directional relationship to total and manufacturing employment growth, while maintenance expenditures on local roads have no relationship to total and manufacturing employment growth. Also, maintenance expenditures on the three types of roads have no relationship to service employment growth (see Figures 19 and 20; and Tables XI and XII in Appendix).

The temporal effect of this relationship seems to indicate that in the interstate counties, the total road expenditures and capital expenditures on the three types of roads have a long-term effect on the three employment sectors, and in particular on the total and service employment sectors; however, total maintenance expenditures and maintenance expenditures on the three types of roads have a short-term effect on the three employment sectors in the non-interstate counties.

The temporal effect of the various road investments is short-term, and not very clear in the cases where no relationship is found between road investment and economic development. However, the total road expenditures and capital expenditures on the three types of roads have a longer-term effect on manufacturing employment growth. On the other hand, in both groups, the temporal effect of the three employment sectors is mostly immediate in triggering the different road investments.

The cumulative lag effect of the different road expenditures on the three employment sectors is significant, but the cumulative effect of the total road expenditures and capital expenditures on the three types of roads is more significant on total and service employment growth in the interstate counties. In the non-interstate counties, the cumulative lag effect of the different roads on the three employment sectors is not significant, but the effect of the total road expenditures and capital expenditures on the three types of roads is significant on manufacturing employment growth.

However, the relative magnitude effect of total road and capital expenditures in the three types of roads on employment growth is much greater than that for maintenance expenditures in the interstate counties. In the non-interstate counties, the relative magnitude effect of both capital expenditures and maintenance expenditures is insignificant (see Tables XIII and XIV in Appendix).

Coastal Counties Versus Non-Coastal Counties

At this level of aggregation, the results of the relationship between road investment and economic development suggest that in the coastal counties the total road expenditures and capital expenditures on the three types of roads have a one-way directional relationship running from the road investments to the three employment sectors. In the non-coastal counties, the total road expenditures and capital expenditures on the three types of roads have a bi-directional relationship to total and manufacturing employment growth, with the exception of capital expenditures on secondary and local roads. These two road expenditures have a one-way directional relationship running from the expenditures to manufacturing employment growth and capital expenditures on local roads, which have no relationship to total employment growth. Also, in this group the total road expenditures and capital expenditures on the three types of roads have no relationship to service employment growth (see Figure 12).

In terms of the relationship between maintenance expenditure on the three types of roads and the three employment sectors, the results suggest that in the coastal counties, maintenance expenditures have a one-way directional relationship running from road expenditures to the three employment sectors. In the non-coastal counties, the results are mixed. Maintenance expenditures on primary roads have a bi-directional relationship to the three employment sectors, maintenance expenditures on secondary roads have a one-way directional relationship running from road expenditures to the three employment sectors, and maintenance expenditures on local roads have no relationship to the three employment sectors.

Therefore, the general pattern suggests that in the coastal counties, the total road expenditures, capital expenditures, and maintenance expenditures on the three types of roads have a one-way directional relationship running from the various road expenditures to the three employment sectors.

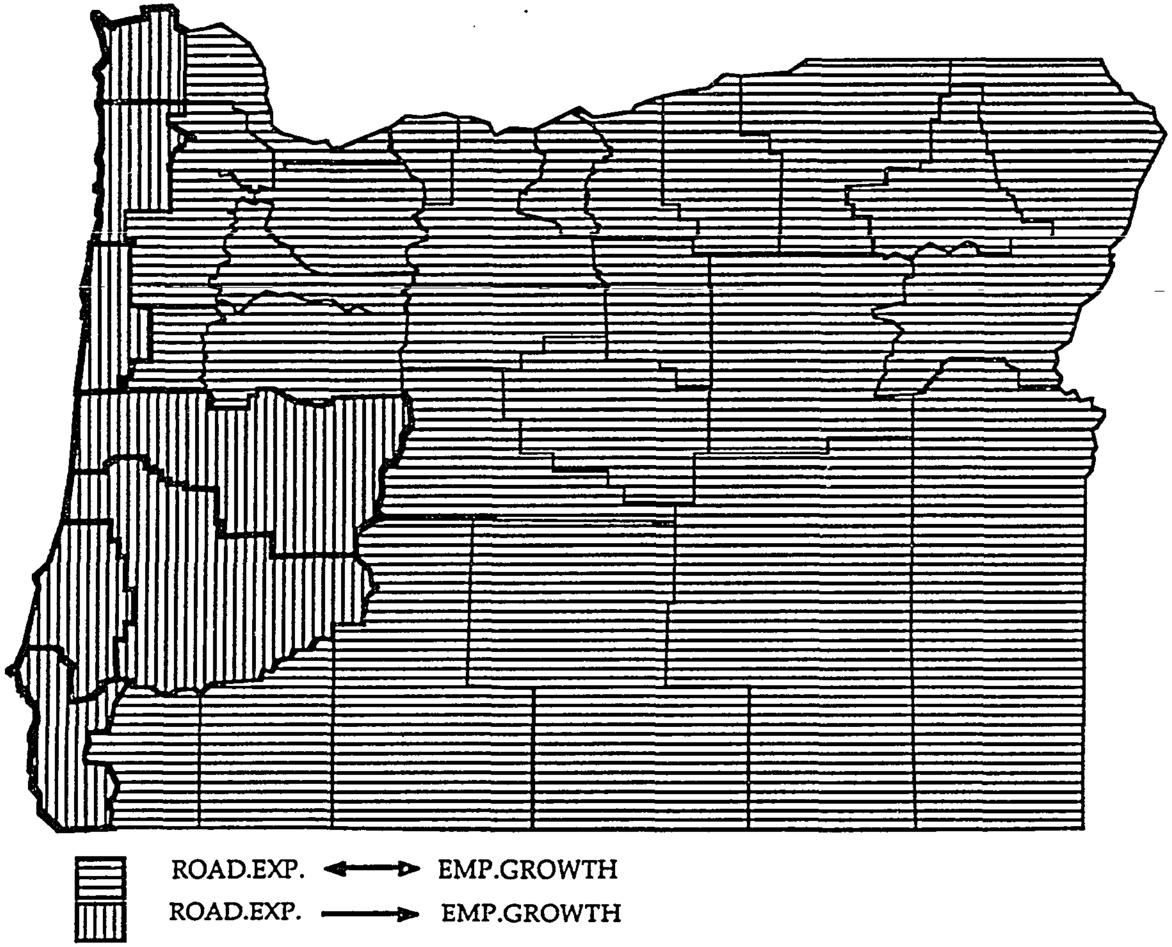


Figure 12. General pattern of the relationship between roads investments and employment to growth in the coastal vs. non-coastal counties. Source: Author

In the non-coastal counties, the results are mixed, but the general pattern is that most of the different road expenditures have a bi-directional relationship to the three employment sectors (See Figures 21 and 22; and Tables XV and XVI in Appendix).

However, it is worth noting that when Douglas and Lane counties are excluded from the costal group the results did not change very much for both groups.

The temporal effect seems to indicate that in both coastal and non-coastal counties, the different road expenditures have a long-term effect on the three employment sectors. In the cases where there is no relationship between the total road expenditures and capital expenditures on the three types of roads and service employment growth, the temporal effect on service employment growth is not quite clear. On the other hand, the temporal effect of the three employment sectors is mostly immediate. The cumulative lag effect of the different road expenditures on the three employment sectors is significant, and the cumulative effect of the total road expenditures and capital expenditures for the three types of roads is especially significant on total and manufacturing employment growth. Also, in both groups, the relative magnitude effect of total road expenditures and capital expenditures in the three types of road on employment growth is much greater than that for maintenance expenditures (see Tables XVII and XVIII in Appendix).

Oregon Department of Transportation's Designated Five Regions

At this level of aggregation, the results of the relationship between road investments and economic development suggest than regions 1, 2, 3, and 5, have a one-way directional relationship running from the total road expenditures to the three employment sectors. However, in region 4, no relationship can be identified between the total road expenditures and the three employment sectors (see Figure 13).

In terms of the relationship between capital expenditures on the three types of roads and the three employment sectors, the results suggest the following. First, capital expenditures on primary and secondary roads have a one-way directional relationship running from the two road expenditures to total and service employment sectors in regions 1, 2, 3, and 5, and there is no relationship between capital expenditures on the three types of roads and total and service employment growth in region 4. Second, capital expenditures on local roads have a bi-directional relationship to total employment growth in regions 1, 2, 3, and 5, a bi-directional relationship to service employment growth in regions 2 and 3, and no relationship to service employment growth in regions 1 and 5.

Also, the relationship between capital expenditures on the three types of roads and manufacturing employment growth gives mixed results. First, capital expenditures on primary roads have a bi-directional relationship to manufacturing employment growth in regions 1 and 4, and a one-way directional relationship running from road expenditures to manufacturing employment growth in regions 2, 3, and 5. Second, capital expenditures on secondary roads have a one-way directional relationship running from road expenditures to manufacturing employment growth in regions 1, 4, and 5, and a bi-directional relationship to manufacturing employment in regions 2 and 3. Third, capital expenditures on local roads have a one-way directional relationship running from road expenditures to manufacturing employment growth in regions 1 and 3, a bi-directional relationship to manufacturing employment in region 2, and no relationship to manufacturing employment in regions 4 and 5.

The results of the relationship between maintenance expenditures on the three types of roads and the three employment sectors suggest the following. First, maintenance expenditures on primary roads have a bi-directional relationship to the three employment sectors in all regions. Second, maintenance expenditures on secondary roads have a one-way directional relationship running from road expenditures to the three employment sectors in regions 1, 2, 3, and 5, and no relationship to the three employment sectors in region 4. Third, maintenance expenditures on local roads have a one-way directional relationship running from road expenditures to total employment growth in regions 1, 3, and 5, and no relationship to total employment in regions 2 and 4. Maintenance expenditures on local roads have a one-way directional relationship running from road expenditures to manufacturing employment growth in regions 1 and 3, and no relationship to manufacturing employment growth in regions 2, 4, and 5. Maintenance expenditures on local roads have a one-way directional relationship running from road expenditures to service employment growth in region 3, and no relationship to service employment growth in regions 1, 2, 4, and 5.

Therefore, the relationship holds at the aggregate level when it demonstrates that road expenditures tend to lead to employment growth in regions 2, 3, and 5. Once we move down to the different relationships of the primary, secondary, and local levels, the results are mixed (see Figures 23 – 27 and Tables XIX – XXIII in Appendix).

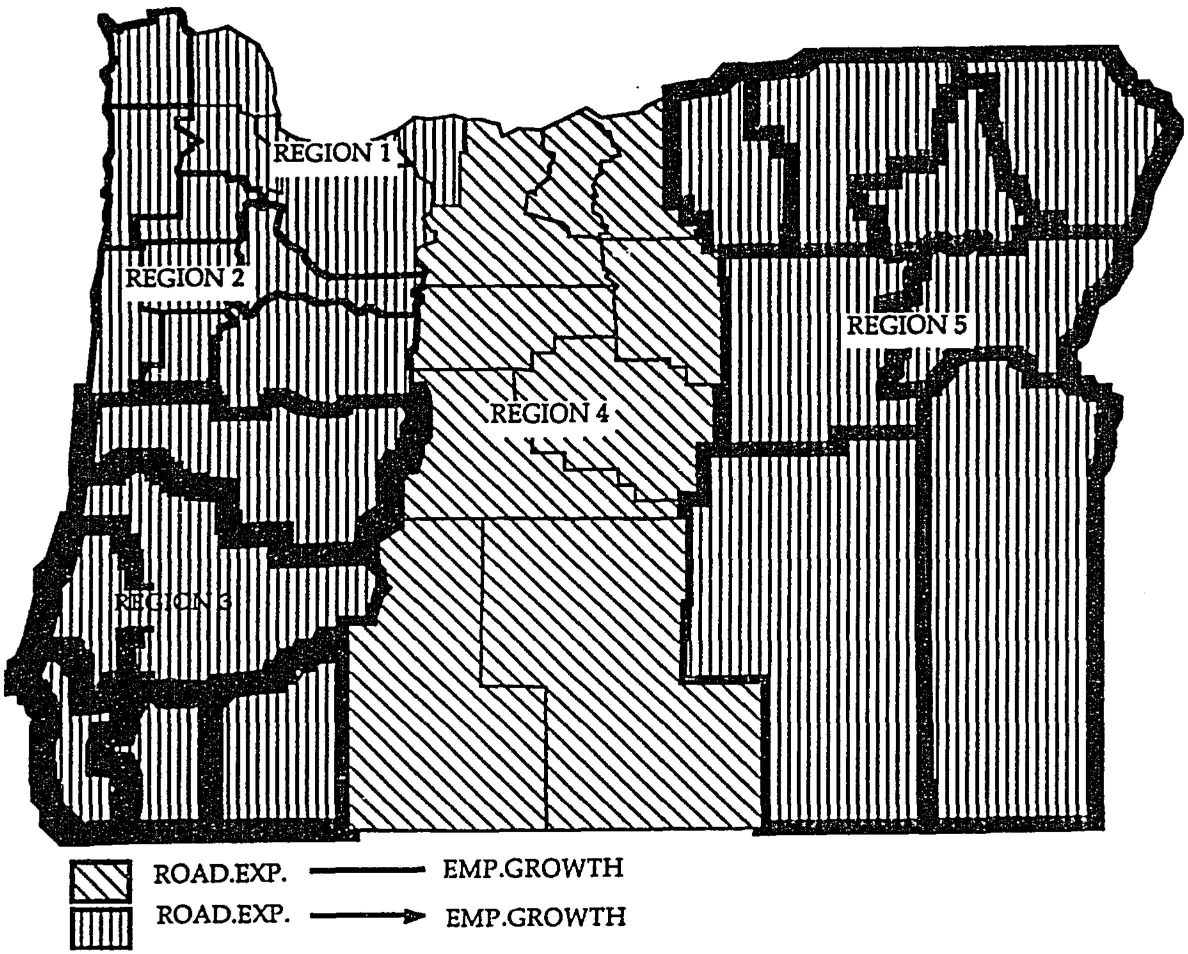


Figure 13. General pattern of the relationship between roads investments and employment to growth in the Oregon Department of Transportation's five designated regions. Source: Author

The temporal effect for the investment seems to indicate that the different road expenditures, in particular primary and secondary road expenditures, have a long-term effect on the three employment sectors in regions 1, 2, 3, and 5. In region 4, since there is no relationship between road expenditures and the three employment sectors, the temporal effect is not quite clear. On the other hand, the temporal effect of the three employment sectors on the different road expenditures is mostly immediate. The cumulative lag effect of the different road expenditures on the three employment sectors is significant. Nevertheless, the cumulative effect of the total road expenditures and capital expenditures on the three types of roads is more significant, in particular in regions 1 and 5. Also, in regions 1 and 2, the relative magnitude effect of total road expenditures and capital expenditures in the three types of roads on employment growth is more significant than that for maintenance expenditures. On the other hand, in regions 3, 4, and 5, the relative magnitude effect of both capital road expenditures and maintenance road expenditures is not very significant and not much difference can be observed between the two (see Tables XXIV – XXVIII in Appendix).

County-Level Relationship

At this level of spatial disaggregation the results are mixed, and no systematic pattern can be identified. For example, in Multnomah, Clackamas, Washington, Linn, Coos, Baker, Malheur, Umatilla, and Union counties, total road expenditures have a one-way directional relationship that runs from total road expenditures to total employment growth. In the other counties, the relationship is quite different. Some have a bilateral relationship, some have no relationship, and some have a one-way directional relationship that runs from total employment to total road expenditures (see Figure 14).

CONCLUSION

The primary objective of this study has been to analyze the dynamic impact of road investment on economic development. The main question this research is designed to address is a) the general relationship between the various road investments and economic development, b) dynamic effect in the State as a single geographic unit, as different spatial groupings, and at the county level.

One of the major knowledge gaps in the field of economic development concerns the effect of road investments on economic development. Earlier, the linkage between road investments and economic development was taken for granted and many large-scale projects were built with relatively little analytic effort. The present study is an attempt to determine the causal relationship between road investment and economic development, and its time-lag effect in Oregon. The principal findings are that:

1. The level of aggregation is of great importance in determining the causal relationship between road investment and economic development.

2. At higher levels of aggregation, such as the state as one geographic unit, a more direct relationship from road investment to economic development is observed.

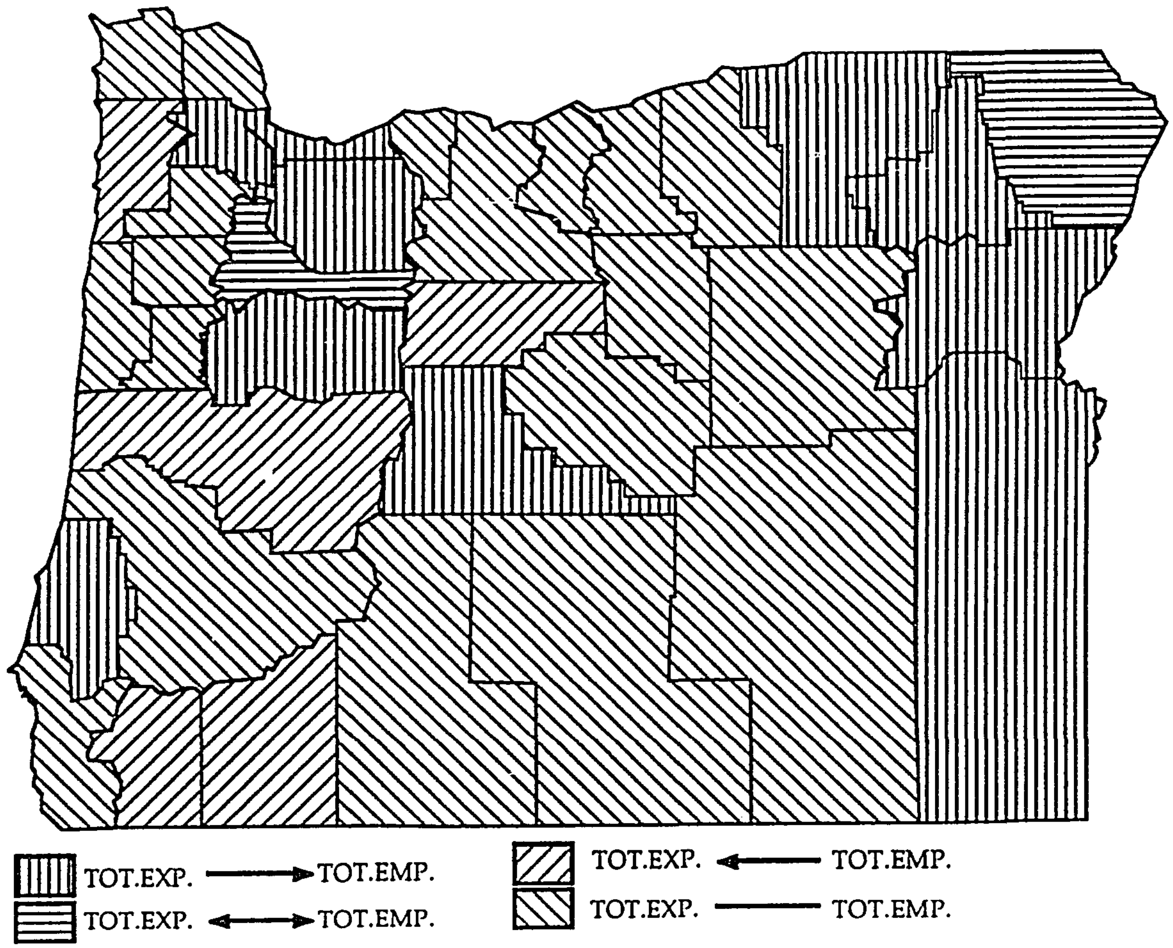


Figure 14. General pattern of the relationship between roads investments and employment to growth in individual Oregon counties. Source: Author

3. Lower levels of aggregation, such as the individual counties as separate geographic units, produce mixed results regarding the causal relationship between road investment and economic development.

4. We cannot rely on the results of the different spatial groupings, and the county level as a project or a policy guide. However, the state results generally seem to indicate that a one-way directional relationship runs from the various road investments to growth in the three employment categories.

5. The type of road investment and type of road do influence economic development, and in particular capital expenditures on primary and secondary roads have a great impact on economic development in the region.

6. The temporal effect of this investment indicates that the total road expenditures and capital expenditures for the three types of road have a longer-term effect on employment growth than maintenance expenditures have.

7. The cumulative lag effect of the total road expenditures and capital expenditures for the three types of roads is more pronounced and its relative magnitude effect is greater on the three employment sectors than is the comparable effect of the maintenance expenditures in most spatial groupings.

The empirical findings of this research can be interpreted in many different ways. However, it is important to stress the fact that transportation investment usage as a criterion for economic development at the state and regional level is well supported. Even though this research has highlighted the complexity of this dynamic relationship, it clearly pinpointed the direct and strong relationship between road investment and economic development at the state level. The interpretation of this finding is in total agreement with the previous works that have stressed the top-down approach as the way to allocate resources to transportation and other sectors of the economy.

This research additionally highlighted the limitation of using the aggregate approach as a means of allocating resources at the local level, such as the sub-state and county level. At this level, other techniques, such as cost-benefit analysis, can be more useful in examining the impact of road investment on economic development. Such techniques are disaggregate in nature and more focused, and thus, would be more useful in studying this relationship at the lower end of analysis. This approach can be complementary to the aggregate approach used in this particular research.

In addition, this research highlighted the real dynamic effect of road investment on economic development. It also demonstrated the dynamic effect of each type of expenditure (construction and maintenance) and each type of road (primary, secondary, and local) on employment to growth. It also explains how the various road expenditures impact employment to growth as the unit of analysis changes. However, the finding of this research clearly pointed out that construction expenditures in the primary and secondary roads is more effective in triggering employment to growth in this region, and its effect is long lasting.

Despite the fact that both industries, to a certain extent, have benefited from the various road investments, the findings of this research highlighted how each type of industry is effected by the various road expenditures. It was very clear that total employment and service employment is the greatest beneficiary from the various road investments, especially at the state level and the Portland metropolitan counties. This coincides with the general trend for the nation as a whole where most industries are moving away from a manufacturing to service-oriented base.

Furthermore, the interpretation of the above findings enhance our understanding of this dynamic relationship. It also offers more insight into the theories and empirical works of transportation investment and economic development.

Overall, the study of the impact of the various road investments on employment growth in the three sectors has demonstrated the complexity of the relationship. The results lead to a conclusion that the level of geographic aggregation is of great importance in determining the directionality of this relationship. In other words. the different spatial groups have greatly affected the directionality of this relationship. At a higher level of geographic aggregation, the results of the study tend to support the anticipated outcome that the different road expenditures cause employment growth in the three economic sectors. Also, the various road investments, in particular the total road expenditure, and capital expenditures for the three types of roads tends to have a significant long-term effect on employment growth in the three economic sectors. On the other hand, at the other end of the analysis, the disaggregate, level on the county level the results tend to be mixed, and a great discrepancy has been observed. This finding is in agreement with the findings of Aschauer (1990) and Montgomery et al. (1989), which argue that at the aggregate level the relationship between road investment and economic development is more direct, while at a lower level of geographic aggregation it becomes very difficult to determine.

This analysis also shows that the different spatial groupings have demonstrated different relationships. For instance, when Portland metropolitan counties as one group are examined against the rest of the state's counties as another group, the results show that in most cases in the Portland metropolitan counties group the relationship is direct and runs from road expenditures to employment growth in the three economic sectors; however, in the rest of the state's counties as another group the relationship is bi-directional for most of the different road expenditures, with employment growth in the three employment sectors. This finding is in agreement with the finding of Eagle and Stephanedes (1987), which contends that the state regional centers are the biggest beneficiary of road investment and the relationship is more direct and clearer.

In another instance, when urban counties as one group are examined against the non-urban counties as another group, the results show a bi-directional relationship between the total road expenditures and capital expenditures for the three types of roads and total and manufacturing employment growth in both groups. However, in the urban counties as one group, service employment growth has a bi-directional relationship to the total road expenditures and capital expenditures for the three types of roads. In the non-urban counties, service employment has no relationship to the total road expenditures and capital expenditures for the three types of roads.

The overall conclusion is that the different spatial grouping present different directional relationships. Nevertheless, the general pattern for most spatial groupings tends to suggest either a one-way directional relationship running from road investment to economic development or a bi-directional relationship. No findings support the hypothesis that employment growth causes road expenditures, with the exception of very few cases, especially at the lower end of the analysis at the county level, where the results are highly discrepant and mixed.

Finally, the time-lag effect, measured by lag length and cumulative lag effect of the different road investments, changes as the level of aggregation changes, although the general pattern seems to indicate that the total road expenditures and capital expenditures for the three types of roads, particularly primary and secondary roads, have a long-term effect on employment growth in the three economic sectors (total, manufacturing, and service employment). However, the results for the urban counties as a group and the interstate counties as another group seem to suggest that total as well as manufacturing employment growth benefit greatly from the road investment overall; these results are consistent with the findings of previous researchers (Carlino and Mills, 1987; Wheat, 1969; and Shafran and Wegmann, 1969). In the Portland metropolitan counties as a group and the coastal counties as another group, the results indicate that total, and in particular service, employment growth is the biggest beneficiary of road investments. This finding is consistent with the findings of Briggs (1981; 1983).

In terms of employment growth in the three economic sectors (total, manufacturing, and service), the temporal effect is immediate and mostly statistically significant at the concurrent period. However, the cumulative lag effect of most road expenditures is statistically significant in triggering employment growth in the three economic sectors. But the total road expenditures and capital expenditures for the three types of roads, particularly primary and secondary roads, have the greatest effect on employment growth.

CHAPTER VI

DISCUSSION AND CONCLUSIONS

This study of the effect of road investment on economic development in Oregon aids our understanding of the dynamic relationship between the different road investments and employment growth in the three economic sectors (total, manufacturing, and service employment). Huge amounts in investments have been spent on roads without clear knowledge of the impact on economic development in the region. Scholarly work has speculated on the impact of road investment on economic development, without a basic understanding and a clear-cut theory. Findings from this study, and hopefully others related to it, will help fill this void.

In addition, the analysis provides some new insights about this dynamic relationship. Also, the research supports other research in this field that argues that the relationship between transportation investment and economic development is obscure and not clearly understood.

These ideas are considered further, beginning with a discussion of the generalizability of the study, followed by theoretical implications, then policy implications, and ending with research limitations, topics which need further research and a final conclusion.

GENERALIZABILITY OF THE STUDY

As noted in the previous chapters, the Oregon case is unique. On the one hand, the Oregon Department of Transportation, and in particular its

Highway Division, is one of the early leaders and the state is one of the early pioneers of road development in the nation. On the other hand, Oregon economics is fluctuating, less stable, and more sensitive to national economic trends than are other states due to its dependence on natural-resource industries. The state, generally speaking, spends less on economic development programs than other states in the country. Recently, Oregon's economy was hit hard by the recession in the nation's economy. Thus, Oregon is the case of a state that spent a lot in the early years to develop an integrated network of roads, which is now hard-pressed to maintain and/or expand as a result of the deteriorating economic conditions and declining revenue sources. It currently is not possible to draw any definite conclusions about the generalizability of this study's results to other regions, due to the varying economic conditions and levels of road development in other regions.

THEORETICAL IMPLICATIONS

The relationship between road investment and economic development has never been clearly established. Researchers with interest in this area have always disagreed and speculated about the role of road investment on economic development. Also, no clear-cut theory has ever presented itself to guide researchers on this subject. Although historically transportation investments have played a great role in the development of a region, early classic location theories of Hoover, Losch, and Isard indicate that low-cost transportation has a great impact on the pattern and distribution of activities in space, thereby affecting economic development. Recently this contention has been disputed and the effect of road investments in the regions of a highly developed country like the United States needs further examination. Although traditional theories are elegant, it may be questionable whether they are relevant today. Filling in these theoretical gaps is beyond the scope of this study, but some insights have been given.

Regarding the questions addressed in this research, the findings of this study provide limited empirical support for the concept that road investment causes economic development. The idea that road investment, and more generally transportation investment, has a central effect on economic development was still under question before this study and will continue to be afterwards. In this study, an examination of the relationship between the different road expenditures and employment growth in the three economic sectors for the different spatial groupings gives a different result. As the level of geographic aggregation changes, the dynamic relationship changes too.

In this study, the research paradigm serves as a valid model on the basis of how to examine and investigate the dynamic relationships between road investment and economic development. This model offers a longitudinal examination of this relationship, which can offer a better understanding of the relationship than a one short cross-sectional study would. In other words, the relationship between road investment and economic development is dynamic. Thus, a longitudal study of the effect of road investment on economic development would capture the long-term effect and the change in the level of road investment on this relationship, especially as Payne-Maxie (1980) indicated,because most of the previous short-term studies were misleading and inaccurate in evaluating long-term effect.

There remains a need for a model that can account for the other factors that influence regional economic development. Perhaps a model that investigates this dynamic relationship should incorporate factors that contribute to economic development, such as the cost and availability of land, labor, and capital; relative tax rates; and availability of services and other necessary infrastructure. Finding the right measures of these factors of economic development, and finding the consistent time-series data for a small geographic unit, is a difficult task, but not an impossible one. This further illustrates the complexity of involving other economic development factors, and demonstrates the need for further investigation of this relationship.

POLICY IMPLICATIONS

The effect of road investment on economic development, and the desire of state and local governments to ascertain the definite impact of this investment on this region's economic development, will continue to be an important topic for researchers and policy makers. State and local government policy makers and transportation planners will continue to encourage and promote the development and maintenance of quality highways and bridges, and a highly integrated network of roads. The aim of this investment is to keep the system safe and cost-effective, and provide efficient access throughout the state. Such a system will enhance the region's competitive advantage and attract new industries and economic activities by improving accessibility. Oregon's limited funds have limited the state's spending on economic development programs, especially on programs that enhance the state's position as an industrial site, tourist destination, and foreign investment site. It is clearly stated by th City Club of Portland (1987) report, Forbes (1990), and others that Oregon's well-built and maintained network of roads is just one part of the infrastructure supporting future economic development, but it is a very central one. Furthermore, developing new development requires coordination among the elements of that infrastructure to move people, goods, and products in every area of the state.

Oregon's biggest public investment today is at great risk. State highways are aging, bridges are deteriorating more rapidly, and traffic exceeds capacity on many state roads. Essential maintenance and construction work has been delayed because of inadequate funding. Oregon's inadequate funding is preventing the expansion of roadway system, resulting in greater maintenance, repair, and moderation work to be differed. The net result is growth of a backlog of work as well as a need to face higher costs and increased revenue resources in the future.

From the results presented in this study, it is clear that the relationship between road investment and economic development is a complex one, and no clear end conclusion can be drawn. Also, the nature of this relationship varies from one region to another, and also within each region, depending on the economic environment and other economic development factors. However, this research has demonstrated that the level of aggregation is central in determining the direction of this relationship. At the aggregate level, the state as one geographic unit, road investment has a positive impact on economic development in this region. In particular, total road investments and capital expenditures on primary and secondary roads have a one-way directional relationship running from the road expenditures to the three employment sectors (total, manufacturing, and service), and the effect of the investment is long-term.

Since most resource allocation decisions occur at the higher levels of government, the implication of this research would support those policy makers and transportation planners using transportation investment as a criterion for economic development at the regional and national level. Conversely, this study does not support the use of economic development as a criterion for transporation investment at the sub-state and county level. At those lower levels, a disaggregate technique, such as cost-benefit analysis, would be more useful in measuring the impact of this investment on economic development. In particular, at this stage the issue is not a llocation of resources; rather it is more a matter of prioritizing among alternative projects. It is also worth noting that at the sub-state level of spatial groupings, and in particular Portland metropolitan counties, a strong relationship between highway investment and economic development was demonstrated. This is can probably be attributed to the fact that all the other components of development are in place in the regional centers in comparison to other regions.

The results of the different spatial groupings are mixed. In the Portland metropolitan counties versus the rest of the state's counties, the results suggest that Portland metropolitan counties are the biggest beneficiary of road investment, and that the relationship between road investment and economic development is strong and direct. This finding is consistent with the fact that the state's economic development is concentrated in the population areas of the Portland metropolitan counties.

Another implication of this study is that both manufacturing and service industries have benefited from road investment, although the disagreement and speculation on the type of industry that benefits most from road investment persist among academics and policy makers. This is complicated more by the fact that Oregon's economy is just like the rest of the nation's economy in shifting from goods-producing (manufacturing) to service-producing (non-manufacturing).

The results of this study did not support the thesis that maintenance expenditures have a strong relationship to economic development, nor that maintence has a long-term effect. This finding implies that investment in maintenance is not sufficient to trigger greater employment growth in this region. It is clearly understood that the state is juggling with its limited resources, but maintenance of the biggest public investment in the state should receive a fair share, especially because maintenance employment tends to be more premanent than the other employment, and its trickle-down effect on the region is long-lasting.

RESEARCH LIMITATIONS

This study attempted to overcome some of the shortcomings other research has encountered. To investigate the relationship, the time-series analysis is used instead of the commonly used and frequently criticized cross-sectional method. Using this method limited our choices of measurements, in particular our economic development measure. Some argue that income or population is a much better measure of economic development in the region. However, the problem with other measures is that it is difficult to find a good consistent set of data for the long period of time without tabulation and calculation, especially at the disaggregate level of analysis.

Also, it is frequently documented in the transportation and economic development literature that other factors of economic development are as important as transportation investment. It is, thus, recommended that a better method of control for the other intervening development factors should be explored in future research, considering the extreme difficulty of finding consistent time-series data and accurate methods of measuring development factors. Previous research (Carlino and Mills, 1987; Wilson, Stevens, and Holyoke, 1977) found that transportation investment, and in particular highway investment, had a secondary role when other development variables were held constant. However, the criticism of these studies and others that try to control the effects of economic development variables is that these studies are cross-sectional in nature. Therefore, a snapshot study of one or two periods may not reflect the real development trends in the dynamic relationship in this region, and the results of the previous studies are rendered highly inconclusive.

SUGGESTIONS FOR FURTHER RESEARCH

Clearly, the greatest need is for more studies on the effect of road investment on economic development in other places. These studies would enhance our understanding of the dynamic relationship, and determine whether the results of this case study are unique to Oregon or generally applicable.

Overall, there are several research issues that deserve further attention. First, the dynamic causal relationship between road investment and economic development is still unsettled and further research is required, especially on local and project levels. Second, the process of county assortment into different spatial groups is relatively random, although clues from the literature and previous studies have indicated that certain groupings such as urban, metropolitan, and interstate counties may present a different relationship than the rest of the state's counties do. Therefore, a lot of overlapping among the different groupings may make it difficult to generalize. Thus, it is advisable to develop more rigorous and systematic criteria for studying this relationship.

Finally, although this research is restricted to Oregon counties, it would be informative to investigate this relationship in other states that have similar economic conditions as well as investments levels, to extend the results and explain the dynamic relationship between road investment and economic development at a different regional level so that comparisons can be made. Overall, potential research should examine all the possibilities that can increase our understanding of this complex relationship.

CONCLUSION

Oregon's road network is a critical part of the state's infrastructure, linking cities and counties within the state to each other and to the rest of the nation. Also, it is predicted that transportation in Oregon will increase at 2.5 percent per year, and automobiles and heavy truck traffic will increase at an even higher rate. Furthermore, rail line abandonment throughout the state is rising, adding to the increased use of trucks for freight movement. As a result, the heavy-haul capability of the state's road network needs enhancement to handle this increase in truck traffic as well as the increase in automobile usage. Since Oregon's population is increasing at a rapid rate, a stronger economic development is predicted. The result of this development will be is greater demand on the state's highway and road network system.

Nevertheless the empirical findings of this research cannot strongly support the argument that road investment leads to economic development, especially at the disaggregate level. However, the research does prove one thing, that overall the relationship between road investment and economic development is either a one-way directional relationship running from road investment to economic development or a bi-directional relationship, and no reverse causation is found, especially at the more aggregate level. It is apparent that greater road investment is needed in this region. But, it is the challenge of future research to precisely pinpoint the link between road investment and economic development.

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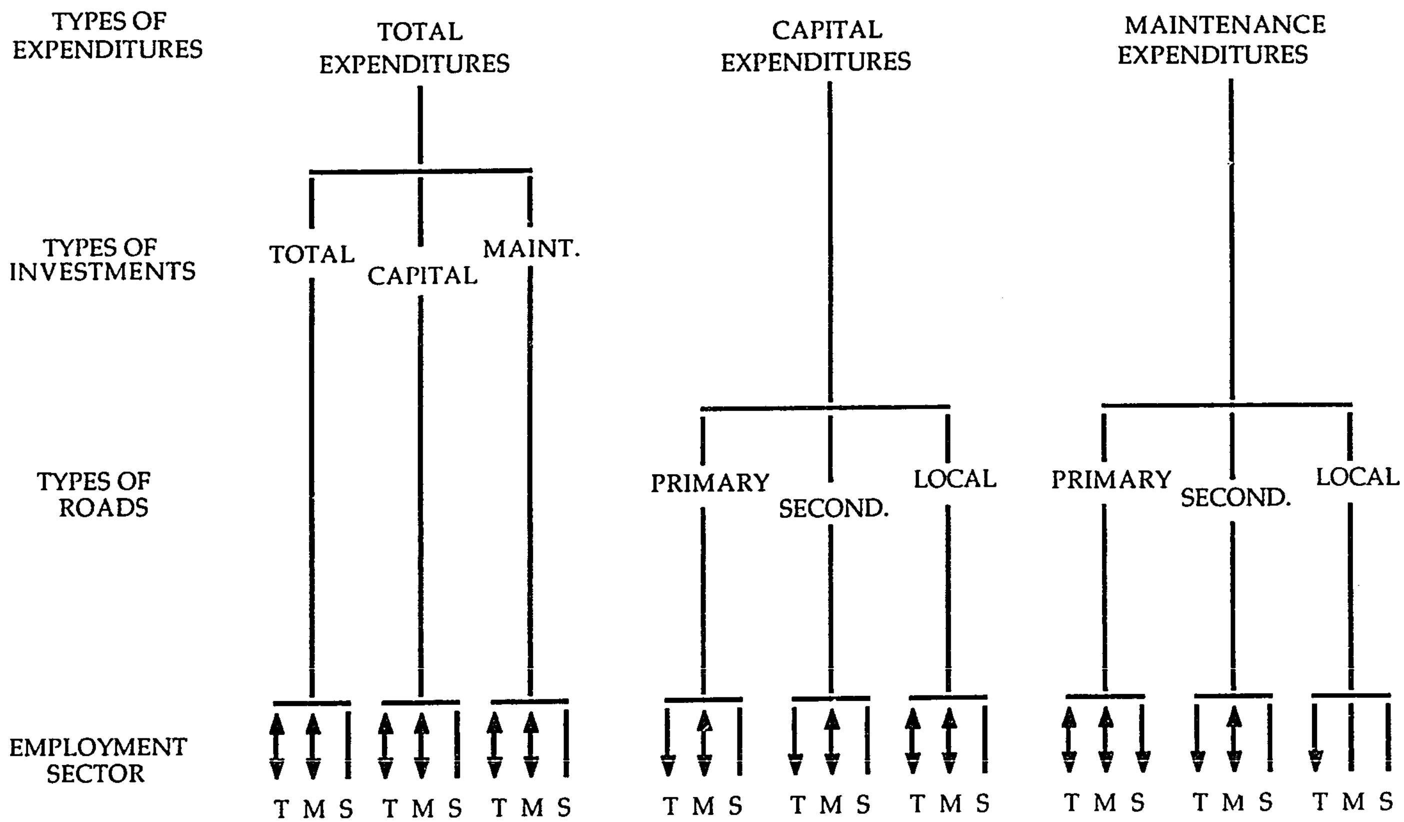
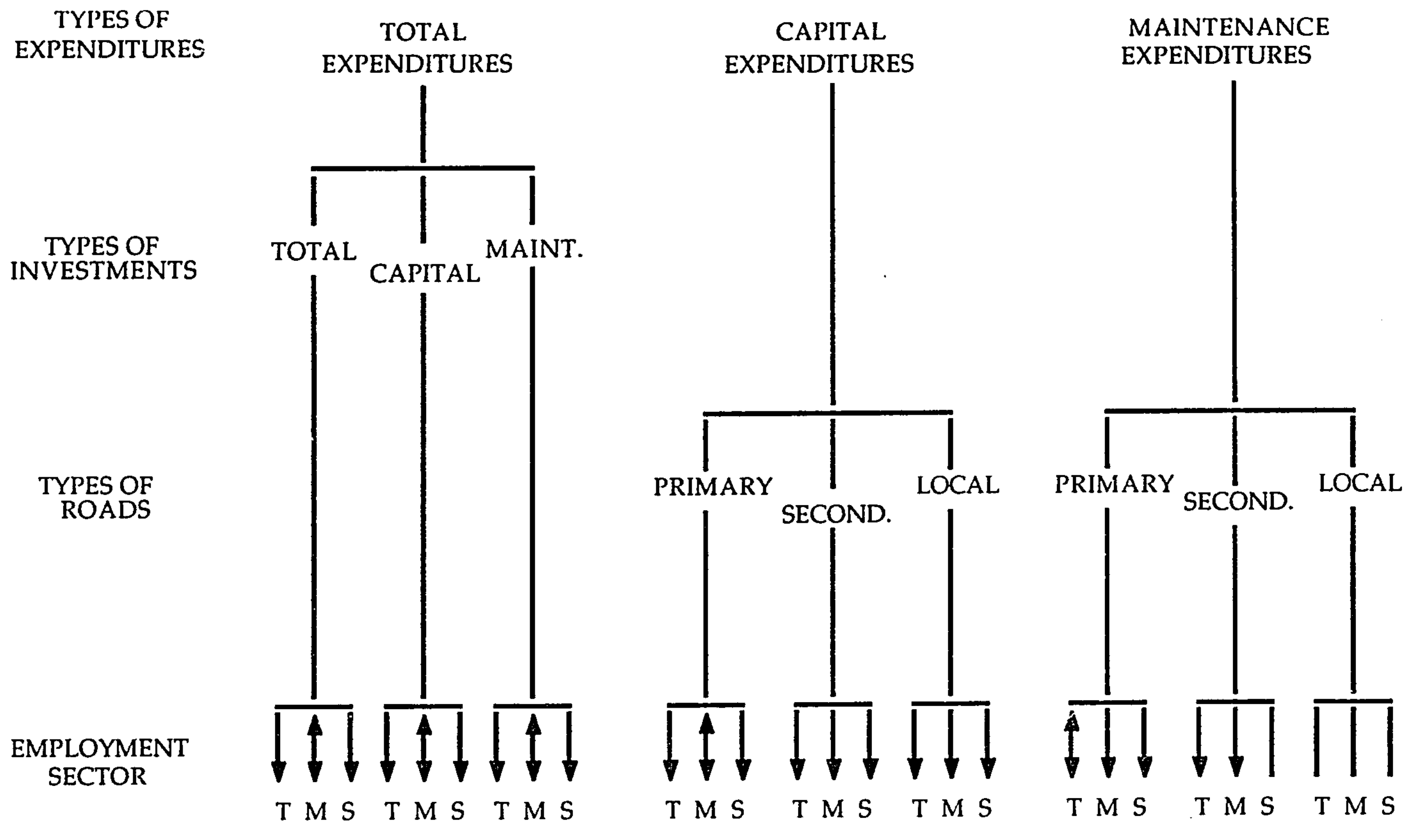
APPENDIX

TABLES AND FIGURES REPRESENTING THE DIRECTIONALITY, AS WELL AS THE TEMPORAL ASPECT, OF THE RELATIONSHIP BETWEEN THE VARIOUS ROADS EXPENDITURES AND THE THREE EMPLOYMENT SECTORS



Note: T = Total Employment; M = Manufacturing Employment; S = Service Employment.

Figure 15. Direction of the Causal Relationship Between the Various Roads Investments with Employments to Growth in the Rest of the State Counties.



Note: T = Total Employment; M = Manufacturing Employment; S = Service Employment.

Figure 16. Direction of the Causal Relationship Between the Various Roads Investments with Employments to Growth in the Portland Metropolitan Counties.

TABLE III

DIRECTION OF THE CAUSAL RELATIONSHIP BETWEEN THE VARIOUS ROADS EXPENDITURES AND EMPLOYMENTS TO GROWTH AT THE PORTLAND METROPOLITAN COUNTIES

Direction of Causality
Road Expenditures (EX) vs. Employment (EM)

	Total Expenditures						Capital Expenditures						Maintenance Expenditures					
	Grand		Capital		Maint.		Primary		Secondary		Local		Primary		Secondary		Local	
	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.
Tot. Emp.																		
EX ➜ EM	7.09	A	8.19	A	3.70	A	7.90	A	2.74	A	3.36	A	4.20	A	2.26	A	0.11	A
EM ➜ EX	1.10	R	0.98	R	4.87	A	0.74	R	0.90	R	8.03	A	9.28	A	0.48	R	0.44	R
Mfg. Emp.																		
EX ➜ EM	2.34	A	2.70	A	2.87	A	2.30	A	2.53	A	11.69	A	8.37	A	3.33	A	0.37	R
EM ➜ EX	4.01	A	3.71	A	7.74	A	0.23	R	0.67	R	0.31	R	1.37	R	0.46	R	0.44	R
Svc. Emp.																		
EX ➜ EM	10.46	A	12.16	A	6.94	A	12.32	A	5.07	A	7.39	A	6.00	A	0.23	R	0.46	R
EM ➜ EX	0.0003	R	1.04	R	1.68	R	0.42	R	0.73	R	0.04	R	0.80	R	0.36	R	0.37	R

F-critical(10, 104) = 1.91
A :: Accept causality hypothesis
R :: Reject causality hypothesis

TABLE IV

DIRECTION OF THE CASUAL RELATIONSHIP BETWEEN THE VARIOUS ROADS EXPENDITURES AND EMPLOYMENT TO GROWTH AT THE REST OF THE STATE COUNTIES

Direction of Causality
Road Expenditures(EX) vs. Employment (EM)

	Total Expenditures						Capital Expenditures						Maintenance Expenditures					
	Grand		Capital		Maint.		Primary		Secondary		Local		Primary		Secondary		Local	
	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.
Tot . Emp.																		
EX ➔ EM	12.02	A	15.72	A	12.75	A	7.08	A	47.70	A	40.14	A	24.26	A	47.84	A	4.91	A
EM ➔ EX	3.73	A	2.16	A	5.19	A	0.61	R	1.34	R	45.62	A	45.66	A	0.28	R	0.44	R
Mfg. Emp.																		
EX ➔ EM	3.83	A	5.60	A	3.75	A	2.50	A	17.61	A	8.88	A	20.52	A	20.52	A	1.12	R
EM ➔ EX	15.34	A	10.82	A	17.55	A	4.73	A	12.24	A	10.49	A	66.27	A	2.66	A	0.13	R
Svc. Emp.																		
EX ➔ EM	0.51	R	0.24	R	0.17	R	0.15	R	0.37	R	0.11	R	2.53	A	0.59	R	0.20	R
EM ➔ EX	0.23	R	0.41	R	0.15	R	0.37	R	0.81	R	0.16	R	0.19	R	0.42	R	0.75	R

F-critical(10, 974) = 1.83
A :: Accept causality hypothesis
R :: Reject causality hypothesis

TABLE VI

TEMPORAL EFFECT OF THE VARIOUS ROADS EXPENDITURES ON EMPLOYMENTS TO GROWTH IN THE REST OF THE STATE COUNTIES

Road Expenditures vs. Employment

	Total Expenditures			Capital Expenditures			Maintenance Expenditures		
	Grand	Capital	Maint.	Primary	Seconday	Local	Primary	Seconday	Local
Total									
laglength	$(5.27)^6$	$(5.32)^6$	$(4.71)^7$	$(3.55)^6$	$(8.13)^6$	$(10.13)^5$	$(3.45)^7$	$(7.00)^6$	$(2.08)^5$
cuml.lag	(111.09)	(209.86)	(446.30)	(83.70)	(632.49)	(1428.52)	(308.72)	(6.85)	(13.87)
Muf.Emp									
laglength	$(5.89)^6$	$(5.70)^6$	$(5.18)^6$	$(4.02)^6$	$(6.52)^6$	$(8.78)^6$	$(4.96)^6$	$(5.47)^6$	(1.76)*
cuml.lag	(217.88)	(330.19)	(878.56)	(143.74)	(780.96)	(2077.39)	(531.33)	(417.82)	(8.52)
Sev.Emp.									
laglength	(-0.65)*	(-0.48)*	(-1.21)*	(-0.58)*	(0.48)*	(0.78)*	(5.39)	(-0.84)*	(1.12)*
cuml.lag	(0.58)*	(0.15)*	(0.71)*	(0.18)*	(0.11)*	(0.29)*	(2.00)	(5.02)	(31.39)

F-critical(974,10) = 1.83
lag length = T-value; T-critical = 1.96
cumulative lag = F-statistics over the lag period.
* = F-Statistics not Significant at 5% Significance Level.
Exponent = Represent lag length.

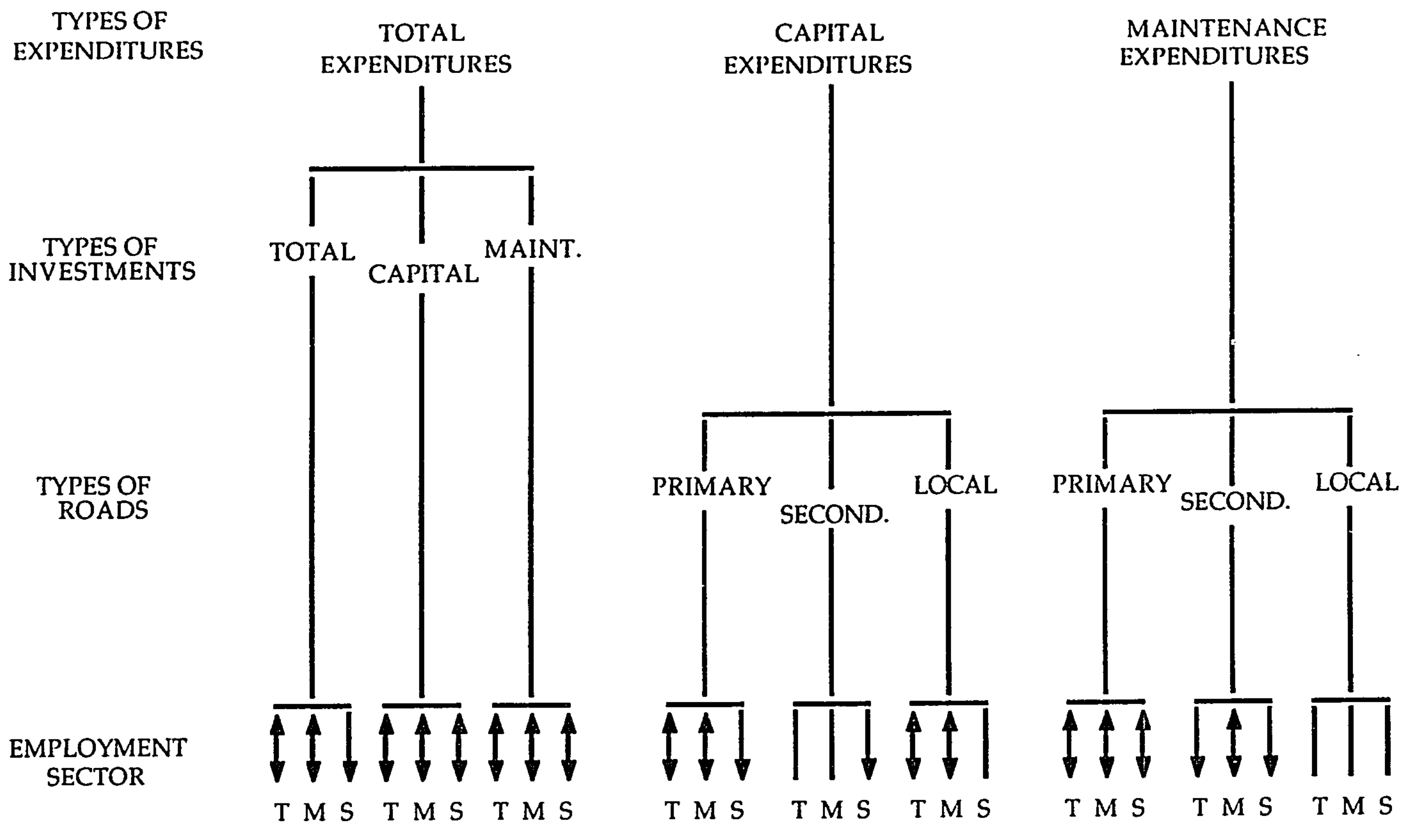
TABLE V

TEMPORAL EFFECT OF THE VARIOUS ROADS EXPENDITURES ON EMPLOYMENTS TO GROWTH AT THE PORTLAND METROPOLITAN COUNTIES

Road Expenditures vs. Employment

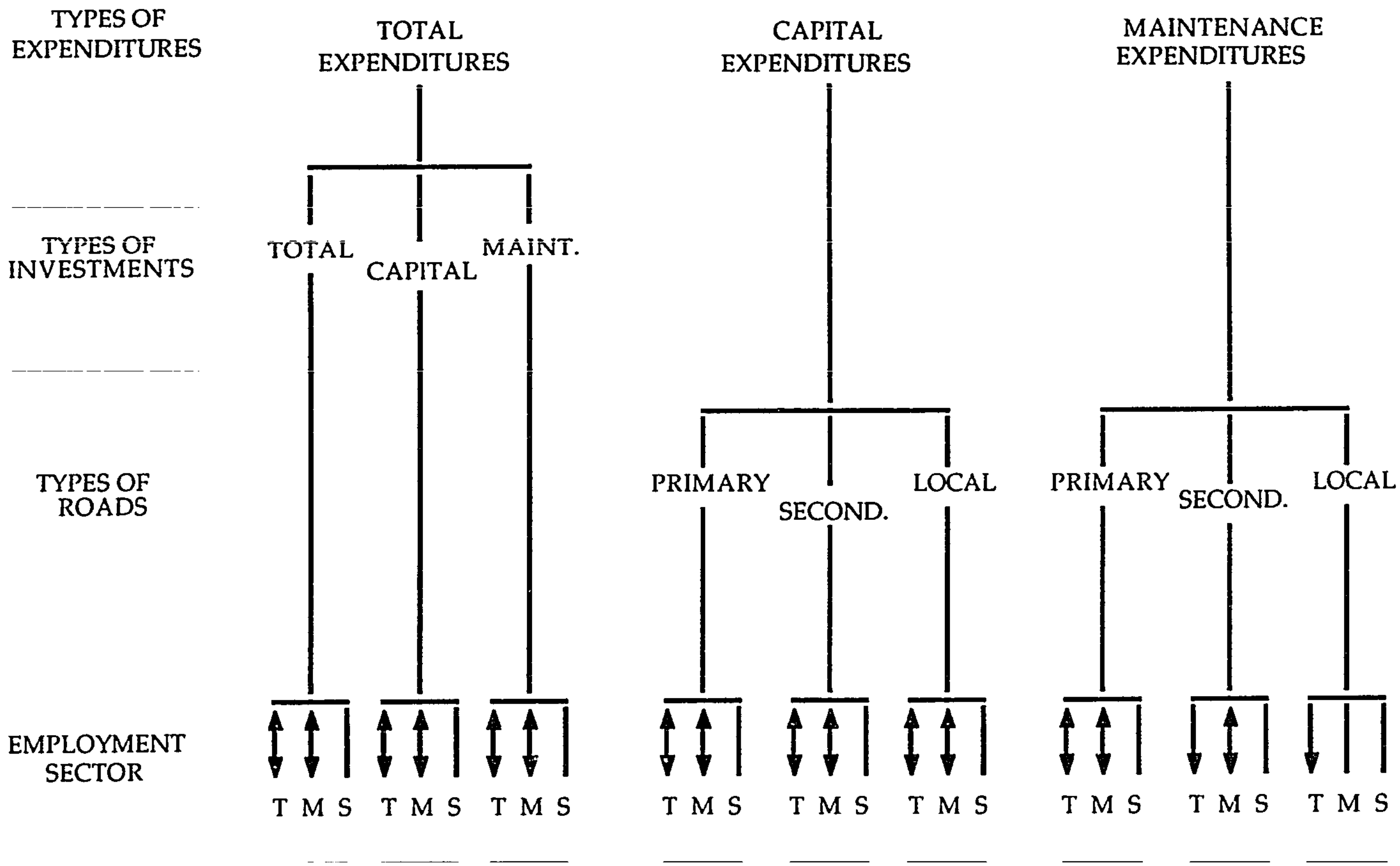
	Total Expenditures			Capital Expenditures			Maintenance Expenditures		
	Grand	Capital	Maint.	Primary	Secondary	Local	Primary	Secondary	Local
Total									
lag length	(3.54)^{6}	(3.94)^{6}	(6.26)	(3.71)^{6}	(2.62)^{6}	(4.91)^{6}	(7.08)	(2.86)	(-1.09)
cuml.lag	(67.47)	(227.06)	(24.29)	(234.51)	(11.10)	(239.64)	(32.94)	(7.17)	(1.80)*
Mfg. Emp.									
lag length	(2.08)^{6}	(2.35)	(4.85)	(2.03)^{6}	(2.61)^{6}	(3.45)^{5}	(5.39)	(2.20)	(-1.14)
cuml.lag	(56.88)	(182.36)	(13.35)	(176.81)	(22.91)	(180.35)	(17.85)	(2.91)	(2.17)
Svc. Emp.									
lag length	(4.07)^{6}	(4.53)	(6.96)^{1}	(4.41)^{6}	(2.72)^{5}	(5.32)	(7.98)	(-3.23)	(-1.13)
cuml.lag	(64.43)	(178.24)	(28.27)	(186.73)	(13.67)	(212.97)	(39.40)	(3.97)	(2.03)

F-critical(10, 104) = 1.91
lag length = T-value; T-critical = 1.97
cumulative lag = F-statistics.over the lag period.
* = F- Statistics Not Significant at 5% Significance Level.
Exponent = Represent lag length



Note: T = Total Employment; M = Manufacturing Employment; S = Service Employment.

Figure 17. Direction of the Causal Relationship Between the Various Roads Investments with Employments to Growth in the Urban Counties.



Note: T = Total Employment; M = Manufacturing Employment; S = Service Employment.

Figure 18. Direction of the Causal Relationship Between the Various Roads Investments with Employments to Growth in the Rural Counties.

TABLE VII

DIRECTION OF THE CAUSAL RELATIONSHIP BETWEEN THE VARIOUS ROADS EXPENDITURES AND EMLOYMENTS TO GROWTH AT THE URBAN COUNTIES

Direction of Causality
Road Expenditures (EX) vs. Employment (EM)

	Total Expenditures						Capital Expenditures						Maintenance Expenditures					
	Grand		Capital		Maint.		Primary		Secondary		Local		Primary		Secondary		Local	
	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.
Tot . Emp.																		
EX → EM	12.15	A	15.23	A	7.62	A	14.78	A	0.32	R	3.25	A	12.83	A	2.67	A	0.14	R
EM → EX	2.66	A	2.49	A	9.44	A	2.28	A	1.27	R	11.84	A	7.58	A	0.39	R	0.73	R
Mfg. Emp.																		
EX → EM	3.95	A	5.02	A	2.22	A	4.76	A	0.11	R	2.72	A	5.55	A	2.28	A	0.34	R
EM → EX	7.41	A	6.95	A	14.88	A	5.81	A	0.29	R	21.51	A	8.18	A	2.56	A	0.6	R
Svc. Emp.																		
EX → EM	18.72	A	22.75	A	14.14	A	22.51	A	8.35	A	0.13	R	12.62	A	1.94	A	0.55	R
EM → EX	0.13	R	3.16	A	4.16	A	0.73	R	7.53	R	1.58	R	6.12	A	0.94	R	0.62	R

F-critical(10, 224) = 1.83
A :: Accept causality hypothesis
R :: Reject causality hypothesis

TABLE VII

DIRECTION OF THE CAUSAL RELATIONSHIP BETWEEN THE VARIOUS ROADS EXPENDITURES AND EMPLOYMENT TO GROWTH AT THE RURAL COUNTIES

Direction of Causality
Road Expenditures (EX) vs. Employment (EM)

	Total Expenditures						Capital Expenditures						Maintenance Expenditures					
	Grand		Capital		Maint.		Primary		Secondary		Local		Primary		Secondary		Local	
	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.
Tot . Emp.																		
EX → EM	8.62	A	12.22	A	11.60	A	10.35	A	2.79	A	7.79	A	44.95	A	51.32	A	10.54	A
EM → EX	7.59	A	4.19	A	4.86	A	2.60	A	6.68	A	44.17	A	64.62	A	0.60	R	0.55	R
Mfg. Emp.																		
EX → EM	2.48	A	2.45	A	2.94	A	2.51	A	2.17	A	2.16	A	16.55	A	15.37	A	1.54	R
EM → EX	17.12	A	11.78	A	13.55	A	8.29	A	12.51	A	55.59	A	50.78	A	7.27	A	0.17	R
Svc. Emp.																		
EX → EM	0.23	R	0.19	R	0.18	R	0.13	R	0.43	R	0.42	R	3.55	R	0.55	R	0.99	R
EM → EX	0.24	R	0.42	R	0.13	R	0.37	R	0.12	R	1.09	R	0.34	R	0.60	R	0.85	R

F-critical(10, 824) = 1.83
A :: Accept causality hypothesis
R :: Reject causality hypothesis

TABLE IX

TEMPORAL EFFECT OF THE VARIOUS ROADS EXPENDITURES ON EMPLOYMENTS TO GROWTH AT THE URBAN COUNTIES

Road Expenditures vs. Employment

	Total Expenditures			Capital Expenditures			Maintenance Expenditures		
	Grand	Capital	Maint.	Primary	Seconday	Local	Primary	Seconday	Local
Total									
laglength	(4.80)^{6}	(5.30)^{6}	(3.86)	(4.95)^{6}	(-2.72)	(4.42)^{6}	(7.77)	(2.72)	(-1.45)
cuml.lag	(122.65)	(417.90)	(31.89)	(409.82)	(2.67)	(231.22)	(41.45)	(12.00)	(2.00)
Muf.Emp									
laglength	(3.14)^{6}	(3.44)^{6}	(6.12)	(3.12)^{6}	(0.42)	(3.49)^{5}	(6.67)	(-1.43)	(-1.37)
cuml.lag	(119.25)	(368.11)	(36.12)	(330.17)	(0.16)*	(223.60)	(41.24)	(0.86)*	(2.34)
Sev.Emp.									
laglength	(5.44)^{6}	(6.02)^{6}	(7.15)	(5.76)^{6}	(-2.21)	(5.20)^{6}	(8.54)	(-3.49)	(-1.47)
cuml.lag	(87.68)	(338.20)	(29.19)	(338.47)	(5.27)	(225.37)	(41.96)	(2.93)	(2.10)

F-critical(10,224) = 1.83
lag length = T-value; T-critical = 1.96
cumulative lag = F-statistics over the lag period.
* = F-Statistics Not Signifacant at 5% Signiface Level.
Exponent = Represent lag length.

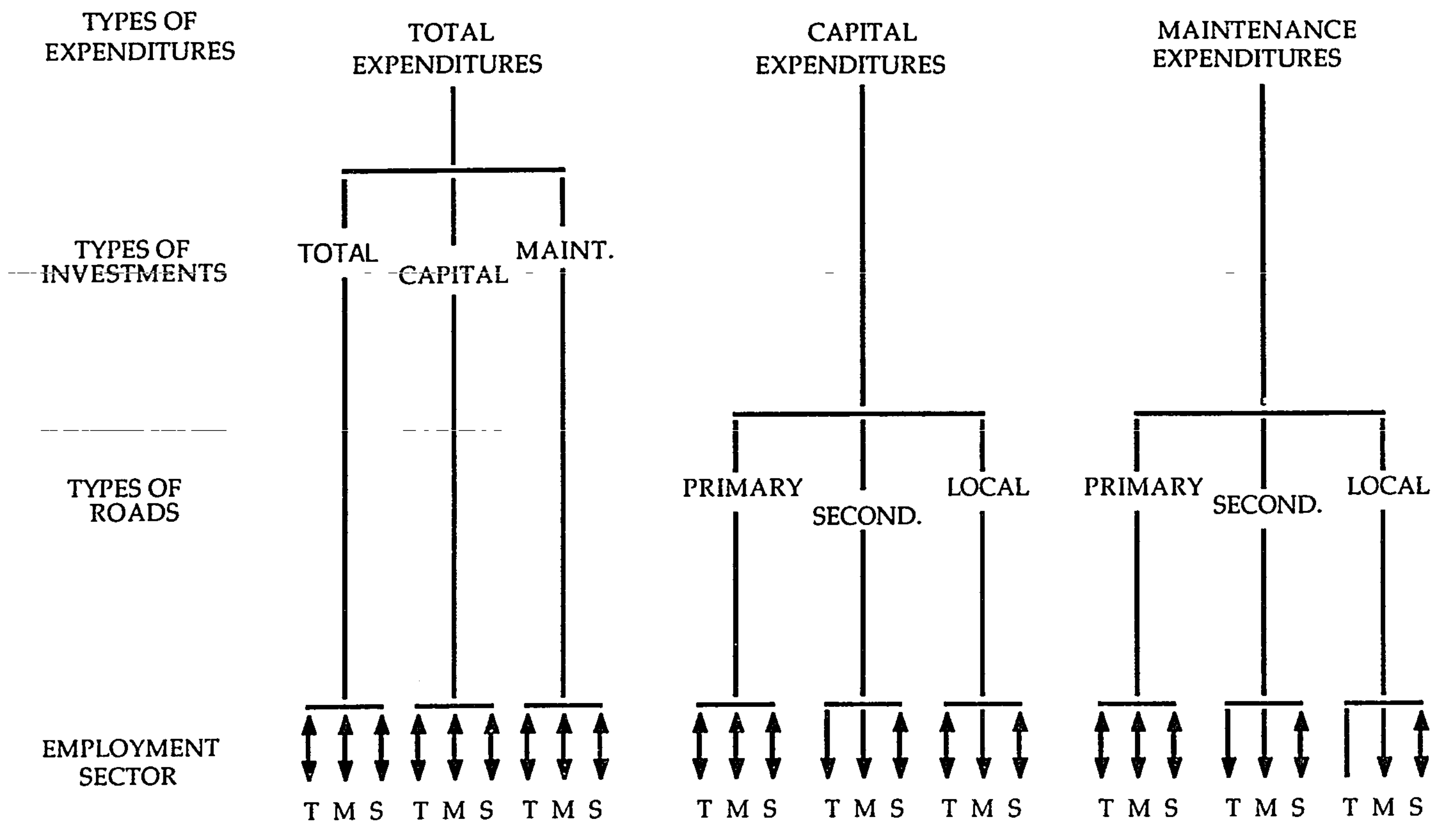
TABLE X

TEMPORAL EFFECT OF THE VARIOUS ROADS EXPENDITURES ON EMPLOYMENTS TO GROWTH AT THE RURAL COUNTIES

Road Expenditures vs. Employment

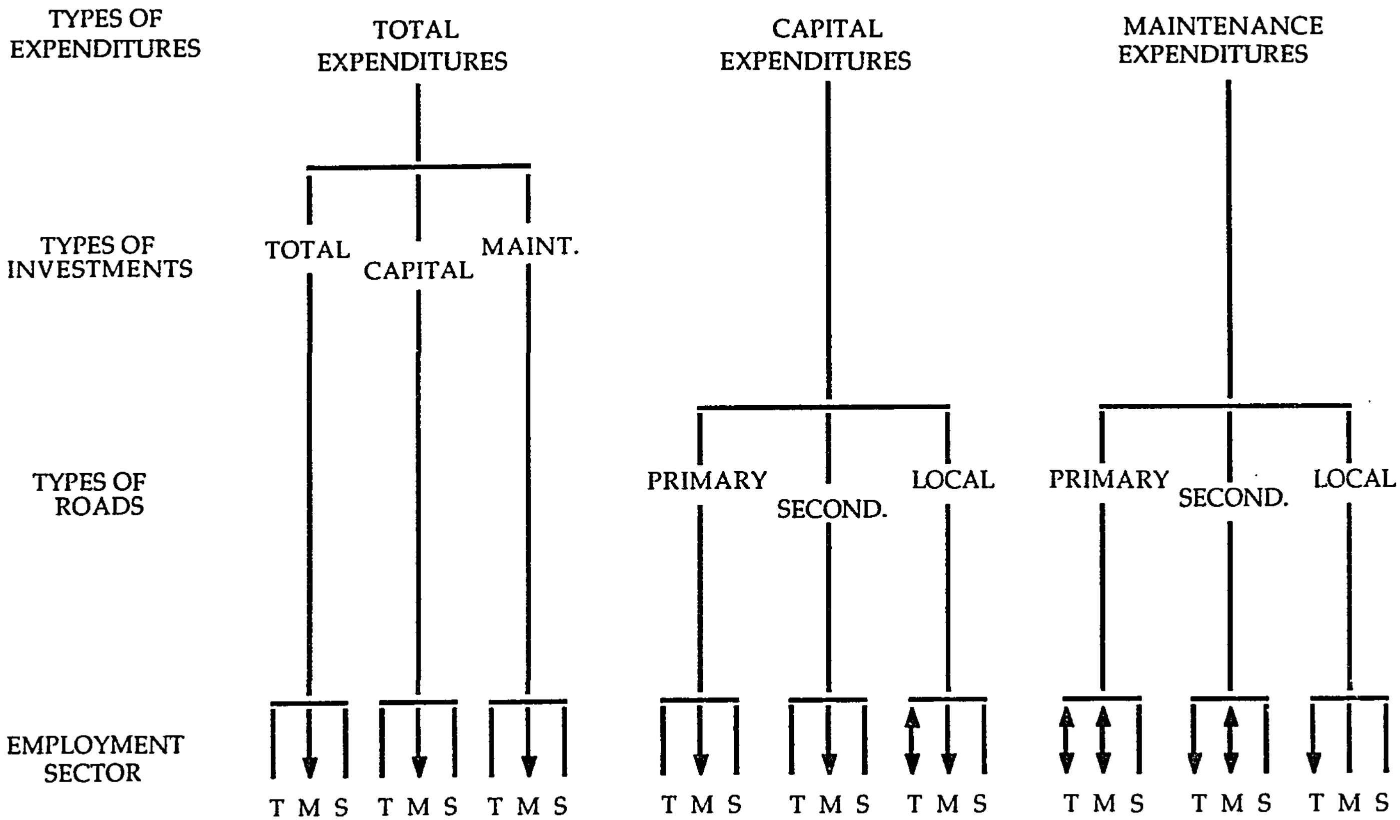
	Total Expenditures			Capital Expenditures			Maintenance Expenditures		
	Grand	Capital	Maint.	Primary	Secondary	Local	Primary	Secondary	Local
Total									
lag length	(5.06)^{7}	(4.77)^{7}	(3.69)^{7}	(4.38)^{7}	(2.93)^{6}	(5.76)^{6}	(3.95)^{4}	(5.81)^{7}	(2.52)
cuml.lag	(91.21)	(154.35)	(474.38)	(109.82)	(107.93)	(467.53)	(312.21)	(253.22)	(31.43)
Muf. Emp.									
lag length	(4.62)^{7}	(4.43)	(3.56)^{6}	(4.00)^{7}	(2.64)^{6}	(5.84)^{6}	(4.36)^{4}	(5.12)	(1.95)
cuml.lag	(148.38)	(212.93)	(568.74)	(149.64)	(153.92)	(578.38)	(102.33)	(412.42)	(18.15)
Sev. Emp.									
lag length	(-0.60)	(0.40)	(-1.27)	(-0.56)	(0.27)	(1.16)	(-1.08)	(-0.83)	(-0.11)
cuml.lag	(0.13)*	(0.79)*	(1.25)*	(0.12)*	(0.59)*	(0.22)*	(2.58)*	(0.87)*	(0.78)*

F-critical(10, 824) = 1.83
lag length = T-Value; T-Critical = 1.96
cumulative lag = F-Satistics.over the lag period.
* = F-Statistics Not Significant at 5% Significance Level.
Exponent = Represent lag length.



Note: T = Total Employment; M = Manufacturing Employment; S = Service Employment.

Figure 19. Direction of the Causal Relationship Between the Various Roads Investments with Employments to Growth in the Interstate Counties.



Note: T = Total Employment; M = Manufacturing Employment; S = Service Employment.

Figure 20. Direction of the Causal Relationship Between the Various Roads Investments with Employments to Growth in the Non-Interstate Counties.

TABLE XI

DIRECTION OF THE CAUSAL RELATIONSHIP BETWEEN THE VARIOUS ROADS EXPENDITURES AND EMPLOYMENT TO GROWTH AT THE INTERSTATE COUNTIES

Direction of Causality
Road Expenditures (EX) vs. Employment (EM)

	Total Expenditures						Capital Expenditures						Maintenance Expenditures					
	Grand		Capital		Maint.		Primary		Secondary		Local		Primary		Secondary		Local	
	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.
Tot . Emp.																		
EX → EM	7.27	A	22.76	A	10.37	A	19.25	A	2.74	A	12.00	A	26.64	A	3.99	A	0.25	R
EM → EX	11.25	A	10.86	A	26.72	A	10.34	A	0.90	R	25.52	A	20.36	A	0.50	R	0.89	R
Mfg. Emp.																		
EX → EM	3.98	A	6.16	A	2.80	A	4.66	A	2.10	A	52.47	A	22.67	A	2.76	A	3.12	A
EM → EX	24.26	A	21.77	A	35.43	A	17.96	A	0.21	R	0.94	R	28.45	A	0.31	R	0.55	R
Svc. Emp.																		
EX → EM	29.74	A	36.90	A	20.79	A	21.94	A	3.37	A	2.16	A	33.37	A	2.00	A	22.53	A
EM → EX	3.11	A	5.14	A	15.65	A	15.49	A	2.63	A	3.80	A	3.15	A	2.32	A	14.12	A

F-critical(10, 524) = 1.83
A :: Accept causality hypothesis
R :: Reject causality hypothesis

TABLE XII

DIRECTION OF THE CAUSAL RELATIONSHIP BETWEEN THE VARIOUS ROADS EXPENDITURES AND EMPLOYMENTS TO GROWTH AT THE NON-INTERSTATE COUNTIES

Direction of Causality
Road Expenditures(EX) vs. Employment (EM)

	Total Expenditures						Capital Expenditures						Maintenance Expenditures					
	Grand		Capital		Maint.		Primary		Secondary		Local		Primary		Secondary		Local	
	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.
Tot . Emp.																		
EX ⇒ EM	0.56	R	1.75	R	0.16	R	1.43	R	0.67	R	2.62	A	16.58	A	24.38	A	9.31	A
EM → EX	1.80	R	0.46	R	0.91	R	0.75	R	1.79	R	15.07	A	16.10	A	0.76	R	0.88	R
Mfg. Emp.																		
EX → EM	7.88	A	4.93	A	6.92	A	2.57	A	6.46	A	18.56	A	4.43	A	3.87	A	1.44	R
EM → EX	0.95	R	0.40	R	0.55	R	0.69	R	1.11	R	0.51	R	11.77	A	5.28	A	0.65	R
Svc. Emp.																		
EX → EM	0.11	R	0.28	R	0.28	R	0.52	R	0.55	R	0.43	R	0.29	R	0.47	R	0.57	R
EM → EX	0.20	R	0.26	R	0.63	R	0.70	R	1.24	R	0.88	R	0.39	R	0.30	R	0.86	R

F-critical(10, 524) = 1.83
A :: Accept causality hypothesis
R :: Reject causality hypothesis

TABLE XIII

TEMPORAL EFFECT OF THE VARIOUS ROADS EXPENDITURES ON EMPLOYMENTS TO GROWTH AT THE INTERSTATE COUNTIES

Road Expenditures vs. Employment

	Total Expenditures			Capital Expenditures			Maintenance Expenditures		
	Grand	Capital	Maint.	Primary	Secondary	Local	Primary	Secondary	Local
Total									
lag length	(6.93)^{6}	(7.55)^{6}	(10.40)	(7.00)^{6}	(2.67)^{5}	(6.68)^{6}	(11.23)	(2.00)^{5}	(-1.40)
cuml.lag	(297.67)	(817.47)	(82.68)	(706.98)	(13.28)	(717.70)	(92.15)	(4.21)	(1.13)*
Mfg. Emp.									
lag length	(5.25)^{6}	(5.63)^{6}	(2.91)^{1}	(4.99)^{6}	(2.07)^{6}	(6.70)^{5}	(10.97)	(2.80)	(0.52)
cuml.lag	(294.22)	(723.67)	(122.72)	(559.18)	(52.10)	(847.34)	(113.21)	(13.79)	(0.83)*
Svc. Emp.									
lag length	(7.57)^{6}	(8.26)^{6}	(10.21)	(11.61)	(2.09)	(2.52)	(7.82)^{6}	(2.46)^{7}	(7.45)^{6}
cuml.lag	(228.13)	(683.42)	(71.52)	(90.96)	(22.15)	(15.00)	(625.64)	(3.96)	(619.77)

F-critical(10, 524) = 1.83
lag length = T-Value; T-Critical = 1.96
cumulative lag = F-Statistics.over the lag period.
* = F-Statistics Not Significant at 5% Significance Level.
Exponent = Represent lag length

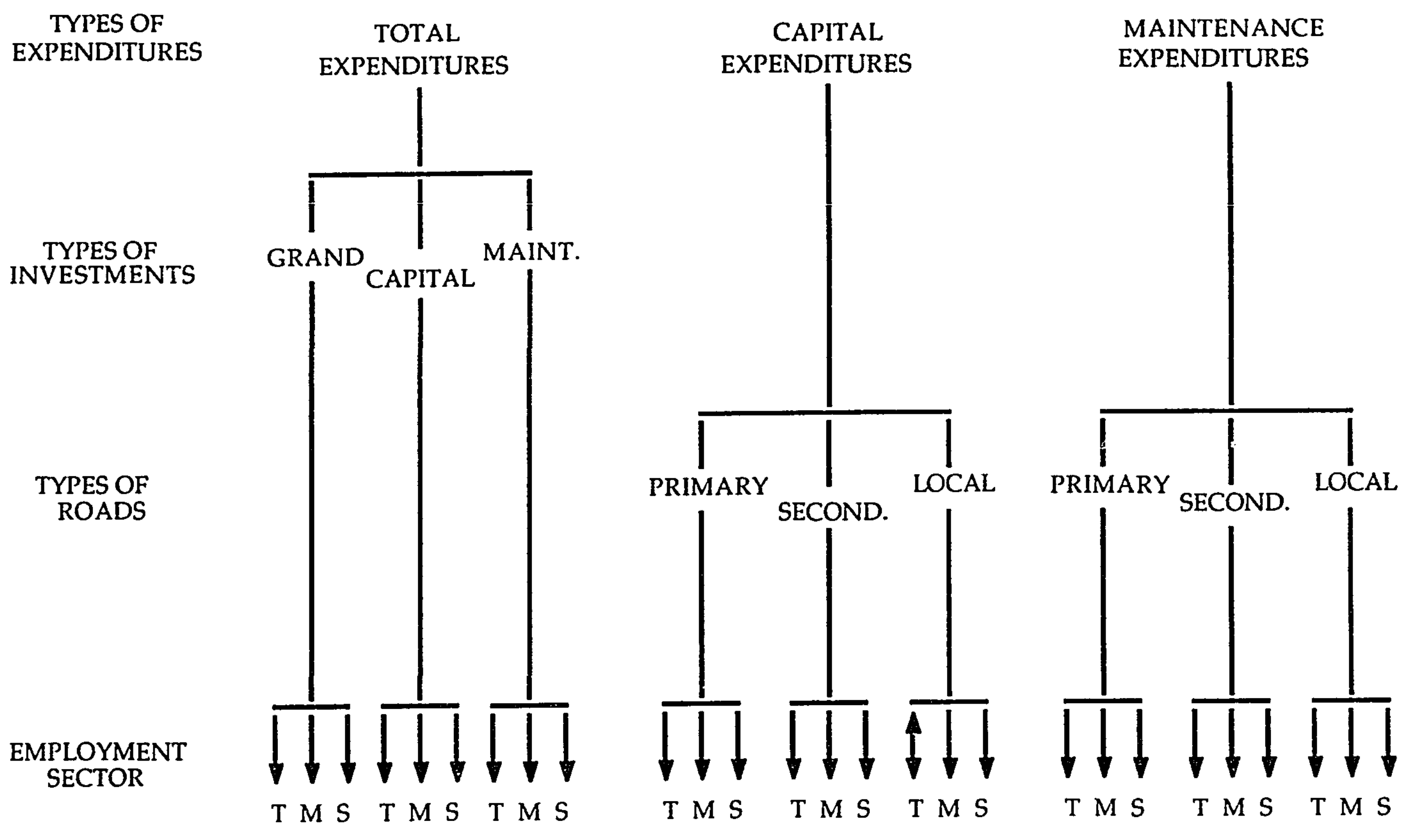
TABLE XIV

TEMPORAL EFFECT OF THE VARIOUS ROADS EXPENDITURES ON EMPLOYMENTS TO GROWTH AT THE NON-INTERSTATE COUNTIES

Road Expenditures vs. Employment

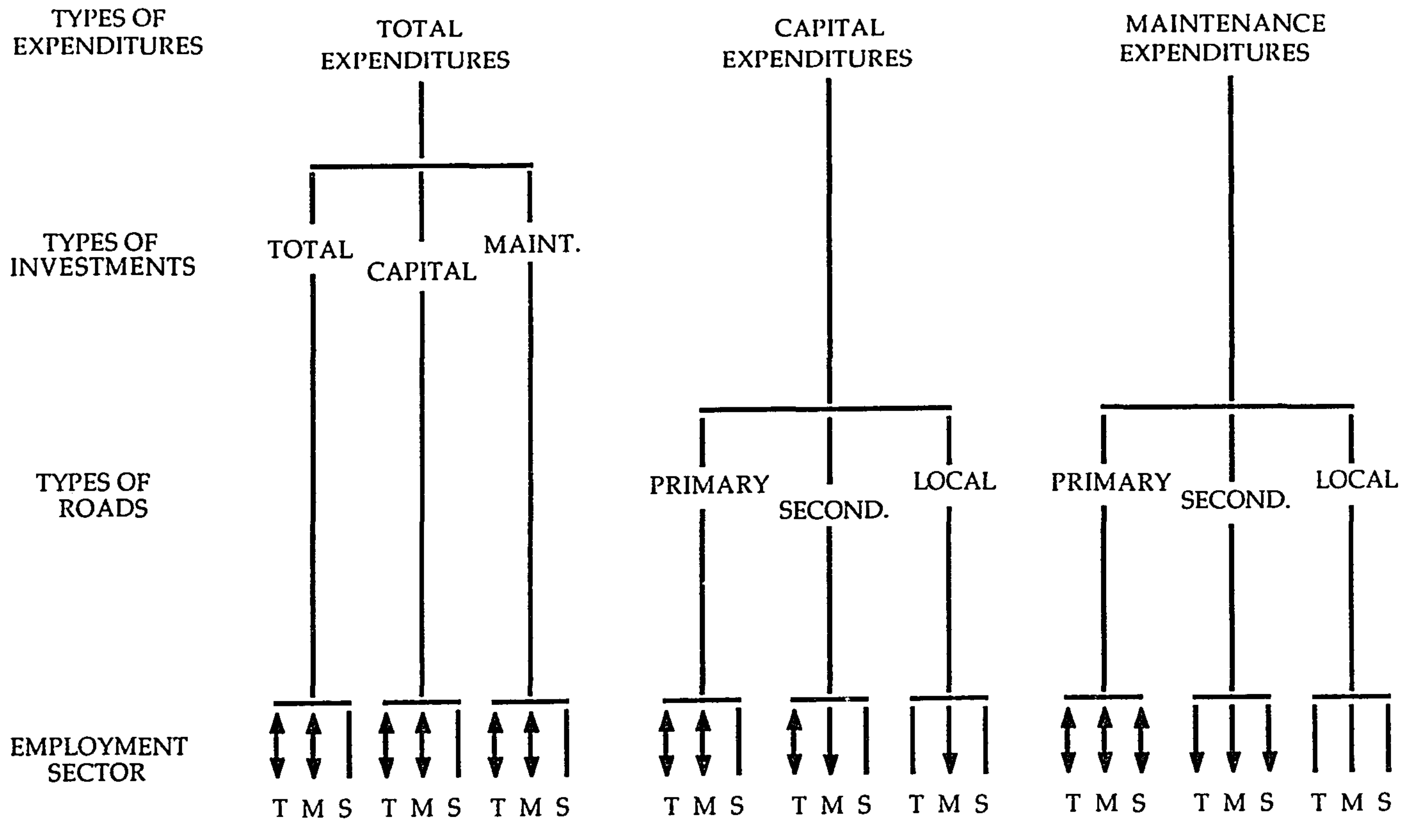
	Total Expenditures			Capital Expenditures			Maintenance Expenditures		
	Grand	Capital	Maint.	Primary	Secondary	Local	Primary	Secondary	Local
Total									
lag length	(5.36)	(3.45)	(10.79)	(2.68)	(3.0)	(4.15)	(9.55)	(5.10)^{6}	(3.01)^{6}
cuml.lag	(25.00)	(39.81)	(96.23)	(25.07)	(27.08)	(89.71)	(49.62)	(119.92)	(47.32)
Mfg. Emp.									
lag length	((3.56)^{4}	(3.28)^{4}	(2.44)^{3}	(2.54)^{5}	(2.05)^{3}	(3.76)	(6.68)	(3.91)^{3}	(1.74)
cuml.lag	(85.49)	(121.39)	(123.71)	(81.62)	(52.20)	(149.65)	(49.90)	(276.65)	(9.26)
Svc. Emp.									
lag length	(-0.58)	(-0.34)	(-1.03)	(-1.09)	(-0.91)	(0.17)	(-0.56)	(0.44)	(0.61)
cuml.lag	(0.88)*	(0.31)*	(6.29)	(4.36)	(1.03)*	(0.23)*	(0.33)*	(0.01)*	(0.93)*

F-critical(10, 524) = 1.83
lag length = T-Value; T-Critical = 1.96
cumulative lag = F-Statistics.over the lag period.
* = F-Statistics Not Significant at 5% significanc Level.
Exponent = Represent lag length.



Note: T = Total Employment; M = Manufacturing Employment; S = Service Employment.

Figure 21. Direction of the Causal Relationship Between the Various Roads Investments with Employments to Growth in the Coastal Counties.



Note: T = Total Employment; M = Manufacturing Employment; S = Service Employment.

Figure 22. Direction of the Causal Relationship Between the Various Roads Investments with Employments to Growth in the Non-Coastal Counties.

TABLE XV

DIRECTION OF THE CAUSAL RELATIONSHIP BETWEEN THE VARIOUS ROADS EXPENDITURES AND EMPLOYMENTS TO GROWTH AT THE COSTAL COUNTIES

Direction of Causality
Road Expenditures (EX) vs. Employment (EM)

	Total Expenditures						Capital Expenditures						Maintenance Expenditures					
	Grand		Capital		Maint.		Primary		Secondary		Local		Primary		Secondary		Local	
	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.
Tot. Emp.																		
EX → EM	2.14	A	2.31	A	2.82	A	2.38	A	17.80	A	14.71	A	14.27	A	9.87	A	3.13	A
EM → EX	0.78	R	0.45	R	1.04	R	0.19	R	0.31	R	13.60	A	1.46	R	0.25	R	0.21	R
Mfg. Emp.																		
EX → EM	5.53	A	4.16	A	5.77	A	2.21	A	7.83	A	44.07	A	19.90	A	2.51	A	2.00	A
EM → EX	1.03	R	0.90	R	1.08	R	0.17	R	1.47	R	1.36	R	0.01	R	1.13	R	1.74	R
Svc. Emp.																		
EX → EM	2.20	A	2.65	A	2.93	A	4.25	A	14.92	A	16.84	A	19.70	A	2.51	A	2.00	A
EM → EX	0.37	R	0.57	R	0.57	R	0.20	R	1.55	R	0.51	R	0.01	R	1.13	R	1.74	R

F-critical(10, 194) = 1.83
A :: Accept causality hypothesis
R :: Reject causality hypothesis

TABLE XVI

DIRECTION OF THE CAUSAL RELATIONSHIP BETWEEN THE VARIOUS ROADS EXPENDITURES AND EMPLOYMENTS TO GROWTH AT THE NON-COASTAL COUNTIES

Direction of Causality
Road Expenditures (EX) vs. Employment (EM)

	Total Expenditures						Capital Expenditures						Maintenance Expenditures					
	Grand		Capital		Maint.		Primary		Secondary		Local		Primary		Secondary		Local	
	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.
Tot . Emp.																		
EX → EM	34.75	A	45.30	A	25.05	A	43.06	A	16.23	A	1.57	R	40.05	A	8.20	A	0.86	R
EM → EX	12.96	A	12.28	A	37.41	A	12.37	A	57.69	A	0.35	R	33.13	A	0.75	R	0.39	R
Mfg Emp.																		
EX → EM	10.37	A	15.24	A	7.38	A	14.76	A	2.04	A	91.01	A	33.31	A	6.25	A	0.42	R
EM → EX	31.16	A	29.23	A	52.35	A	26.76	A	0.77	R	1.14	R	36.39	A	0.002	R	0.11	R
Svc. Emp.																		
EX → EM	0.61	R	0.16	R	0.43	R	0.11	R	0.38	R	0.14	R	33.31	A	6.25	A	0.42	R
EM → EX	0.86	R	0.10	R	0.70	R	0.12	R	0.54	R	0.16	R	36.39	A	0.002	R	0.11	R

F-critical(10, 854) = 1.83
A :: Accept causality hypothesis
R :: Reject causality hypothesis

TABLE XVII

TEMPORAL EFFECT OF THE VARIOUS ROADS EXPENDITURES ON EMPLOYMENTS TO GROWTH AT THE COASTAL COUNTIES

Road Expenditures vs. Employment

	Total Expenditures			Capital Expenditures			Maintenance Expenditures		
	Grand	Capital	Maint.	Primary	Secondary	Local	Primary	Secondary	Local
Total									
lag length	(2.66)^{6}	(2.53)^{6}	(3.35)^{7}	(9.26)^{6}	(4.84)	(5.71)	(2.10)^{1}	(2.55)^{3}	(2.91)^{7}
cuml.lag	(21.90)	(38.96)	(147.19)	(1442.21)	(163.29)	(536.92)	(125.84)	(46.33)	(9.47)
Mfg. Emp.									
lag length	(3.71)^{6}	(3.39)^{6}	(4.55)^{5}	(2.00)^{6}	(4.24)^{6}	(6.08)^{5}	(4.23)^{6}	(2.47)^{6}	(2.18)^{6}
cuml.lag	(78.85)	(103.03)	(414.90)	(31.02)	(292.85)	(898.99)	(245.66)	(117.28)	(32.45)
Svc. Emp.									
lag length	(2.08)^{6}	(2.02)^{6}	(2.68)^{7}	(2.81)^{6}	(4.47)^{6}	(4.80)^{5}	(2.43)^{7}	(3.04)^{6}	(2.50)^{7}
cuml.lag	(6.31)	(15.06)	(69.63)	((36.87)	(81.82)	(272.10)	(72.95)	(16.67)	(31.90)

F-critical(10, 194) = 1.83
lag length = T-value; T-critical = 1.96
cumulative lag = F-statistics over the lag period.
Exponent = Represent lag length.

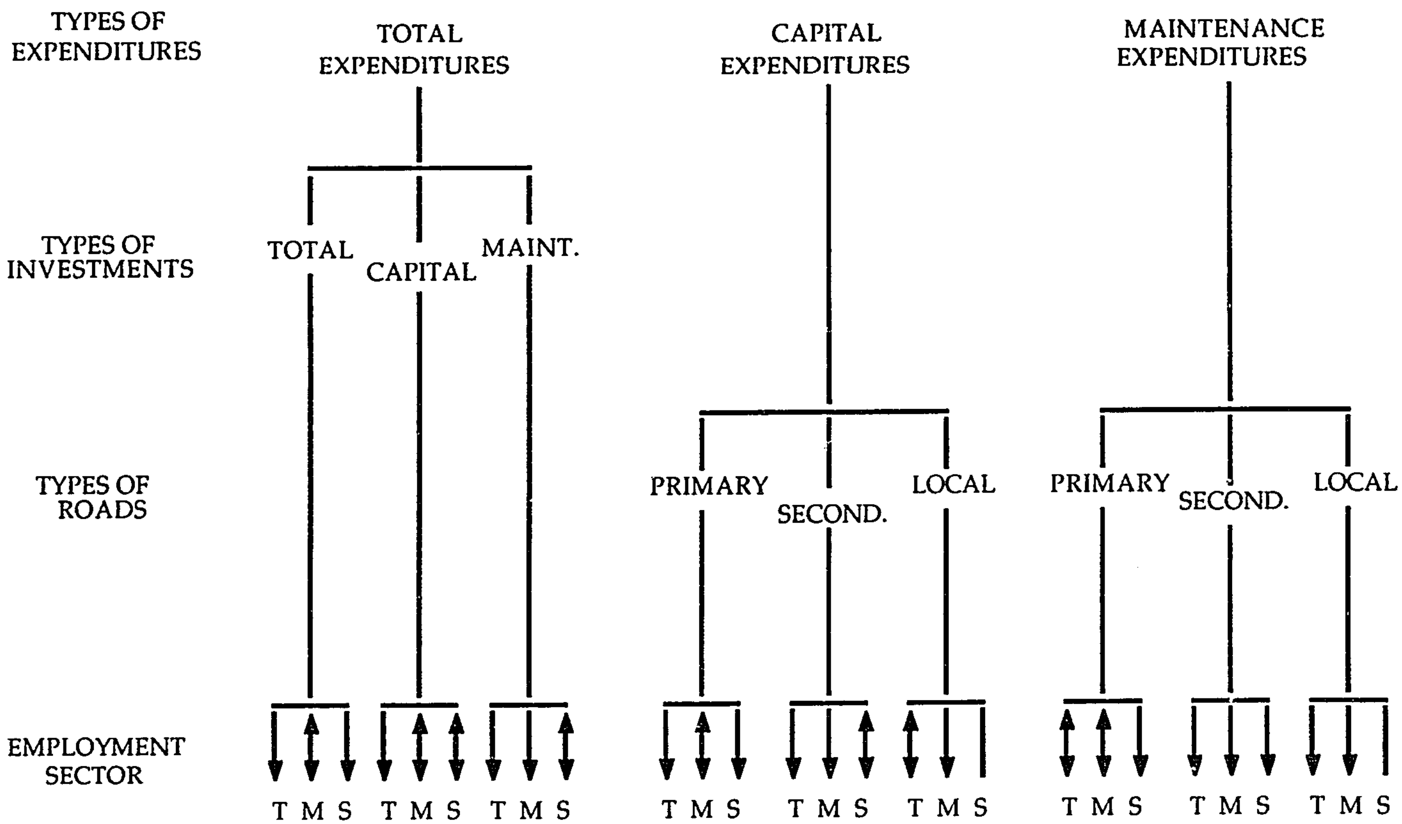
TABLE XVIII

TEMPORAL EFFECT OF THE VARIOUS ROADS EXPENDITURES ON EMPLOYMENTS TO GROWTH AT THE NON-COASTAL COUNTIES

Road Expenditures vs. Employment

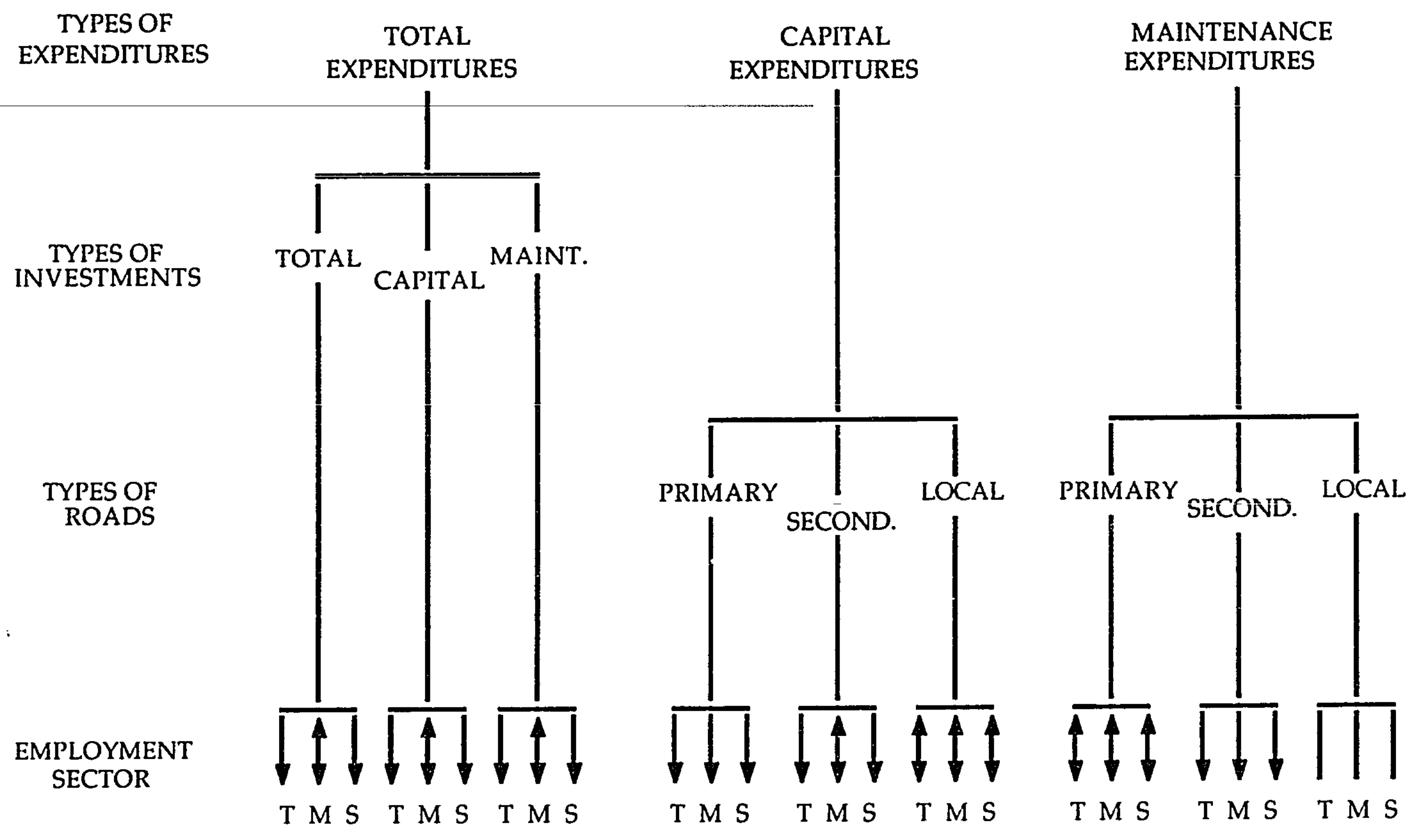
	Total Expenditures			Capital Expenditures			Maintenance Expenditures		
	Grand	Capital	Maint.	Primary	Secondary	Local	Primary	Secondary	Local
Total									
lag length	(8.48)^{6}	(9.38)^{6}	(2.10)^{5}	(9.06)	(2.83)^{6}	(1.25)	(2.61)^{4}	(2.38)^{4}	(0.30)
cuml.lag	(457.01)	(1664.44)	(198.94)	(1537.51)	(33.51)	(8.44)	(194.26)	(20.44)	(0.45)*
Mfg. Emp.									
lag length	(6.18)^{6}	(6.81)^{6}	(2.45)^{6}	(6.47)^{6}	(2.28)^{6}	(6.90)^{6}	(2.86)^{6}	(2.38)^{6}	(0.29)
cuml.lag	(450.70)	(1514.32)	(211.96)	(1298.92)	(82.89)	(1405.05)	(178.60)	(43.29)	(0.93)*
Svc. Emp.									
lag length	(-0.52)	(-0.41)	(-1.14)	(-0.47)	(-0.02)	(0.57)	(4.30)^{3}	(2.83)^{4}	(-0.17)
cuml.lag	(0.17)*	(0.11)*	(0.84)*	(0.11)*	(0.13)*	(0.24)*	(34.3)	(87.00)	(0.12)

F-critical(10, 854) = 1.83
lag length = T-value; T-critical = 1.96
cumulative lag = F-statistics over the lag period.
* = F- Statistics Not Significant at 5% Significance Level.
Exponent = Represent lag length.



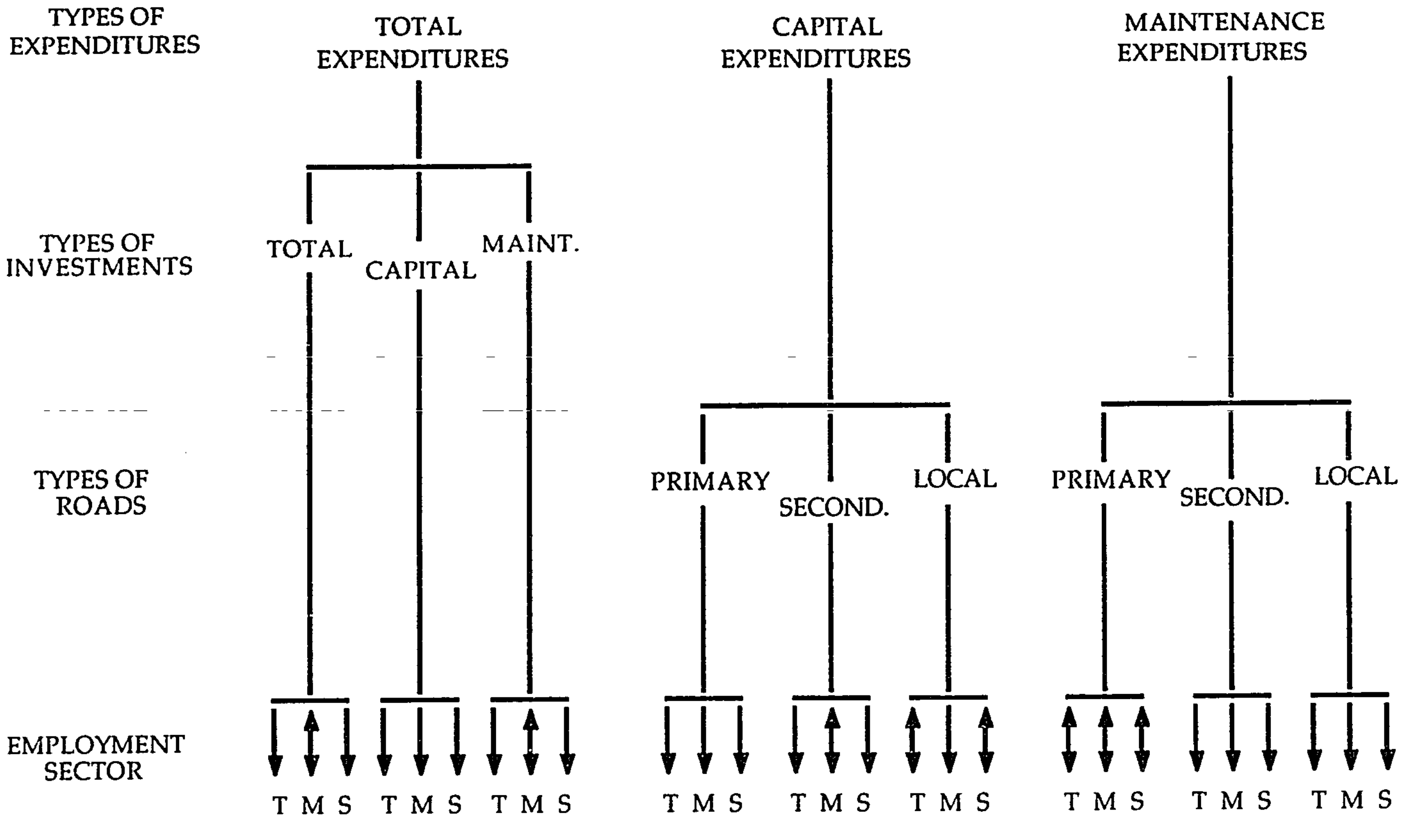
Note: T = Total Employment; M = Manufacturing Employment; S = Service Employment.

Figure 23. Direction of the Causal Relationship Between the Various Roads Investments with Employments to Growth in Region I.



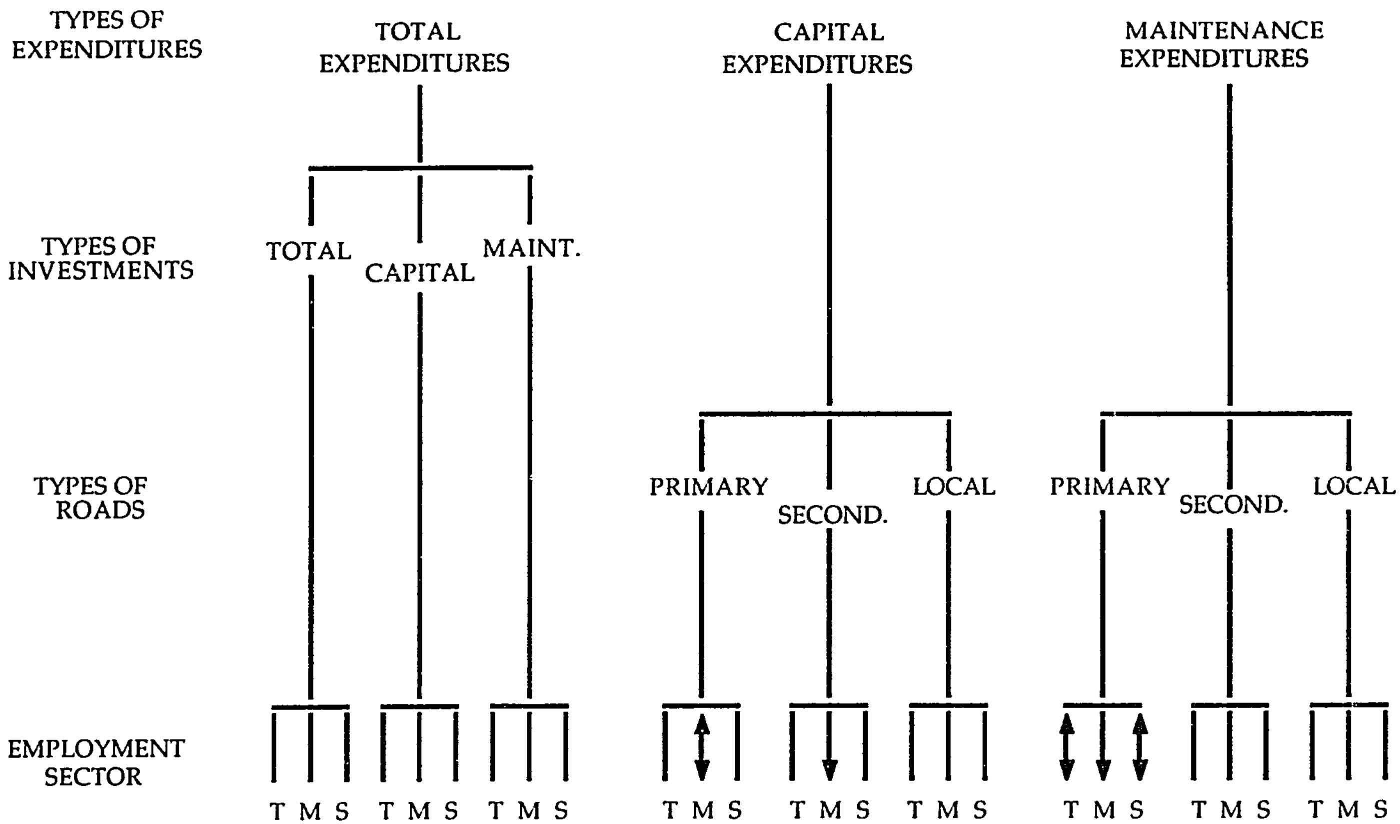
Note: T = Total Employment; M = Manufacturing Employment; S = Service Employment.

Figure 24. Direction of the Causal Relationship Between the Various Roads Investments with Employments to Growth in Region II.



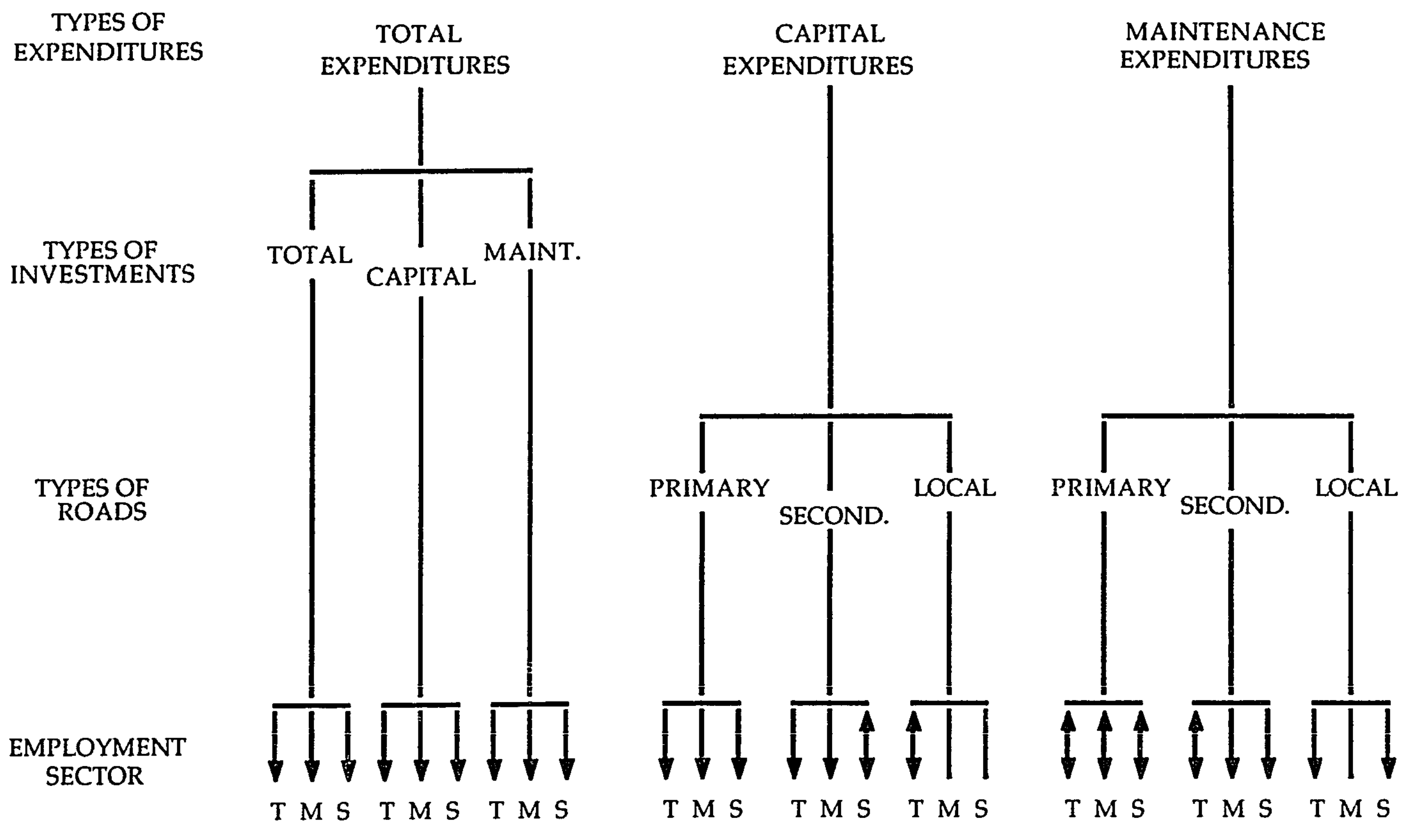
Note: T = Total Employment; M = Manufacturing Employment; S = Service Employment.

Figure 25. Direction of the Causal Relationship Between the Various Roads Investments with Employments to Growth in Region III.



Note: T = Total Employment; M = Manufacturing Employment; S = Service Employment.

Figure 26. Direction of the Causal Relationship Between the Various Roads Investments with Employments to Growth in Region IV.



Note: T = Total Employment; M = Manufacturing Employment; S = Service Employment.

Figure 27. Direction of the Causal Relationship Between the Various Roads Investments with Employments to Growth in Region V.

TABLE XIX

DIRECTION OF THE CAUSAL RELATIONSHIP BETWEEN THE VARIOUS ROADS EXPENDITURES AND EMPLOYMENTS TO GROWTH IN REGION I

Direction of Causality
Road Expenditures (EX) vs. Employment (EM)

	Total Expenditures						Capital Expenditures						Maintenance Expenditures					
	Grand		Capital		Maint.		Primary		Secondary		Local		Primary		Secondary		Local	
	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.
Tot . Emp.																		
EX → EM	7.64	A	8.66	A	4.03	A	8.35	A	2.50	A	4.03	A	2.23	A	11.47	A	15.81	A
EM → EX	1.30	R	1.20	R	0.97	R	1.19	R	0.18	R	12.07	A	10.77	A	0.25	R	0.95	R
Mfg. Emp.																		
EX → EM	2.75	A	5.96	A	11.50	A	2.42	A	3.57	A	13.87	A	4.18	A	7.84	A	3.62	A
EM → EX	6.33	A	1.91	A	0.31	R	6.11	A	0.11	R	0.13	R	16.78	A	1.00	R	0.67	R
Svc. Emp.																		
EX → EM	11.37	A	13.07	A	7.83	A	13.39	A	8.72	A	0.32	R	5.94	A	2.48	A	0.80	R
EM → EX	0.60	R	2.47	A	2.34	A	0.003	R	7.96	A	0.19	R	0.30	R	0.46	R	0.88	R

F-critical(10, 104) = 1.91
A :: Accept causality hypothesis
R :: Reject causality hypothesis

TABLE XX

DIRECTION OF THE CAUSAL RELATIONSHIP BETWEEN THE VARIOUS ROADS EXPENDITURES AND EMPLOYMENTS TO GROWTH IN REGION II

Direction of Causality
Road Expenditures (EX) vs. Employment (EM)

	Total Expenditures						Capital Expenditures						Maintenance Expenditures					
	Grand		Capital		Maint.		Primary		Secondary		Local		Primary		Secondary		Local	
	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.
Tot . Emp.																		
EX → EM	7.20	A	10.03	A	9.82	A	5.61	A	13.82	A	5.07	A	17.73	A	13.32	A	0.53	R
EM → EX	1.19	R	0.82	R	0.26	R	0.86	R	0.48	R	14.19	A	5.42	A	0.74	R	0.46	R
Mfg. Emp.																		
EX → EM	4.95	A	6.55	A	3.54	A	3.70	A	6.62	A	2.28	A	8.82	A	7.74	A	1.30	R
EM → EX	4.75	A	3.54	A	5.28	A	0.88	R	4.11	A	32.38	A	7.67	A	0.28	R	0.13	R
Svc. Emp.																		
EX → EM	6.97	A	10.01	A	12 .29	A	4.81	A	14.01	A	7.96	A	18.68	A	9.23	A	0.66	R
EM → EX	0.21	R	0.32	R	0.90	R	0.60	R	0.11	R	6.91	A	4.01	A	1.43	R	0.52	R

F-critical(10, 254) = 1.83
A :: Accept causality hypothesis
R :: Reject causality hypothesis

TABLE XXI

DIRECTION OF THE CAUSAL RELATIONSHIP BETWEEN THE VARIOUS ROADS EXPENDITURES AND EMPLOYMENTS TO GROWTH IN REGION III

Direction of Causality
Road Expenditures (EX) vs. Employment (EM)

Expenditures	Total Expenditures						Capital Expenditures						Maintenance					
	Grand		Capital		Maint.		Primary		Secondary		Local		Primary		Secondary		Local	
	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.
Tot . Emp.																		
EX ➔ EM	2.75	A	3.35	A	3.34	A	1.95	A	15.87	A	16.84	A	5.91	A	13.05	A	2.54	A
EM ➔ EX	0.53	R	0.12	R	0.18	R	0.42	R	0.11	R	13.85	A	17.48	A	0.27	R	0.25	R
Mgf Emp.																		
EX ➔ EM	3.45	A	4.59	A	5.08	A	13.30	A	4.86	A	2.21	A	13.89	A	11.87	A	2.05	A
EM ➔ EX	2.92	A	1.73	R	3.43	A	1.50	R	49.11	A	0.18	R	21.31	A	1.07	R	0.06	R
Svc. Emp.																		
EX ➔ EM	2.01	A	2.59	A	2.76	A	2.26	A	11.37	A	18.30	A	4.08	A	8.48	A	2.10	A
EM ➔ EX	0.64	R	0.60	R	0.36	R	0.23	R	0.74	R	5.33	A	9.30	A	0.01	R	0.36	R

F-critical(10, 164) = 1.83
A :: Accept causality hypothesis
R :: Reject causality hypothesis

TABLE XXII

DIRECTION OF THE CAUSAL RELATIONSHIP BETWEEN THE VARIOUS ROADS EXPENDITURES AND EMPLOYMENTS TO GROWTH IN REGION IV

Direction of Causality
Road Expenditures (EX) vs. Employment (EM)

	Total Expenditures						Capital Expenditures						Maintenance Expenditures					
	Grand		Capital		Maint.		Primary		Secondary		Local		Primary		Secondary		Local	
	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.
Tot . Emp.																		
EX → EM	0.63	R	0.89	R	0.35	R	0.76	R	0.66	R	0.26	R	3.54	A	0.57	R	0.64	R
EM → EX	0.86	R	0.12	R	0.22	R	0.72	R	0.50	R	0.97	R	9.44	A	0.11	R	0.93	R
Mfg. Emp.																		
EX → EM	0.21	R	0.65	R	0.37	R	2.39	A	4.58	A	0.03	R	8.77	A	0.33	R	0.13	R
EM → EX	1.28	R	0.16	R	0.36	R	17.79	A	0.33	R	0.76	R	0.54	R	0.13	R	0.81	R
Svc. Emp.																		
EX → EM	0.12	R	0.18	R	0.25	R	0.57	R	0.43	R	0.47	R	5.04	A	0.55	R	0.40	R
EM → EX	0.14	R	0.12	R	0.41	R	0.33	R	0.18	R	0.76	R	7.94	A	0.84	R	0.79	R

F-critical(10, 254) = 1.83
A :: Accept causality hypothesis
R :: Reject causality hypothesis

TABLE XXIII

DIRECTION OF THE CAUSAL RELATIONSHIP BETWEEN THE VARIOUS ROADS EXPENDITURES AND EMPLOYMENTS TO GROWTH IN REGION V

Direction of Causality
Road Expenditures (EX) vs. Employment (EM)

	Total Expenditures						Capital Expenditures						Maintenance Expenditures					
	Grand		Capital		Maint.		Primary		Secondary		Local		Primary		Secondary		Local	
	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.	F-val.	Deci.
Tot . Emp.																		
EX → EM	6.23	A	7.62	A	7.60	A	6.71	A	2.40	A	4.91	A	2.75	A	6.33	A	5.96	A
EM → EX	0.71	R	0.28	R	0.56	R	0.25	R	0.47	R	14.93	A	6.33	A	1.91	A	0.31	R
Mfg Emp.																		
EX → EM	2.63	A	1.95	A	2.71	A	1.91	A	19.39	A	0.46	R	2.89	A	3.03	A	0.21	R
EM → EX	1.27	R	0.76	R	1.77	R	0.63	R	0.71	R	0.33	R	11.39	A	0.10	R	0.19	R
Svc. Emp.																		
EX → EM	9.82	A	11.96	A	14.15	A	10.84	A	9.19	A	0.23	R	9.30	A	10.25	A	4.87	A
EM → EX	0.25	R	0.39	R	0.55	R	0.13	R	12.71	A	0.50	R	13.87	A	0.42	R	0.46	R

F-critical(10, 224) = 1.83
A :: Accept causality hypothesis
R :: Reject causality hypothesis

TABLE XXIV

TEMPORAL EFFECT OF THE VARIOUS ROADS EXPENDITURES ON EMPLOYMENTS TO GROWTH IN REGION I

Road Expenditures vs. Employment

	Total Expenditures			Capital Expenditures			Maintenance Expenditures		
	Grand	Capital	Maint.	Primary	Secondary	Local	Primary	Secondary	Local
Total									
lag length	(3.69)^{6}	(3.92)^{6}	(7.12)	(3.78)^{6}	(6.59)^{4}	(4.93)^{6}	(2.45)^{7}	(3.14)^{6}	(4.40)^{6}
cuml.lag	(85.30)	(279.25)	(63.77)	(278.83)	(55.25)	(315.28)	(99.50)	(6.39)	(12.80)
Mfg. Emp.									
lag length	(2.47)^{6}	(2.56)^{6}	(2.36)^{6}	(2.38)^{6}	(2.16)^{5}	(3.18)^{6}	(2.39)^{6}	(2.81)^{6}	(2.52)^{6}
cuml.lag	(98.82)	(296.74)	(66.34)	(289.18)	(3.18)	(207.48)	(179.77)	(78.58)	(48.41)
Svc. Emp.									
lag length	(4.17)^{6}	(4.53)^{6}	(7.67)	(4.47)^{6}	(5.90)^{6}	(-0.78)	(8.44)	(-1.60)	(-1.83)
cuml.lag	(55.96)	(211.31)	(53.63)	(215.93)	(322.27)	(0.11)*	(66.40)	(3.23)	(5.84)

F-critical(10. 104) = 1.91
lag length = T-value; T-critical = 1.97
cumulative lag = F-statistics over the lag period.
* = F- Statistics Not Significant at 5% Signifacance Level.
Exponent = Represent lag length.

TABLE XXV

TEMPORAL EFFECT OF THE VARIOUS ROADS EXPENDITURES ON EMPLOYMENTS TO GROWTH IN REGIONII

Road Expenditures vs. Employment

	Total Expenditures			Capital Expenditures			Maintenance Expenditures		
	Grand	Capital	Maint.	Primary	Secondary	Local	Primary	Secondary	Local
Total									
lag length	(3.54)^{5}	(3.92)^{6}	(6.29)	(2.81)^{7}	(4.22)^{7}	(2.95)^{5}	(5.86)^{5}	(4.12)^{6}	(-0.69)
cuml.lag	(66.53)	(111.92)	(19.38)	(88.07)	(234.28)	(273.71)	(2.52)	(41.86)	(0.17)*
Mfg. Emp.									
lag length	(3.33)^{7}	(3.51)^{6}	(3.27)^{6}	(2.45)^{7}	(4.18)^{6}	(2.66)^{5}	(3.15)^{5}	(2.95)^{5}	(1.60)
cuml.lag	(71.43)	(112.26)	(27.47)	(34.82)	(296.73)	(320.67)	(6.97)	(35.47)	(9.60)
Svc. Emp.									
lag length	(3.24)	(3.80)^{7}	(4.06)	(2.90)^{7}	(3.83)^{5}	(3.61)	(6.78)	(4.06)^{6}	(-2.17)
cuml.lag	(42.49)	(82.52)	(11.01)	(29.75)	(151.03)	(199.91)	(2.42)	(16.32)	(2.09)

F-critical(10, 254) = 1.83
lag length = T-value; T-critical = 1.96
cumulative lag = F-statistics over the lag period.
* = F-Statistics Not Significant at 5% Significant Level.
Exponent = Represent lag length.

TABLE XXVI

TEMPORAL EFFECT OF THE VARIOUS ROADS EXPENDITURES ON EMPLOYMENTS TO GROWTH IN REGIONIII

Road Expenditures vs. Employment

	Total Expenditures			Capital Expenditures			Maintenance Expenditures		
	Grand	Capital	Maint.	Primary	Secondary	Local	Primary	Secondary	Local
Total									
lag length	(2.06)^{7}	(1.84)^{6}	(8.12)	(2.82)^{5}	(4.50)^{6}	(4.41)	(2.11)^{7}	(3.41)^{6}	(0.08)
cuml.lag	(5.02)	(10.89)	(78.12)	(31.31)	(98.99)	(444.42)	(73.32)	(27.94)	(3.25)
Mfg. Emp.									
lag length	(3.00)^{7}	(2.74)^{6}	(3.56)^{7}	(2.48)^{7}	(4.61)^{6}	(6.54)^{7}	(3.05)	(3.11)^{6}	(0.11)
cuml.lag	(28.57)	(44.81)	(239.80)	(8.79)	(243.14)	(1117.31)	(159.46)	(96.67)	(0.43)*
Svc. Emp.									
lag length	(2.66)^{7}	(2.44)	(2.08)	(3.38)^{6}	(4.06)^{7}	(4.61)^{5}	(7.80)	(3.21)^{6}	(2.52)^{5}
cuml.lag	(2.63)	(3.33)	(38.92)	(31.47)	(46.45)	(231.43)	(44.68)	(7.64)	(3.35)

F-critical(10, 164) = 1.83
lag length = T-value; T-critical = 1.96
cumulative lag = F-statistics over the lag period.
* = S- Statistics Not Significant at 5% Significace Level.
Exponent = Represent lag length.

TABLE XXVII

TEMPORAL EFFECT OF THE VARIOUS ROADS EXPENDITURES ON EMPLOYMENTS TO GROWTH IN REGION IV.

Road Expenditures vs. Employment

	Total Expenditures			Capital Expenditures			Maintenance Expenditures		
	Grand	Capital	Maint.	Primary	Secondary	Local	Primary	Secondary	Local
Total									
lag length	(3.70)	(1.67)	$(2.76)^7$	(1.25)	(0.48)	$(2.43)^4$	(2.29)	(-1.05)	(-1.88)
cuml.lag	(14.43)	(6.77)	(156.50)	(4.08)	(2.56)	(58.67)	(73.97)	(0.02)*	(6.01)
Mfg. Emp.									
lag length	(3.88)	(1.71)	$(2.60)^5$	$(2.51)^4$	$(2.31)^4$	(1.17)	$(2.64)^6$	(0.87)	(-1.81)
cuml.lag	(17.15)	(4.89)	(224.67)	(59.37)	(7.96)	(2.25)	(67.09)	(0.37)*	(5.52)
Svc. Emp.									
lag length	(-0.052)	(-0.30)	(-1.07)	(-0.53)	(0.78)	(1.71)	$(6.18)^3$	(-0.95)	(-0.14)
cuml.lag	(0.63)*	(0.03)*	(6.45)*	(0.04)*	(0.18)*	(1.18)*	(4.73)	(1.16)*	(0.07)*

F-critical(10, 254) = 1.83
lag length = T-value; T-critical = 1,96
cumulative lag = F-statistics over the lag period.
* = F- Statistics Not signifacnt at 5% Significance Level.
Exponent = Represent lag length.

TABLE XXVIII

TEMPORAL EFFECT OF THE VARIOUS ROADS EXPENDITURES ON EMPLOYMENTS TO GROWTH IN REGION V

Road Expenditures vs. Employment

	Total Expenditures			Capital Expenditures			Maintenance Expenditures		
	Grand	Capital	Maint.	Primary	Secondary	Local	Primary	Secondary	Local
Total									
lag length	(3.40)^{6}	(3.27)^{6}	(9.30)	(3.14)^{7}	(3.13)	(5.53)	(2.15)^{6}	(2.96)^{6}	(1.67)^{6}
cuml.lag	(27.85)	(62.30)	(81.09)	(47.23)	(15.10)	(211.70)	(48.31)	(27.11)	(11.80)
Mfg. Emp.									
lag length	(2.26)^{6}	(2.24)^{7}	(2.26)^{5}	(2.06)^{6}	(4.99)^{6}	(3.26)	(1.83)^{5}	(1.83)^{5}	(1.22)
cuml.lag	(22.28)	(44.63)	(93.72)	(32.61)	(204.27)	(16.05)	(53.28)	(28.83)	(3.53)
Svc. Emp.									
lag length	(4.07)^{7}	(3.85)^{6}	(2.12)^{7}	(3.57)^{6}	(5.82)^{6}	(2.80)	(8.96)	(3.47)	(2.50)^{6}
cuml.lag	(30.29)	(71.98)	(67.68)	(57.15)	(197.99)	(9.44)	(42.84)	(22.56)	(16.17)

F-critical(10, 224) = 1.83
lag length = T-value; T-critical = 1.96
cumulative lag = F-statistics over the lag period.
Exponent = Represent lag length.