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A STUDY OF THE ASSOCIATION OF THE INVESTMENT TAX CREDIT WITH INVESTMENT SPENDING

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A STUDY OF THE ASSOCIATION OF THE INVESTMENT TAX CREDIT WITH INVESTMENT SPENDING

BY

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CHAPTER 1

INTRODUCTION

Tax credits, which are amounts that are allowed to be applied directly against a tax liability, have been used frequently in the United States within the past quarter century as part of the income tax system. Often in the past, Congress has enacted various tax credit measures solely under the presumption or belief that the measures will be effective in fulfilling the perceived or stated purpose. Over the years, tax credit provisions have become a part of the law for a number of reasons. They have been designed to, among other things, stimulate the economy, provide equity among taxpayers, or encourage some activity deemed beneficial by Congress. One of those credits, the investment tax credit, is the subject of the research in this paper.

The investment tax credit originally became part of the income tax law in 1962 during the Kennedy administration. The credit was proposed in and enacted by Congress based upon

the belief that it would encourage the purchase of certain types of business assets, which would result in a stimulation of investment and growth within the U.S. economy. Additionally, Congress accepted the argument that the level of unemployment would be reduced. Although beginning with the period of its original enactment the primary goal of the investment tax credit was to promote capital formation, the credit was billed by its promoters as a panacea that would mitigate many of the nation's economic maladies.

The investment tax credit's primary goal of promoting capital formation is considered to be a worthwhile economic goal. Although capital formation may give rise to many complex social and economic consequences, Hickman [1975] cited the following four primary reasons why increased investment spending and capital formation are important:

1. Jobs. Increased ... capital constitute(s) the quickest and most direct way to put resources at the disposal of those persons who will use them to expand business operations and jobs....

2. Productivity. Increased ... capital make(s) possible the increased productive capacity that enables workers to turn out more goods and services....

3. Real Wages. As increased ... investment permit(s) workers to turn out more goods and services, there is more to share and real wages can increase....

4. Inflation. Increased ... investment, by increasing productivity and the amount of goods and services produced, help(s) keep prices down. [Hickman, 1975, p. 282].

It appears that since the credit's origin, the general consensus among legislators has been that the investment tax credit does provide a stimulus for an increased level of investment spending for equipment by American business entities. However, the credit was suspended one time because it was considered too stimulative. It was abandoned later because it was considered too inflationary. Nonetheless, on balance, it has been considered to be a necessary element during about 18 of the last 21 years. The belief that the credit has acted as a stimulant to investment spending is also maintained by a number of researchers in the economics field. However, there is also the belief held by others that the investment tax credit is not an effective tool for stimulating growth in investment spending. This contrary stance also appears in the scholarly literature on the subject.

It seems in the past, particularly in the political arena, that the issue of the investment tax credit has been

discussed based upon theoretical and ideological views of "interested persons" rather than upon factual empirical evidence. The basic issues of proper policy, such as with the investment tax credit, should be clarified by a series of empirical analyses. The difference between what is supposed to happen and the actual investment behavior needs to be examined further in order for more certainty to exist surrounding the national tax policy relating to the investment tax credit.

Statement of the Problem and Research Purpose:

> The poor performance of the American economy in recent years has generated considerable interest in the use of tax policy to stimulate economic growth. Opinion regarding the possible effectiveness of tax policy in achieving this objective differs sharply. [Aaron and Pechman, 1981, p. vii].

The investment tax credit was originally enacted in 1962, when the economy of the United States was performing far below its potential. The investment tax credit was intended to spur lagging replacement and net additions to capital in order to increase the national growth rate. However, during the process of considering the investment tax credit provisions, Congress accepted with little questioning the purported benefits that would result from the enactment of the provisions. "... An examination of the legislative

history of the investment tax credit ... contains very little evidence that Congress conducted any serious or thorough tax analysis of the issues involved." [Klein, 1976, p. 507]. Nevertheless, the investment tax credit provisions became a part of the tax law in the United States at that point, and except for two interruptions (October 10, 1966 until March 10, 1967 and April 18, 1969 until August 16, 1971), these provisions have been a part of the law for over twenty-one years.

Despite this experience period of over two decades, it is still debatable whether the investment tax credit is an appropriate means (in terms of cost and benefits and relative efficiency) for achieving the increase in the economy as a whole. But perhaps more significant, it is still debatable whether the investment tax credit even is effective in meeting its primary goal of stimulating investment. In the meantime, the provisions have cost the United States Treasury billions of dollars in terms of lost revenues (estimated to be $19.255 billion in fiscal year 1982 and $17.170 billion in fiscal year 1983 for the regular investment tax credit. [Executive Office of the President, 1983, pp. G-27].) Further, "estimates of the effect on investment vary widely. These questions (relating to the effectiveness and efficiency of the credit) are still unsettled." [Fromm, 1971, p. vii].

A number of empirical studies have been generated over the past two decades relating to the impact of the investment

tax credit provisions on the level of investment spending within the United States. Both simplistic and sophisticated research efforts have been performed examining the issue of the impact or effectiveness of the investment tax credit, yet in retrospect it seems that none of the efforts have proven to be totally satisfactory. However, the effectiveness of the investment tax credit as an incentive to investment spending is very difficult to evaluate because many influences impinge directly and indirectly on capital outlays.

These issues surrounding the investment tax credit are too important to our national economy to remain unsettled. Therefore, it is appropriate to examine one of these issues again. The purpose of this research is to examine the impact of the investment tax credit as a stimulant to investment spending in the United States economy. Moreover, a research methodology is utilized that has not been formerly reported in the literature with respect to this topic.

Specific Topic of the Research:

The specific research questions to be examined are:

1. Has the availability of the investment tax credit provisions given rise to an increased level of investment expenditures within the United States economy over the level of investment expenditures that would have been expected without the availability of the provisions, and

2. Has an increase in the rate of the investment tax credit given rise to an increased level of investment expenditures within the United States economy over the level of investment expenditures that would have been expected had the investment tax credit rate not been increased?

In examining the first research question, a time-period surrounding January 1, 1962 is tested. January 1, 1962 was the effective date of the legislation which first allowed the investment tax credit. In examining the second research question, a time-period surrounding January 21, 1975 is tested. January 21, 1975 was the effective date for legislation that allowed an increase in the rate of the investment tax credit from seven to ten percent.

The main null and alternative hypotheses that result from these research questions are:

Ho1: The availability of the investment tax credit provisions has not increased the level of investment spending within the United States economy over the level of investment spending that would have been expected without the availability of the investment tax credit.

Ha1: The availability of the investment tax credit provisions has increased the level of investment spending within the United States economy over the level of investment spending that would have been expected without the availability of the investment tax credit.

Ho2: The increased investment tax credit rate has not increased the level of investment spending within the United States economy over the level of investment spending that would have been expected had the investment tax credit rate not been increased.

Ha2: The increased investment tax credit rate has in-

> creased the level of investment spending within the United States economy over the level of investment spending that would have been expected had the investment tax credit rate not been increased.

The study is limited to the effect of the provisions relating specifically to the regular investment tax credit as described in sections 38 and 48 of the Internal Revenue Code. Accordingly, the effect of other types of tax credits (e.g. energy tax credit and rehabilitation credit) that are available when making other types of specific acquisitions will not be included in the research.

Additionally, only domestic investment spending is considered in the study since the investment tax credit is intended to stimulate investment in property used predominantly in the United States. Therefore, foreign investments made during the periods examined are not included.

Research Design:

The selected methodology of the research tests the impact of the tax policy "directly" rather than "indirectly," as suggested by Fisher [1971, p. 243]. Much of the research in the past has taken the indirect approach where the reasoning is made that tax policy affects investment behavior, not independently, but through variables such as

cost of capital, rate of return, liquidity, etc. The conflicting results in previous research reflect an underlying lack of agreement among economists as to the specific determinants of investment and their relationships to each other and as to how the investment tax credit variable interacts with these determinants of investment. The authors approached the problem by analyzing the determinants of investment *rather* than the effects of tax policy on investment. According to Fisher [1971, p. 244], "the theoretical basis for such treatment of tax effects (the 'indirect' method) is strong. Nevertheless, it seems a dangerous way to proceed if the focus is on these very effects." The difficulty with the indirect approach is that the results rest entirely on the assumption that the effects of tax policy could be represented as occurring completely and exclusively through the effects on the variables specified in the investment models and as indistinguishable from the effects of anything else causing the same changes on these variables. That is, the assumption is made that the only changes that occur in the investment function variables is because of the change in tax policy.

The "direct" approach, which is utilized in this study, considers the tax policy (the availability of investment tax credit and an increase in the rate of the investment tax credit) as an additional factor that is to be taken into account by an investor when making an investment decision.

Accordingly, in this study's research design, the investment tax credit is considered a part of the investment decision just as are other influencing factors.

The research is performed by completing two major steps. In the first step, multiple regression analysis is utilized whereby the flow of orders for investment items is regressed on the economic variables that are believed to influence the level of investment activity. Three types of investment orders series are included in the regression analyses: qualified investment orders, which includes those assets that may give rise to claiming the investment tax credit; total investment orders; and nonqualified investment orders, which includes those assets that can not give rise to claiming the investment tax credit. In any period included in the study, the sum of the qualified and nonqualified investment orders equals the volume of the total investment orders.

As a result of this step, the fluctuation in the level of investment can be attributed either to the economic variables (the "explained" portion) or to factors not included in the regression equation (the "unexplained" portion or residual). The purpose of the regression analysis step is to isolate the level of the investment spending that may be attributed to forces or influences other than the specified determinants of investment (i.e., the residual).

The regression equation from the first step has an implicit additive error term (the residual) that accounts for

unexplained variance in the regression equation. By subtracting the estimated values of the flow of investment from the actual values, the residual series results which represents the unexplained movements in the investment flow.

In second step of the research design, a time-series analysis technique is performed on the residual series derived from the multiple regression analysis step to determine if the time-series pattern of the residual series after the institution of the investment tax credit in 1962 and after the rate change in 1975 are significantly different from the series before the investment tax credit becomes available and before the rate changes, respectively. The time-series experiment, in this case, characterized as an interrupted time-series experiment, is an "unplanned experiment" to evaluate governmental reform.[Glass et al p. 3]. The time-series design offers a unique perspective on the evaluation of the intervention effects of the investment tax credit, particularly since this technique has not been utilized previously with respect to this issue. "Interventions into societies... do not have merely 'an effect' but 'an effect pattern' across time." This technique is considered to be valuable in studying the impact on investment after the institution of the investment tax credit or after rate changes in the provisions in the sense that any such effect can be observed as being immediate or delayed, increasing or decaying, etc. [Glass et al p. 5].

The general time-series model adapted for this purpose is based upon the Box-Jenkins [1976] (BJ) techniques. The BJ methodology models a time-series of data using an autoregressive-integrated-moving-average (ARIMA) format. Using a minimization of least squares criterion, the methodology fits the data to an autoregressive (AR) model (which characterizes the data as a function of its previous observations), a moving-average (MA) model (which characterizes the data as a function of the previous random shocks), or a combination of these two models. In order to insure stability of the time-series around a given mean, the data is fit either in the original form or in a differenced form. The "I" (in the abbreviation, ARIMA) represents the degree to which the data is differenced. Additionally, the BJ methodology adjusts for seasonality by forming the model as a multiplicative combination of a seasonal model and an adjacent period model.

An adaptation of the above BJ technique, called intervention analysis, is utilized in this research. Intervention analysis was introduced by Box and Tiao [1965 and 1975] and is capable of describing a process that involves an intervention, such as the enactment or rate change of the investment tax credit. This adaptation of the general time-series technique is designed to capture any effect pattern, whether it be immediate, delayed, or gradual, which is associated with an intervention such as the investment tax credit.

As suggested by Pindyck and Rubinfeld, this research design in which both regression and time-series techniques are utilized is likely to provide a better representation of the flow of investment spending than the regression equation alone, or a time-series model alone. This is the case, they assert, "since it includes a structural (economic) explanation of that part of the variance that can be explained structurally, and a time-series 'explanation' of that part of the variance that can not be explained structurally." [Pindyck and Rubinfeld, 1976, p. 539].

In conjunction with the two major steps of the study described above, the following supplementary procedures are also conducted. Firstly, an examination of possible interaction between the investment tax credit and the various economic variables utilized in this study is considered. This procedure is necessary because the presence of any significant interaction of this nature could tend to mask or convolute the results of the tests, whether an association between the investment tax credit and investment activity truly exists or not.

Secondly, a series of intervention analyses is performed on the qualified, total, and nonqualified investment orders series in addition to the intervention analyses performed on the residuals derived from the multiple regression analyses. These ancillary tests are performed in order to confirm the

directional nature of any association found between the investment tax credit and investment activity.

As mentioned above, the regression and intervention analysis steps are conducted using three investment series. Of these three series, the qualified and total investment orders are the investment series of primary interest. In an experimental group versus control group classification scheme, these two variables are a part of the experimental group. The nonqualified investment orders series are used as a part of a control group. The control groups help mitigate the presence of exogenous variables in the economic environment which are not specifically accounted for in the research design.

Format of the Dissertation:

The chapters of this dissertation which follow discuss the eligibility requirements and historical background of the investment tax credit; present the theoretical background of the investment function, a discussion of the relevant works in the investment literature, and a discussion of the economic variables utilized in this study; more specifically discuss the research questions and hypotheses at hand and expound further upon the research methodology used to address these questions and hypotheses; present the results of the tests performed; and finally provide a summary of the work performed along with concluding comments.

A summary of the requirements established for property which qualifies for the investment tax credit is presented in Chapter 2 along with a chronology of the development of the investment tax credit throughout its years of existence. Included in this discussion are statements which provide reasons for the credit's creation and its continued existence throughout its legislative history.

Chapter 3 presents the theoretical background which is often considered by researchers when attempting to explain or understand the investment function. Literature which is relevant specifically to the research questions addressed in this study is also reviewed. Following this review, economic variables are presented which are considered to be influential factors with respect to investment spending decisions. These influencial variables noted are the ones which are used for purposes of determining the "explained" portion, and hence the "unexplained" or residual portion, of the investment flow in the multiple regression analyses.

The methodology utilized in testing the research questions and hypotheses and the time-periods included in the testing are more fully described in Chapter 4. A linear mathematical model is developed for determining the "explained" and "unexplained" (the residual) portions of the investment flow for the periods of time around two points when the investment tax credit becomes available or when the investment tax credit provisions change. Furthermore,

time-series modelling procedures are specified in each case in order for the intervention analysis to be performed. Additionally, the preliminary testing applied to the raw economic data and the ancillary testing applied to the investment orders series are also discussed.

Chapter 5 discusses the results of the tests performed as mentioned in Chapter 4. An interpretation of the results and conclusions regarding the association of the investment tax credit and investment activity are also presented.

Finally, Chapter 6 offers a summary of the research and the primary conclusions reached. Furthermore, the major contributions of the study are discussed along with suggestions for useful and potential future research and recommendations relative to the investment tax credit.

CHAPTER 2

ELIGIBILITY REQUIREMENTS AND HISTORICAL BACKGROUND OF THE INVESTMENT TAX CREDIT

This chapter discusses the eligibility requirements for assets that qualify for the regular investment tax credit. This discussion encompasses a summary of the Internal Revenue Code Sections that specify the rules which govern which asset acquisitions may give rise to the investment tax credit. Further, this chapter presents an historical perspective to the evolution of the investment tax credit legislation from its original enactment up to the present state of affairs. This section of the chapter includes comments of proponents and opponents of the credit throughout the investment tax credit's history.

Eligibility Requirements:

This section of the chapter provides an overview of the provisions of tax law which define the property that

qualifies for the investment tax credit. Since the assets that may be classified as "qualified investment" as mentioned in Section 46(c)(1) of the Internal Revenue Code have changed only slightly over time, this discussion will focus primarily on the current eligibility requirements.

Property that qualifies for the investment tax credit is generically referred to in the Internal Revenue Code as "Section 38 property." Section 38 is the code section which provides the authority for the credit upon the acquisition of certain depreciable property. The definition of "Section 38 property" is given in Section 48(a) of the Internal Revenue Code. Appendix A includes excerpts from Sections 38 and 48.

The depreciable property that meets the definition of Section 38 property includes:

1. tangible personal property (except for air conditioning and heating units). [Internal Revenue Code, Section (48)(a)(1)(A)].

2. other tangible property (except buildings and its structural components) if it--

   a. is used as an integral part of a manufacturing, production, or extraction process, or in providing transportation or certain public utility services; or

   b. constitutes a research facility used in conjunction with any of the activities referred to above (i.e., manufacturing, production, etc.); or

c. is a bulk storage facility of fungible goods if it is used in connection with any of the activities referred to above (i.e., manufacturing, production, etc.). [Internal Revenue Code, Section 48(a)(1)(B)].

3. Certain new elevators and escalators acquired or put into service after June 30, 1963. [Internal Revenue Code, Section 48(a)(1)(C)].

4. Single purpose agricultural or horticultural structures [Internal Revenue Code, Section 48(a)(1)(D)].

5. The portion of the basis of a rehabilitated building which is attributable to qualified rehabilitation expenditures. [Internal Revenue Code, Section 48(a)(1)(E)].

6. A certain portion of the basis of qualified timber property [Internal Revenue Code, Section 48(a)(1)(F)].

7. A storage facility which is not a building or a structural component of a building that is used in connection with the distribution of petroleum or certain petroleum related products. [Internal Revenue Code, Section 48(a)(1)(G)].

Further, for the property to qualify for the investment tax credit, it may not be used predominantly outside of the United States [Internal Revenue Code, Section 48(a)(2)(A)]. Exceptions to this general rule involve certain property used in international transportation and communication activities [Internal Revenue Code, Section 48(a)(2)(B)].

Property which is used to furnish lodging or used in connection with furnishing nontransient lodging is not Section 38 property. [Internal Revenue Code, Section 48(a)(3)]. However, exceptions to this general rule include:

1. nonlodging commercial facilities that are equally accessible to persons using the lodging facilities and those not using the lodging facilities; [Internal Revenue Code, Section 48(a)(3)(A)].

2. property used by a hotel or motel in its conduct of the business of providing lodging if the accomodations are used predominantly by transients; [Internal Revenue Code, Section 48(a)(3)(B)].

3. coin-operated vending machines, washing machines, and dryers; [Internal Revenue Code, Section 48(a)(3)(C)]. and

4. the portion of the basis of historical structures

which is attributable to qualified rehabilitation expenditures. [Internal Revenue Code, Section 48(a)(3)(D)].

Within certain limitations and except for horses, livestock acquired by taxpayers for use in their trade or business or held for the production of income may be treated as Section 38 property. [Internal Revenue Code, Section 48(a)(6)].

Property that may otherwise qualify for the credit may not be classified as Section 38 property if it is used by certain tax-exempt organizations. However, such property shall be treated as Section 38 property if it is used in an unrelated trade or business by such tax-exempt organization and the income from such trade or business is subject to income tax. [Internal Revenue Code, Section 48(a)(4)].

Property that is used by the governments of the United States, any state or political subdivision thereof, any international organization or any instrumentality of any of the above shall not receive Section 38 treatment. [Internal Revenue Code, Section 48(a)(5)].

Any property for which an election has been made to amortize expenditures relating to the rehabilitation of low-income rental housing, certain railroad rolling stock, or certain expenditures for child care facilities shall not be considered Section 38 property. [Internal Revenue Code, Section 48(a)(8)].

Lastly, in most instances, boilers that are fueled primarily by petroleum or petroleum products are not categorized as Section 38 property. [Internal Revenue Code, Section 48(a)(10)(A)]. However, several exemptions to this rule are provided. [Internal Revenue Code, Section 48(a)(10)(B)].

The above summary constitutes the general eligibility requirements under the Internal Revenue Code for assets qualifying for the investment tax credit. Even though the law may seem to be adequately specific, situations still arise where it is difficult to determine, because of the nature of an asset involved, for instance, whether an item is tangible personal property, and therefore eligible for the investment tax credit, or whether such property constitutes a structural component of a building which is not eligible. In order to clarify and expound upon the above law, regulations have been issued by the United States Department of the Treasury. The regulations, which are to act as guidelines in the operationalization of the investment tax credit provisions, are found under Sections 46 through 50. Further, the United States court system has been called upon in many situations to interpret the law in cases where there has been a discrepancy as to the eligibility of a particular piece of property or with the application of the investment tax credit provisions in a particular set of circumstances.

Moreover, the Internal Revenue Service has promulgated its interpretation of the law in situations where questions and potential and actual discrepancy have existed. These interpretations have generally been released in the form of Revenue Rulings and Revenue Procedures.

An Historical Perspective of the Investment Tax Credit:

In order to understand the nature, purpose, and effects of the investment tax credit as an incentive to investment spending, it is important to be aware of the historical development of the provisions. Therefore, in this section of the chapter, an historical perspective is provided of the investment tax credit in the United States since its origin up to the current status of the provisions. It should be noted that the chronology which follows has necessarily been abbreviated to some extent; however, the essence of the historical development of the provisions is provided. Although many of the technical aspects of the provisions are emphasized below, it is also important to note that stated rationale for creating, suspending, or repealing the provisions also is provided. The justification for the legislation dealing with the investment tax credit which is summarized below is that which has been suggested by the major proponents of the legislation (e.g., the President, cabinet members, Congressional leaders, etc.).

An investment tax credit equal to seven percent of the cost of qualifying investment expenditures was first adopted in the United States in 1962. [Internal Revenue Code, Section 46(a)(1)]. The investment tax credit provisions were enacted by Congress and signed by President Kennedy as a part of the Revenue Act of 1962. ["Revenue Act of 1962," P.L. 87-834, Section 2(a)].

A reason for the introduction of the provisions and their ultimate passage, at least in part, is the economic environment of the 1950s and early 1960s. It was generally recognized by economists, government planners, and other concerned individuals that the United States had to do something to make its industrial capacity and output more efficient and more competitive with that of foreign countries, even though excess capacity existed during the period. It was feared that unless the competitive position were to improve, demand would increasingly be supplied by foreign producers. Furthermore, it became apparent that the backlog of consumer demand that arose during World War II had, in large part, been met by this time and as a result, investment spending was declining. Therefore, because of the low level of domestic demand, lagging employment, and accelerated growth in foreign countries, a sense of urgency existed calling for an increase in the rates of growth and investment. President Kennedy believed that the investment tax credit was needed to help reverse the lagging trends within the American economy. [Posey, 1978, pp. 43-46].

In response to these needs perceived by the Kennedy administration and others, the President stated the following in a special message to Congress early in 1961, only 13 days after his inauguration:

> Expansion and modernization of the nation's productive plant is essential to accelerate economic growth and to improve the international competitive position of American industry. Embodying modern research and technology in new facilities will advance productivity, reduce costs, and market new products. Moreover, an early stimulus to business investment will promote recovery and increase employment.
>
> Among the reforms of the Federal tax system which I expect to propose ... is a modification of the income tax laws to provide additional incentives for investment in plant and equipment. [Kennedy, 1962, p. 51].

The modification which Kennedy referred to above was legislation relating to the investment tax credit. The legislation was unveiled on April 20, 1961. [Kennedy, 1962, pp. 292-293].

Although the investment tax credit was first proposed in 1961 in the 1st session of the 87th Congress, it was not until 1962 in the 2nd session of the 87th Congress that the investment tax credit provisions were passed. The provisions became law on October 16, 1962, retroactive to qualifying investments made on or after January 1, 1962. ["Revenue Act of 1962," P.L. 87-834, Section 2(h)]. The credit provisions as they were approved permitted a reduction in a taxpayer's tax liability equal to seven percent (three percent for most

public utilities) of the cost of qualifying property that had a useful life of at least eight years. Reduced credits were allowed for investments in qualifying property with a useful life of between four and eight years, while no credit was given for investments made with useful lives of less than four years. [Internal Revenue Code, Sections 46(c)(2) and (3)]. Only $50,000 of used assets could qualify for the credit each year. [Internal Revenue Code, Section 48(c)(2)]. Additionally, the amount of credit that could be used in any one year in reducing a taxpayer's liability was limited to $25,000 plus 25 percent of the tax liability in excess of $25,000. [Internal Revenue Code, Section 46(a)(2)]. Another feature of the initial set of provisions, known as the "Long Amendment," provided that the basis of qualifying assets acquired be reduced for depreciation purposes by the amount of the potential investment tax credit whether the taxpayer received tax benefits from the credit or not. [Internal Revenue Code, Section 48(g)].

On August 14, 1964, the "Long Amendment" was repealed by the Revenue Act of 1964. As a result, taxpayers no longer were required to reduce the basis of assets acquired after December 31, 1963 and for assets acquired before January 1, 1964, the basis was to be increased by the amount by which it had formerly been reduced effective for years after December 31, 1963. ["The Revenue Act of 1964," P.L. 88-272, Section 203(a)(1)]. The justification for the repeal was that the

adjustment severely restricted the incentive effect of the credit and that it had proved troublesome to taxpayers because of the tedious bookkeeping required. [Senate Committee on Finance, Senate Report No. 830, p. 40]. The depreciation basis reduction worked detrimentally for some taxpayers, because they received no tax benefit from the investment tax credit but had to reduce their depreciation basis by seven percent anyway. Additionally, part of the bookkeeping difficulty revolved around the fact that many taxpayers had to carry two depreciation bases for each asset since many states did not follow the federal basis reduction rules for purposes of state income tax computation. This dual basis situation further impacted upon the calculation involving the determination of gains and losses. [Posey, 1978, p. 75].

There were a few insignificant, but expansionary changes that occurred between 1962 and 1966. For example, H.R. 7101 was introduced to Congress by Representative Eugene Keogh in June 1963. The bill was intended to clarify the definition of the property which qualified for the investment tax credit. [H.R. 7101, 88th Congress, First Session; and Keogh, 1963, p. 12309]. Further, during the period bipartisan support for the investment tax credit concept grew because it was felt that the credit was performing as intended. In fact, efforts were made to extend the concept of the investment tax credit into new territory. For instance, the

administration announced that a proposed treaty with India contained a provision for the investment tax credit on investment made in India. [New York Times, April 1, 1965, p. 51]. However, in 1966 the Investment Credit and Accelerated Depreciation Suspension Act of 1966 [P.L. 89-800] was enacted which called for the temporary suspension of the investment tax credit. The suspension period was originally to run from October 10, 1966 through December 31, 1967. The Act was deemed necessary because of the stress of the military effort in Vietnam and the resulting economic strain and inflation within the economy. [Shanahan, 1966, p.33].

The Act was one step in an effort to restrain further price increases. According to Henry H. Fowler, Secretary of the Treasury, the temporary removal of these special tax incentives to investment would:

> (1) Contribute to a restraint of inflationary developments that are proving disruptive of the financial markets and placing excessive strain on the capital goods industries, (2) Promote a more sustainable rate of balanced economic growth..., and (3) Support a policy of monetary restraint while avoiding the burdens and risks of excessively tight money and high interest rates. [Hearings before the Committee on Finance, p.5].

Secretary Fowler was very clear in his request on behalf of the Administration that a suspension rather than an elimination of the investment tax credit would best serve the nation's interests.

Although at the time of passage the suspension was to be in effect until the end of 1967, the suspension period was short-lived, as it was terminated effective March 10, 1967 upon President Johnson's approval of H.R. 6950 [P. L. 90-26] on June 13, 1967. [Congressional Record--House, 1967, pp. 16847-16848]. The suspension was lifted as interest rates were dropping, new housing starts were up, order backlogs were dropping, capital appropriations and expenditures were down, and the labor supply problem had eased. [Mills, 1967, p. 6893]. (Chapter 3 includes a discussion of various approaches to investment theory. Various economic variables and their relationship to investment activity are also discussed.) March 10, 1967 also was the effective date for increased application of the credit from 25 percent to 50 percent of the tax liability over $25,000. [Income Tax Regulations, 1968, [Reg. 1.46-1(b)(1)(ii)(b)]].

In 1969, as President Nixon first took office, the nation appeared to be more concerned than ever with inflation. It was felt by the administration that the investment tax credit was one of the "enemies" in the fight against inflation. [House Report No. 91-142, 1969, p. 19].

On April 21, 1969, President Nixon recommended the repeal of the investment tax credit effective that day. In effect, the President said that the need for modernization that was present in the early 1960's had been taken care of

by the $400 billion investment in plant and equipment. Further, Nixon felt that a reduction of the surtax that existed at the time from ten percent to five percent was prudent only with the repeal of the investment tax credit. [Nixon, 1969, pp. 312-313].

As offered by David M. Kennedy, Secretary of the Treasury, the removal of the investment tax credit was part of an over-all plan designed to provide for an orderly expansion of the nation's economy.

> Stated simply, the case for removal of the investment credit rests primarily upon the fact that the social needs and economic conditions of the 1970s will be greatly different from those of a decade ago. Stimulation of a sluggish rate of business investment was a high priority goal in the early 1960s.... (At this time), instead of inducing still more business investment, additional resources will be available to meet pressing needs for housing, to aid state and local governments, and to improve the lot of the poor. [Committee on Ways and Means, 1969, p. 20].

The chairman of the Joint Economic Committee, Wright Patman, made the following remarks in Congress indicating his and the committee's reasoning for recommending the repeal of the investment tax credit:

> First. The rate of expenditure on plant and equipment is and has been excessive. In the face of a sharply lower operating rate of less than 84 percent in manufacturing, business has reported plans for increasing investment outlays this year by 13 to 14 percent. Even more is planned for 1970-1972, according to the McGraw-Hill survey.
>
> Second. The investment credit promotes the business cycle, encouraging larger swings in

activity instead of damping down fluctuations as good tax policy should.

Third. The credit distorts business incentives, encouraging investment in lower paying projects which business should not be undertaking either from the standpoint of its own long-term rate of return on capital or from the social viewpoint of encouraging a high productivity economy.

Fourth. The investment credit tends to promote inflation since it encourages excessive investment in boom years and then requires that additional demand stimulus be provided in the resulting recessions if unemployment is to be cured.

Fifth. Business has an adequate flow of funds to finance its investments even without this credit, hence this device may be causing excess funds to flow abroad, worsening the balance of payments.

Sixth. At a time when the Federal Government needs such large sums for high priority programs that we face extension of the 10 percent surtax. The investment tax credit costs the Treasury a revenue loss of at least $3 billion per year.

Seventh. The investment credit is very discriminatory and if the time ever comes that a demand stimulus is needed again, the appropriate course would be a tax cut for consumers. [Patman, 1969, p. 13,287].

Additionally, the Senate Finance Committee summarized its position supporting the repeal of the investment tax credit:

1. The investment tax credit was exerting inflationary pressure.

2. The investment tax credit had "outlived its usefulness."

3. The investment tax credit requires more severe monetary restrictions than would otherwise be necessary.

4. The investment tax credit should be repealed rather than suspended because of the twofold deterrent provided by a suspension (discussed below).

5. The investment tax credit repeal would increase revenue by $1.35 billion in fiscal year 1970. [Senate Report 91-321, 1969, pp. 10-15].

As there was apparently a shift in the national priorities, the repeal of the investment tax credit was intended to be a "permanent" rather than a temporary measure. The rationale for a permanent repeal as opposed to a temporary suspension was twofold. Firstly, it was felt that the investment tax credit does not lend itself well to an "on again, off again," countercyclical approach. Secondly, the suspension approach places a double deterrent on investment by giving no special incentive for investment and encouraging deferral so that the investment tax credit can be claimed at a later date. [House Report No. 91-321, 1969, p. 2]. Therefore, as a part of the Tax Reform Act of 1969, the

investment tax credit provisions were repealed upon receiving the official approval from President Nixon on December 30, 1969. [Nixon, 1969, pp. 1044-1046].

In December 1971, the investment tax credit was restored by the 1971 Revenue Act. ["1971 Revenue Act," P.L. 92-178, Section 101(c)]. In presenting his proposal to the Congress which called for the reenactment of the credit, President Nixon made the following statement:

> I will propose to provide the strongest short- term incentive in our history to invest in new machinery and equipment that will create new jobs for Americans.... This tax credit for investment in new equipment will not only generate new jobs, it will raise productivity; it will make our goods more competitive in the years ahead. [Nixon, 1971, p. 887].

In Nixon's proposal, the credit proposed was called a "job development credit," even though it was intended to provide the same incentive for machinery and equipment as the investment tax credit and was to function identically to the investment tax credit.

In its report which followed the hearings on the legislation, the House Ways and Means Committee summarized the primary reasons that the "job development investment credit" should be adopted. The reasons for adopting the "job development investment credit" were as follow:

1. The new credit was to bolster the economy

and create jobs by encouraging expenditures on machinery and equipment which the committee felt had been sagging badly.

2. The new credit would combat inflation. An increased flow of goods into the market was supposed to keep prices down.

3. The balance of payments would improve because more efficient facilities would allow exporters to compete effectively. [House Report No. 92-533, 1971, pp.5-6].

Both the Senate Finance Committee and the House Ways and Means Committee concluded that the credit

> should be restored as a means of providing stimulus to the lagging domestic economy by reducing the cost of capital to U.S. manufacturers. This (would) also serve to place them in a more competitive position with foreign manufacturers and in that manner (would) help improve our present serious balance-of-payments situation. [Committee Report on P. L. 92-178, 1972, pp.11,351].

The Revenue Act of 1971 was aimed, in part, to expanding the job opportunities for Americans and the investment tax credit was considered to be a major instrument for accomplishing this goal.

In late 1974 after Watergate began to fade, economic issues moved to the forefront of consideration. President Ford made the following observation and recommendation:

> We need more capital.... To help industry buy more machines and create more jobs, I am recommending a liberalized ten percent investment tax credit. This credit should be especially helpful to capital intensive industries such as primary metals, public utilities, where capacity shortages have developed. [Ford, 1974, p. 253].

Because of the economic difficulties of the early to mid 1970's which became more apparent upon the passing of Watergate and with the Organization of Petroleum Exporting Countries oil embargo affecting the economy, support for the investment tax credit and economic incentives in general were at one of the highest points in years. There seemed to be no question that incentives would be a part of the tax law; the only question seemed to be relating to the amount to be allowed. [Posey, 1978, pp. 171-172].

As a "temporary" measure to aid the economy, a provision in the Tax Reduction Act of 1975 raised the investment tax credit rate from seven percent to ten percent. ["Tax Reduction Act of 1975," P.L. 94-12, Section 301(a)]. The new rate was to apply to qualifying property acquired after January 21, 1975 and before January 1, 1977, after which the rate was to return to the seven percent level. The Act also included a change in the amount of used property that would qualify for investment tax credit in any one year, from

$50,000 to $100,000. ["Tax Reduction Act of 1975," P.L. 94-12, Section 301(c)(1)]. This change was also intended to be temporary as an expiration date of December 31, 1976 was set. Thereafter, the old limitation was to apply. President Ford signed these measures into law on March 29, 1975. [Ford, 1975, p. 408].

The Tax Reform Act of 1976 [P.L. 94-455, 1976] extended the temporary ten percent rate and the $100,000 used property limitation until December 31, 1980. These temporary measures were then to revert to the old rules (seven percent and $50,000) after that date. ["Tax Reform Act of 1976," P.L. 94-455, Sections 801 and 802(a)(2)].

Upon justifying this increased rate extension, the House Ways and Means Committee issued the following statement:

> The temporary liberalizaiton of the investment credit provided by the 1975 Tax Reduction Act was adopted for two reasons. First, encouraging investment in new equipment, and modernization of existing facilities was thought to improve the long-run ability of the economy to achieve economic growth without inflationary pressure. Second, increasing aggregate demand in the short run was considered to be an important part of a program for recovery from the worst recession in more than two decades.
>
> Since the beginning of 1975, investment plans have been repeatedly reduced, and planned expenditures in new plant and equipment are expected to be 10 percent lower in 1975 as compared to 1974. Because of the need to provide greater certainty to investors about the availability of the credit in the future, and the need to provide a continuing stimulus to the economy, the 10-percent investment tax credit was extended four additional years. [House Report No. 94-658, 1975, p. 187].

The Revenue Act of 1978, however, changed the temporary nature of the rules. The 1978 law permanently set the rate at ten percent to be effective January 1, 1981, when the temporary extensions were scheduled to expire. The new law also permanently changed the used property limitation from $50,000 to $100,000, effective also on January 1, 1981. The new law also increased the amount of the credit that a taxpayer could use to offset a tax liability in any one year. ["Revenue Act of 1978;" P.L. 95-600; Sections 301(a)(1), 311(b), and 312(a)].

It was deemed prudent to make the higher rate permanent for two reasons:

1. The investment tax credit provisions were believed to have been effective in stimulating investment since its enactment in 1962.

2. It was believed that the uncertainty surrounding the temporary provisions whether the credit would be extended or made permanent had reduced the effectiveness of the credit. The change of the nature of the provisions from temporary to permanent would aid in

> promoting orderly investment programs by businesses. [Report of the Committee on Ways and Means, Report No. 95, p. 82].

For the two years after 1978, the investment tax credit provisions remained essentially unchanged with no temporary or permanent suspensions or revocations in response to economic fluctuations. However, with the change in administration in the executive branch of the federal government in 1981, a new tax program was offered which was designed primarily to increase savings and spur investment. As a part of this new tax program, the Economic Recovery Tax Act of 1981 (ERTA), the investment tax credit provisions were further liberalized and brought in tandem with the new accelerated cost recovery (depreciation) system (ACRS). ["ERTA," P.L. 97-34, 1981]. The provisions were intended to stimulate investment spending. [Report of the Committee on Ways and Means, Report No. 201, p. 73]. The Senate Finance Committee indicated that the then existing rules for determining depreciation and the investment tax credit needed to be replaced because they did not provide the investment stimulus that is essential to an expanding economy. The committee stated that they believed that the restructuring of the depreciation and investment tax credit rules would "be an effective way of stimulating capital formation, increasing productivity, and improving the nation's competitiveness in

international trade.[Senate Finance Committee, Report No. 144, p. 47]. It was believed that as a result of the 1981 act, virtually all property would generate as much or more credit than allowed under prior law.

In 1982, the Tax Equity and Fiscal Responsibility Act (TEFRA) provided for several changes in the investment tax credit provisions effective with qualifying property placed into service after 1982. Under the new (and current) provisions, the basis of an asset acquired is reduced by one-half of the amount of the investment tax credit taken. However, as an alternative to the basis reduction rule, a taxpayer can generally elect to claim a reduced credit: an investment tax credit of 8 percent (rather than 10 percent) for five-year ACRS property and an investment tax credit of 4 percent (rather than 6 percent) for three-year ACRS property. ["TEFRA," P.L. 97-248, Section 205(a)(1); and Internal Revenue Code, Section 48(q)(1) and (4)]. Additionally, a new limit was set which would reduce the amount of credit that could be used to offset a tax liability. The new law allows a taxpayer to use the investment tax credit to offset 85 percent (rather than 90 percent) of a tax liability in excess of $25,000. ["TEFRA," P.L. 97-248, Section 205(b)(1); and Internal Revenue Code, Section 46(a)(3)].

Apparently, Congress enacted these provisions because they recognized that coupled with the accelerated write-offs allowed by ACRS, the prior investment tax credit provisions

may have been too generous. In fact, under certain discount and present-value assumptions, the combined benefit of the ACRS cost recovery deduction and the immediate benefit of the investment tax credit was greater than the economic benefit of expensing an asset in the year of purchase. [TEFRA, Andersen, 1982, p. 10].

Upon looking back on the brief history of the investment tax credit in the United States, it is easy to see that there have been many changes in the investment tax credit provisions for a number of different reasons. These changes resulted primarily because of the belief held by those involved in the political process that the changes would aid in, among other things, stimulating a slumping economy or helping to slow-down a booming economy. However, it has also been suggested that the investment tax credit has been used not only as a major economic tool but as a political scapegoat, as well. [Posey, 1978, p. 74]. The effectiveness of this tool in producing the desired impact, however, is not truly known nor has the efficiency (based upon cost/benefit analyses) of this aspect of fiscal policy been thoroughly studied. Nonetheless, the benefit perceived by legislators to result from the credit's presence apparently has been sufficient to keep the provisions in the law as an incentive device.

History of Other Changes:

The time periods included in the tests of this study are limited to April 1, 1954 through September 30, 1966 and October 1, 1971 through December 31, 1980. Therefore, only those tax policy changes that occurred during these periods and only those changes that could have affected investment activity need be considered by the methodology of the study. Other tax policy changes that occurred during these two time periods which may have had some impact on investment activity, other than those changes related to the investment tax credit discussed above, include changes such as tax rate structure changes, the enactment of the Class Guideline Lives depreciation system, and the depreciation recapture provisions. These tax policy factors are implicitly accounted for upon utilizing a control group. A detailed discussion of the application of the control group in controlling for these and other factors follows in Chapter 4.

Summary:

A synopsis of the requirements established for property which qualifies for the investment tax credit has been presented in this chapter along with a chronology of the development of the investment tax credit throughout its years of existence. Included in this discussion have been

statements which provide rationale for the credit's creation and continued existence throughout its legislative history.

CHAPTER 3

THEORETICAL FRAMEWORK: A REVIEW OF LITERATURE

Introduction:

Although the primary focus of this paper is not aimed at economic theory, a general understanding of the current state of investment theory along with the major known determinants of or factors influencing investment is important. As background to the discussions of investment theory, a brief discussion of the nature of and utilization of investment incentives is provided first. Next, a discussion is offered which provides a very general perspective of investment theory. The discussion which follows next describes three major theories or approaches that are currently believed to provide reasonable explanations of investment behavior. Following the discussion of the three general approaches, the highlights of several specific empirical studies are presented. The studies included represent the major

econometric efforts which have introduced the investment tax credit in their investment functions as an incentive device. After the review of specific research endeavors, a set of major determinants of investment which come from the theoretical and empirical discussions is summarized. The determinants of investment spending discussed in this chapter are then considered in Chapter 4 for purposes of the empirical testing of this study. As may be expected, because of the nature of the coverage in this chapter, significant overlap occurs between the sections within this chapter. Nonetheless, the ensuing discussion serves as the foundation for the empirical work which follows, and assists in placing the work, including the results, in an appropriate perspective.

A major theme running throughout this chapter is that investment theory is in a state of flux and that no one single approach to explaining investment activity has "risen to the top" to become the one theory acceptable to most economic theorists. It is because of this perceived state of investment theory and the fact that this study uses a methodology that has not previously been used to examine the investment tax credit, that this study is so noteworthy. The methodology, while based on generalized notions of investment theory, is not overly constrained by prior or uncertain theoretical concepts or the biases of any one particular approach.

In this chapter, three well supported approaches to investment theory are described. Further, upon describing a number of empirical works in the investment literature in which the investment tax credit was studied, it is seen that many of the empirical works reviewed have based their studies upon one or parts of the several theoretical approaches. In applying the knowledge gleaned from such a review for purposes of this study, it becomes apparent that the selection of a particular approach could tend to inject a bias into the results of the study that could have nothing to do with reality. Therefore, since there could be problems associated with the selection of any one of the approaches, no one particular approach is adopted for use in this study. Instead, economic variables that are generally considered important in the various approaches to investment theory are discussed in this chapter and then later serve as the foundation for the empirical portion of this dissertation. The economic variables described are ones that seem to appear continually in the economics literature as being potentially important in investment theory. The variables utilized in the study account for the structural component of the fluctuation of investment activity. The details of the methodology adopted for this study are discussed in Chapter 4.

The Utilization of Investment Incentive Devices:

Since the early 1950s, tax systems throughout the non-Communist world have become replete with tax devices to stimulate investment spending. According to Eckstein [1962, p. 351], during the ten year period preceding the enactment of the investment tax credit when the overall trends in the use of policy instruments were in the direction of more general and less selective devices, all sorts of selective devices, such as depreciation allowances, investment credits and tax exemptions, were almost faddishly embraced to stimulate investment activity.

These devices have been utilized primarily to aid in the achievement of long-run goals (e.g., increased productivity or growth rate). For instance, it is believed that devices, such as the investment tax credit, can be used successfully to expand production capabilities when substitution between capital and labor is possible. As a result of the additional capital being available to a given labor force, the production possibilities open to a society at any point are increased.[Brown, 1962, pp. 335-336].

With the substantial degree of attention and study given to the subject of investment stimulants, it is apparent that investment is considered to be very important in the overall scheme of economic strategy. Investment is considered important because it is believed to contribute to future

output, current demand, and current employment. Moreover, net investment, which is gross investment less replacement investment, contributes to overall economic growth. [Eisner, 1978, p. 1].

In general, tax incentives are believed to stimulate investment or capital expenditures in two ways. Firstly, tax incentives increase the after-tax rate of return on capital by reducing the amount of taxes that must be paid on income from assets or by affecting the timing of the tax payments in favor of the future. The higher rate of return attributable to the presence of an incentive would tend to make the investment more appealing. Secondly, tax incentives increase a firm's cash flow by reducing the tax liability. Often, the internal-funds effect is captured by the inclusion of a cash flow variable in the investment function as a determinant of the speed at which firms eliminate any gap between their desired and actual stocks of capital. [Coen, 1968, pp. 200-201].

Investment Theory--A General Perspective:

Though many people have often claimed that increased investment is generally good for the economy, it is not clear as to what "strings need to be pulled" in order for the level of investment to increase. This uncertainty with investment incentive strategies revolves around the lack of a clear

understanding of the nature of the investment function. The nature of the investment function has been studied, theorized, and debated at great length, yet there is still no generally accepted or acceptable theory of investment behavior available. We still know very little as to how investment decisions are made. Nonetheless, it is important that some of the main theoretical arguments and resultant investment theories be presented so that the state of the research in the area of the investment tax credit can be put into perspective and be better understood. Therefore, a general discussion of investment theory is presented in this section; furthermore, the discussion is continued at a more detailed level in the next section of the chapter in which three specific approaches to understanding investment activity are presented.

Meyer and Kuh made the following remark regarding the state of research involving the investment function and resulting empirical conclusions:

> In short, the investment problem is complex and requires treatment of many magnitudes, each with a variety of dimensions. Because the problem is intrinsically so difficult, the literature on the subject reports a number of different analytical approaches many of them complementary but not a few contradictory. The basic problems arise primarily from different interpretations of entrepreneurial motives and a different emphasis given to alternative constraints. [Meyer and Kuh, 1966, p. 6].

Musgrave adds that the question regarding the

effectiveness of tax policy on capital formation can not be answered until we know how the level of capital formation or investment is determined. As to the state of this particular type of research, he comments that:

> Empirical studies, as well as theorizing, permit various explanations, and most likely a complex and changing set of determinants is involved. Yet, different explanations suggest different effects of tax policy and call for quite different remedies. [Musgrave, 1963, p. 47].

The investment theory that has been developed has been applied at both a micro level and at a macro level and many studies have been conducted at each level. However, much of the investment theory that has been developed relates primarily to activity of individual firms. This study requires the application of investment theory at a macro level.

The application of micro investment theory at the macro level has its good and bad points. The researcher must beware of falling into the trap of "fallacy of composition" -- what is true of an individual firm or a number of individual firms may be quite false for all of business or for the economy as a whole. However, in a world where macro investment theory is undeveloped, behavior of individual firms must be used as a basis of understanding, hopefully shedding light on the problems of aggregate investment. [Eisner, 1978, p. 2].

The theory of investment attempts to explain the rate of change in the actual stock of physical capital in order to achieve the level of desired stock. Upon establishing the desired stock, a firm initiates investment projects designed to equate actual property on hand with the desired level of property. [Kuh, 1963(a), p. 260]. It is assumed that subsequent to a change in desired capital, a certain proportion of the resulting expenditure takes place over time because of the varying amounts of time required in formulating plans, appropriating funds, placing orders, and so on.

One of the unresolved issues relates to the specification of the move from the actual level of capital to the desired level of capital. The questions surrounding this issue deal not only with the factors and the relative importance of each of the factors that purportedly effect investment spending but also the exact nature of their mathematical specification. From Jorgenson and Siebert's perspective,

> ... capital is adjusted toward its desired level by a certain proportion of the discrepancy between desired and actual capital in each period.... Alternatively, actual capital may by represented as a weighted average of all past levels of desired capital. [Jorgenson and Siebert, 1968, p. 682].

Gross investment is generally defined as the sum of replacement investment and net investment. Investment

spending incurred to replace existing capital stock is typically modelled as a function of the level of the existing capital stock. Therefore, as the stock of capital becomes larger, investment spending which would be needed to replace the worn out and obsolete of that stock would also increase. Some of the different mechanisms and theories which have been suggested to explain the change from the actual level to the desired level of capital stock are discussed later in this chapter.

Perhaps unfortunately from the standpoint of scientific inquiry, expectations or anticipations concerning the future in general and specific aspects of the future play a crucial role in business investment decision-making. However, in current and previous econometric work, researchers are generally constrained to using past and current data. Attempts have been made to project expectations of the future with ex post data on sales, output, existing capital, inventories, and existing prices and costs. Likewise, individual businessmen try to anticipate the future on the basis of past and current data in their work. However, neither researchers nor business decisionmakers can be certain that relations extrapolated from the past truthfully and consistently relate to the future. It is believed that when such data are substituted for expectations of the future, formidable problems or errors in variables or explicit misspecification of the relations to be estimated result. [Eisner, 1978, pp. 5 and 13].

The businessmen's and economists' lack of ability to predict investment is a problem that apparently contributes to the failure of understanding the investment function. The best efforts to understand the interface of expectations and the investment function have only produced proxies for investment expectations, such as profits and output. Indeed, it is this lack of understanding of investment expectations which prompts the following observation:

> We may conjecture that it is these underlying expectational issues as much as omitted variables and ill-fitting functional forms that contribute both to the persistently large proportions of unexplained variance (in structural investment functions) and to the differences in parametric estimates from different structurings of frequently identical samples. [Eisner, 1978, p. 192].

Investment is the sum of investment for expansion, which is generated by an increase in the desired level of capital stock, plus investment for replacement. In addition to modelling the move between actual capital and desired capital, it is very important that a model for replacement investment be specified since replacement investment predominates in investment expenditures, at least at the aggregate level. Generally, it is assumed that replacement investment is proportional to capital stock. A simple model of replacement investment that has been widely adopted for empirical work is one in which replacement is proportional to

actual capital stock. "The justification for this assumption is that the appropriate model for replacement is ... the infinite stream of replacements generated by a single investment; in the language of probability theory, replacement is a recurrent event." [Jorgenson, 1963, p.251]. Moreover, "this model of replacement investment can be supported on grounds of empirical validity." The proportionality model of replacement investment has proved satisfactory on repeated empirical tests on the aggregate level and with individual firms. [Jorgenson and Siebert, 1968, p. 682].

The above general rendering of the theory of investment serves as a springboard for the discussion which follows. Three different and more detailed approaches to understanding investment activity are detailed below in the next section. These approaches are based on some of the notions previously discussed. Each of the approaches are supported within the economics community and offer reasonable explanations to investment activity. The approaches which are discussed here are: the profit maximization or marginal approach, the acceleration approach, and the neoclassical approach.

Three Approaches to Investment Theory:

As mentioned in the previous section, micro economic theory is generally applied when studying investment activity

at both the micro and macro levels. Investment studies at the macro level have relied upon micro theory because of the lack of development of macro investment theory. This study examines the effectiveness of the investment tax credit at a macro level and must also necessarily be based upon micro economic investment theory. The approaches to investment theory that are described below are all grounded at a micro level.

Profit Maximization or Marginal Approach-

> The application of the calculus as an economic tool in the middle and late nineteenth century at least partially accounts for a marginal approach to explaining investment behavior. The entrepreneur's investment activities, as well as his other business-related activities, are viewed as a function of his sole objective -- profit maximization. Given the assumption of a profit maximization goal, the two primary determinants of investment are (1) the cost of capital equipment, and (2) the market rate of interest. [Wunder, 1978, p. 19].

With this approach, it is assumed that the business manager maximizes profit by comparing the present value of a stream of net receipts expected from a particular investment with the cost of acquiring it. Under such an approach, an investment opportunity may be taken if the present value of the stream of net benefits arising from such investment is positive. On the other hand, an investment opportunity should not be taken if the net present value of the project

is negative. In a more complicated setting, difficulties may arise if various investment opportunities are interdependent. Conceivably, the adoption of any one project might change the net present value of another one. The implication for cases such as this is to invest in that set of projects whose combined payment stream has the maximum net present value.

It is generally assumed that the firm has access to the capital market and that the stream of revenues is uncertain. The determination of the present value of the potential investment requires some discount rate both for uncertainty and for the cost of capital to the firm. [Brown, 1962, p.336]. Interest rates are thus central to marginal theories; their relation to the volume of investment has been the object of many empirical inquiries. [Meyer and Kuh, 1966, p. 8].

The rate of interest has generally been included in this and other approaches (described below) to measure the cost of raising money through a debt issue which would sometimes be a necessary condition before acquiring investment goods. Grunfeld [1966] was impressed with the influence that the interest rate had upon the investment decision when he concluded that "... for the corporations analyzed, the rate of interest seemed to exert a stronger influence on investment decisions than what would be expected from the results of previous studies." [Grunfeld, 1966, p. 211]. In Anderson's [1967] study of the determinants of investment,

the role of the interest rate was highly significant in each case that he noted. Further, it was noted that investment is a decreasing function of the rate of interest and that the rate is not dependent upon the firm's internal structure. [Anderson, 1967, p. 424].

Nonetheless, as time has passed and as institutional changes have occurred, the maximination of utility rather than profits has been considered. As for a general criterion, it is usually said that individuals maximize utility and firms maximize profits. However, with this approach as it relates to a firm's investment decisions, a firm may wish to consider things (e.g., public opinion, social welfare, environmental impact, etc.) that are not directly profit related as well as considering profits. In such a case, the optimization process is conducted so that a firm's affairs are arranged in order that its preferences are best satisfied. This optimization process is referred to as the maximization of utility. Thus, a firm whose managers are acting rationally, may conduct it activities and make those investments which maximize the firm's utility. Consequently, the entrepreneur has been taken out of an one-dimensional behavioral model and placed in an environment characterized by an uncertainty as to the decision variables that were involved in an investment decision. As a result of this modification, the entrepreneur has been placed in a position of maximizing either profits or utility. [Meyer and Kuh, 1966, p. 10].

Accelerator Approach-

A strict construction of the accelerator approach to investment decisions suggests that investment expenditures in a given period are a linear function of the rate of change of output. It is believed that output "measures the expectational and capacity utilization effects embodied in current levels of operation."[Meyer and Kuh, 1966, p. 65]. In other words, investment will increase when sales experience a non-temporary increase if existing capacity is already fully utilized and if sufficient funds are available to finance the acquisition of new capital goods. [Meyer and Kuh, 1966, pp. 121-122]. Explicit in the theory is the concept that a change in desired capital will precipitate the initiation of investment projects.

Although this approach in explaining investment has been very popular because of its relative simplicity, this simplicity and some of the explicit and implicit assumptions have been criticized and have led to a number of variations of the basic accelerator model.

Jorgenson and Siebert make the following comment relating to the general accelerator theory and the plethora of modifications:

> The firm is taken to have a desired level of capital, determined by long-run considerations.

> The precise specification of the desired level of capital has been the subject of a wide variety of alternative theories of investment behavior. The alternative theories do agree, however, on the validity of the fundamental flexible accelerator mechanism for translating changes in desired capital into actual investment expenditures. [Jorgenson and Siebert, 1968, pp. 681-682].

Some of the criticisms of the basic accelerator approach which serve as the basis for some of these variations follow.

The basic assumption of the accelerator model is that the desired capital stock is a constant multiple of output. That is, the implication of this approach is that the desired investment fluctuates "instantaneously" with output. As a result, the swings in investment spending would tend to be erratic and violent; however, the fact is that nonresidential capital stock changes slowly over time and is much less variable than a strict accelerator model would imply. To account for this slow reaction to output, some modifications have added "flexibility" in the form of distributed lag coefficients, by spreading out the reaction of the capital stock over a number of time periods. [Clark, 1979, pp. 77-78].

A very critical assumption that has generated alterations to the basic theory is that, prior to an increase in output, firms must not have excess capacity. Since excess capacity is frequently observed in reality, attempts have been made to alter the accelerator model to fit these facts. [Meyer and Kuh, 1966, p. 14]. In the empirical studies of

Chenery [1952] and Koyck [1954], this aspect was considered and it was noted that high levels of investment expenditure are associated with high ratios of output to capital. Strong empirical results from work performed by Kuh [1963(b)], Eisner [1962, 1963, 1967], and Hickman [1965] also support the flexibility associated with the incorporation of capacity utilization. [Jorgenson and Siebert, 1968, pp. 683 and 685]. Eisner [1967] concluded that a prime determinant of capital expenditures is the relation between expected future demand and existing capacity: If any expected increased future demand can be met by existing excess capacity, then new investment spending will not likely be incurred; on the other hand, if the expected increased demand can not be met with any existing excess capacity, then new investment would be necessary. [Eisner, 1967, p. 364].

Eckstein [1962] considered this issue of capacity utilization in a theoretical perspective particularly as it relates to the effectiveness of tax incentives, such as the investment tax credit. He conceded that capacity utilization would be a factor in the effectiveness of the investment tax credit; however, distributional characteristics of the capacity utilization attribute and other factors need be considered:

> ...some positive effects [of tax incentives] even are inevitable [in periods of excess capacity], since the distribution of excess capacity is not uniform and some cost-saving investment will pay

> even with excess capacity. On the other hand, the effect will be greater in better times, when more businesses find their financial resources strained in relation to their investment opportunities. [Eckstein, 1962, p. 353].

One of the other factors alluded to above by Eckstein is undoubtedly the nebulous "indicators of technical change" variable. This variable also tends to affect the timing of an investment expenditure. The term technical change generally encompasses the independently or exogenously determined changes in the production process

> Technological change cuts a number of ways in its effect upon investment demand. By accelerating the obsolescence of capital specific to outdated processes it has a direct effect in increasing investment demand. However, to the extent that current technological change generates an expectation of further change in the future, the impulse to acquire new capital goods may be restrained. [Eisner and Strotz, 1963, p. 121].

Further,

> ... technological advance may be either labor saving or capital saving and so, even though it may be expected to result in a diminution of cost and expansion of industry output, it is by no means certain that it must lead to an increase in the amount of capital devoted to the industry. [Eisner and Strotz, 1963, p. 66].

Musgrave [1963] contends that even though the dynamic aspects of investment is the main process accounted for in the accelerator theory, it does not provide a full explanation of investment behavior. "To be sure, investment

will not occur unless investors see a prospective demand for the goods which the new capital equipment is to produce." [Musgrave, 1963, p. 51]. Therefore, modifications to the general accelerator model have been made which encompass important institutional constraints such as the role of expectations and profit maximization. Many respected economists, in fact, believe that profits and high profit expectations (and hence demand) are major determinants of business investment and that the factors fit in well with the accelerator theory. [Eisner, 1963, p. 237].

Two alternative rationalizations of this profit oriented accelerator model have been offered. Firstly, Tinbergen [1939] argues that realized profits measure expected profits and that "it is almost tautology to say that investment is governed by profit expectations." [Tinbergen, 1939, p. 34]. Secondly, the rate of investment may be constrained by the availability of funds. [Jorgenson and Siebert, 1968, p. 683].

Profit maximization theories (whether they be a member of an accelerator theoretical classification or otherwise) have brought into prominence the role of expectations and cost considerations. As Tinbergen [1939] suggests, the current and past realized profits measure expected profits of the future.

Investment spending has long been perceived as being related essentially to expectations about the future. The

anticipated profitability of an acquisition depends on a number of things, including expectations of future demand. Meyer and Kuh [1966] suggest that net income, being about as pure a current measure of a firm's profit expectations as is available, also accounts for a large percentage of the liquidity flowing into individual firms. [Meyer and Kuh, 1966, pp. 65-66]. Assuming that profit expectations do determine investment behavior, Jorgenson and Siebert [1968] also concluded that "the main candidate variable for the expectational hypothesis is simply net income after tax, a secondary candidate being gross operating profit." [Jorgenson and Siebert, 1968, p. 685]. Eisner suggests that profits have an impact on the timing of investment rather than on the long-run magnitude of spending. [Eisner, 1978, p. 190].

However, it has been argued that realized profits do not necessarily measure expected profits and that "even the assertion that expected profits govern investment is far from being a tautology." [Grunfeld, 1966, p. 215]. He suggests that the profits variable probably plays the role of a surrogate in that it tends to be correlated with some of the main forces impacting upon investment. [Grunfeld, 1966, p. 211].

Others suggest that it is almost obvious that in a free enterprise society the prospect of increased profit is a very important ingredient of business decisions, and that it is

this factor that drives an efficient allocation mechanism in the market. [Musgrave, 1963, p. 53]. However, many "theories in this category are too general to be useful, except in the normative sense, and tend to ignore numerous features of the investor's milieu that are likely to be important to a decision-maker." [Meyer and Kuh, 1966, p. 21].

The availability of funds rationalization of the profits oriented accelerator model has intrigued many researchers. A very popular understanding of this relationship is that when a firm obtains a large amount of profits, they will usually be in the form of very liquid assets and that very often these liquid assets will be spent on capital goods. [Grunfeld, 1966, pp. 219-220]. It is clear, however, that the propensity to invest is almost certainly not related one to one to the availability of internal funds. Obviously, a profit maximizing manager will use the funds in an alternative project if the rate of return is higher from the alternative project than if the fixed assets are acquired.

Meyer and Kuh [1966] suggest that many empirical efforts have stressed the importance of the liquidity restraint. In fact, they state that "...by far the most outstanding aspect of the direct inquiries is their virtual unanimity in finding that internal liquidity considerations and a strong preference for internal financing are prime factors in determining the volume of investment."[Meyer and Kuh, 1966,

p. 17]. Over time, three conflicting opinions or views have evolved regarding the relationship between liquidity and investment over the course of the business cycle.

> In the first of these views, the liquidity restraint is held to be inoperative in times of recession but effective under prosperous conditions; that is, in a recession investment outlays are curtailed far short of available funds while during an upswing burgeoning optimism overtaxes the available liquidity. The second view just reverses this cyclical relationship, in the belief that money becomes scarce in a downturn because of restricted profit inflows and tougher credit requirements and, conversely, plentiful in a boom because of opposite conditions. Finally, a third group holds that the credit restraint is always operative, with the supply and demand curves for funds shifting together in synchronization over the course of the cycle. [Meyer and Kuh, 1966, pp. 117-118].

When trying to decide upon the credence of the funds availability attribute in the accelerator theory, it must be noted that corporate managers act as if they preferred internal funds to external funds and that approximately three-quarters of total funds sources in the manufacturing sector come from internal funds. [Kuh, 1963(a), p. 263].

Nonetheless, the major propositions that emerge from this approach are that as the net profits get larger, the internally generated funds become larger (given a normal dividend pattern) and that as internal funds become greater, the rate of investment will be greater.

In attempting to justify theoretically the addition of a profits term to an accelerator investment equation, two broad

points arise. Firstly, changes in profits should convey some information about the future profitability of the firm and the requisite level of capital stock. Secondly, internal funds could be less costly than external finance if the market for borrowed funds is imperfect. Larger amounts of internal funds available might thereby lower financing costs and increase investment demand. [Clark, 1979, p. 81].

To summarize, Meyer and Kuh [1966] suggest that the accelerator approach has given birth to two additional theories, and there now exist three distinct theories of investment based upon this approach: the original theory based on changes in output, a capacity utilization theory, and a profit-oriented approach. [Meyer and Kuh, 1966, p.16].

Neoclassical Approach-

The neoclassical approach to understanding investment behavior has received a large degree of attention because of the inclusion of a feature that is not present in the other approaches discussed. In the neoclassical model, investment depends on an attribute called the rental price of capital. This approach is based on the neoclassical principle that the optimal combination of factor inputs should be a function of their relative prices. [Clark, 1979, pp. 81-82]. That is, the demand for capital changes in response to changes in relative factor (e.g., labor and capital) prices or the ratio of factor prices to the price of output. [Jorgenson, 1963,

p. 247]. The essentials of the theory of optimal capital accumulation within the neoclassical framework follow.

The theory can be approached from two alternative and equivalent points of view. The firm's objective is either to maximize its market value or to maximize its profit. In either case, the firm is subject to a production function which relates the flow of output to flows of labor and capital services. With the maximization of the market value of the firm, the firm is treated as accumulating assets in order to supply capital services to itself. In such a case, the marginal product of each current input is considered equal to its real price and the marginal product of each capital service is equal to its real rental. Under the second point of view, the firm is treated as renting assets, either from itself or from another firm, in order to obtain capital services. In this case, profits are determined by comparing the current revenue and the current outlay less the rental value of capital services. [Hall and Jorgenson, 1971, p.12]. Capital is accumulated to provide capital services which are inputs to the production process. The relationship between inputs and the output is summarized in a production function.

More specifically, under the assumption that firms behave so as to maximize their profits and that the markets for their output are perfectly competitive, a firm's "desired level of capital can be derived from the condition that the

value of the marginal product of capital should be equal to the rental price of capital." Also, in the determination of the desired level of capital stock, the flow of capital services is assumed to be proportional to capital stock. [Hall and Jorgenson, 1967, p. 396]. That is, in the neoclassical theory of investment, the desired capital stock is equal to output deflated by the price of capital services or the rental price of capital. This price of capital, in turn, depends on the price of investment goods, the cost of capital, and the tax structure.

The feature of prime importance in the neoclassical approach is the rental price of capital or price of capital services. It is mainly this factor that provides evidence of the differentiation between this and other theories or approaches. This variable attempts to provide a measure of the cost of the utilization of facilities. Under the neoclassical formulation, as the cost of providing capital services increases, the desired level of capital stock would decrease, assuming all other factors remain constant.

Jorgenson [1967] states that the rental price of capital variable is to capture the role of relative prices and factor costs in determining the desired capital stock and in influencing the rate of investment. The variable is to measure some combination of "the rate of interest, the level of stock prices, the price of investment goods, and changes in the price of investment goods."[Jorgenson, 1967, p. 135].

Sunley describes the variable as being "the price which a business firm must pay (or impute to itself) for the use of capital assets. It is the price for the use of physical capital just as the wage rate is the price for the use of labor services. It includes an amount for capital recovery, a net after-tax return on the amount invested, and the tax on this income." [Sunley, 1973, p. 210]. Coen [1975] suggests that this rental price of capital variable, or the price paid for the use of one machine for one period, can be conceptualized as consisting of two components. The first component is the amount of interest a firm must pay each period on funds borrowed to finance an initial investment. The second component is the present value of the cost of all future replacements needed to maintain one unit of capital. "It represents, then, the replacement expense per period expressed as an annuity whose present value equals the present value of the cost of all future replacements. [Coen, 1975, p. 62]. In a competitive market, this rental price of capital will "clear the market for machine services, equating the quantity supplied by capitalists to the quantity demanded by firms for use in production." [Bradford, 1980, p. 284]

Generally speaking, empirical evidence supports the contention that the explanatory power of investment models is improved when the rental price of capital is included. [Arnold, 1975, p. 32]. However, this is not to imply that the mathematical specification has been firmly established.

To the contrary, the proper specification of the variable has not yet been established. In fact, Jorgenson (who is usually attributed with the development of this variable and its inclusion in an investment theory) used several different specifications of the factor in his works.

Some, in contrast, would argue that the rental price of capital variable has not added much to the state of investment theory. The contention is made that it is sometimes difficult to offer an adequate conceptual understanding of the variable, and it seems that it is even more difficult to operationalize the variable.

> In explaining the apparent failure of this variable, ... (it is suggested) ... that a good part of the problem may stem from (the) inability to measure properly the cost of capital due, for example, to such things as measurement error, aggregation bias, or inadequate information on expectations. Because these difficulties plague most macro-economic efforts, the distinguishing feature of the present case is that the variable of concern does not seem to "work." [Goldfeld, 1979, p. 118].

Not only have there been suggested changes to the specification of the rental price of capital variable, but there have also been attempts to amend the neoclassical model in general terms. For example, Bischoff [1971] modifies the model based upon the empirical observation that most modifications in the capital-output ratio are embodied in new investment and that existing capital goods are less often modified in response to fluctuations in the relative price of inputs.

Jorgenson [1963] admits that previous attempts to appropriately specify the neoclassical theory of capital have fallen short of a "correct" formulation of the theory. As a result, the validity of the neoclassical theory remains uncertain. [Jorgenson, 1963, pp. 247-248]. This assessment apparently is still valid because Hendershott and Hu [1981] commented that "considerable controversy exists" over the appropriate specification of the rental price of capital variable. The variable must be accurately measured in order for the neoclassical approach to capture the impact of investment correctly. [Hendershott and Hu, 1981, p. 87].

Under the neoclassical approach, therefore, the effects of tax policy on investment behavior enter the investment function through the rental price of capital variable. A change in the tax policy changes the rental value of capital input in several possible ways. The rental price of capital is a function of the rate of return, the price of investment goods, and the tax treatment of business income, and as such, a tax policy change could affect any of the elements of the factor. A change in the rental price of capital results in a change in the desired level of capital stock. A change in the desired level of capital stock will then lead either to an acquisition or disposition of capital assets to bring the actual level of capital in line with the desired level of capital. [Hall and Jorgenson, 1967, pp. 391-392 and 397].

Upon the review of several approaches available to explain investment behavior, one economist concludes that the general thrust of the neoclassical approach is worthy of debate and continued study; however, to gain a clearer understanding of its value, this continued debate and study is a necessity:

> While the inclusion of relative prices is a step in the right direction by theoretical standards, empirically it could be either better or worse.... [The neoclassical model, including the rental price of capital element] arises from strong simplifying assumptions about the way the relative price of capital services affect change in the capital stock; these assumptions may or may not be empirically valid. [Clark, 1979, pp. 82-83].

Evaluation of the Three Approaches-

Attempts have been made to determine which theory does the "best" job of explaining investment activity. This endeavor is important because the alternative approaches to investment behavior provide widely different implications for the determination of investment, for the time structure of the investment process, and therefore, for the effectiveness of tax incentives such as the investment tax credit. Although this endeavor is of upmost importance, clear success in determining the best theoretical approach has not yet been achieved.

Jorgenson and Siebert [1968] examined several approaches

to viewing investment activity. They concluded that the neoclassical approach to investment behavior was superior to the alternative theories that were included in their study: Capital utilization (output) theory, profit expectations theories, and the internal funds theory. [Jorgenson and Siebert, 1968, pp. 705-706]. These alternative theories are all variations of the basic accelerator approach which were discussed earlier.

Jorgenson, Hunter, and Nadiri [1970] assessed four alternative models by fitting data from 1949 to 1964 to 15 manufacturing industries. One model that they tested stressed the rental price of capital asset services; another model stressed the role of changes in business sales and business profits; another model stressed financial factors such as internal cash flow, interest rates, long-term debt capacity, and accrued tax liabilities; and the last model stressed financial factors such as cash flow, interest rates, and the rate of change of stock prices. The conclusion from the appraisal of the four models varied depending on the particular criterion used for determining which model was the "best."

Bischoff [1971(b)] also conducted a test in which he fitted quarterly data for 1953-1968 to five investment models. Once again, the determination of the "best" model was dependent upon the particular criterion selected.

Elliott questioned the results of the Jorgenson and

Siebert study and the generalizations that the authors made from their work. He did not comment on any other comparative studies. Elliott indicated the overall results must be questioned because the study was "based upon a rather meager sample (fifteen firms) given the apparently general objectives of their work." [Elliott, 1973, p. 195].

Elliott went on to conduct an enlarged test of his own and concluded that the Jorgenson and Siebert results should be interpreted as having no general implications beyond their sample. Elliott's research showed that the liquidity explanation of investment (i.e., a variation of the accelerator approach) was among the most effective theories available. However, Elliott finally concluded that his results were not necessarily indicative of the final and true understanding of investment behavior, but rather that the "most relevant explanatory model for individual corporate investment behavior [is still] ... an open question in need of inquiry."[Elliott, 1973, p. 207].

The GAO makes the following comment regarding the efforts that have been made to appraise alternative theories and their resulting models:

> Attempts to appraise alternative econometric models of investment behavior on the basis of accepted standards of validity of specification, such as goodness of fit and absence of correlation in the underlying errors, reveals that the information already available is insufficient to provide a basis for comparison. [Report by the Comptroller General, 1978, p. 15].

It is apparent that each of the theories is "reasonable" in it approach, even though each approach includes a different subset of economic variables, or at the very least, the relative emphasis placed on the variables varies between approaches. As discussed above, the marginal approach includes profits, cashflow, and interest rate as the critical subset of economic variables. Output, profits, cashflow, interest rate, capital stock, capacity utilization, and technological indicators are factors that are often considered when utilizing an accelerator approach. The neoclassical approach considers output, profits, interest rate, rental price of capital, capital stock, and technological indicators to be important factors that should be taken into account. These variables mentioned may either be explicitly considered in the approaches or they may be implicitly considered, in which case their inclusion could come about through the assumptions on which the approaches are based. It is not clear which particular subset of economic variables does the best job of explaining investment activity or what the ideal relative relationship to each other should be.

Therefore, it appears that the uncertainty emanating from these approaches is rooted in a lack of understanding as to the variables that should be considered and their relationship to each other. Further, in trying to evaluate the "goodness" of the different approaches, agreement has not

been reached as to the criteria or methodology that should be used in the evaluation or even if sufficient information is available to make such an evaluation.

This study, for which the methodology is described in detail in Chapter 4, examines the impact of the investment tax credit by utilizing an approach that has not been used before which circumvents much of the above uncertainty. However, some of the basic influential economic variables mentioned in the above discussion are utilized in this study.

Summary-

The preceding discussion has presented several recognized variations of the theory of investment behavior. The three basic approaches to understanding investment activity that were presented were: the profit maximization or marginal approach; the accelerator approach, which has several variations in which different attributes (i.e., output, capacity utilization, profits, availability of internal funds) are particularly emphasized; and the neoclassical approach. Each method seems to provide a reasonable explanation of investment activity; however, agreement has not been reached as to the particular method which best explains investment activity.

A Review of Previous Studies:

This portion of the chapter includes a review of relevant literature in which the effectiveness of the investment tax credit on the level of investment spending is an issue. With the discussion of the general theories in the previous section providing a background of the basic lines of reasoning related to investment behavior, the current section examines econometric applications of investment theory in which the impact of the investment tax credit is considered. There is no effort made to classify the studies along the lines of the previously mentioned theories. Such a classification is not deemed practicable since many of the empirical studies include elements from more than one theory and in some instances, there is little evidence of any theory serving as a base for the empirical work. The studies that are described below are presented in the order in which they appear in the investment literature. This chronological ordering is considered appropriate because often later studies are based upon, influenced by, or are refinements, clarifications, or extensions of earlier ones and such a presentation could help the reader become aware of the evolutionary process involved.

Much of the research discussed below utilizes investment models which include tax-policy variables. These models have been developed over time as econometric methods have become more sophisticated. The methods have been available to provide a measure of objectivity to statements concerning the

effectiveness of various tax policies. Prior to the development of econometric investment models with tax-incentive variables, statements concerning the effectiveness of these incentives were often based on relatively less sophisticated analytical analysis or questionnaires and surveys.

The models in the studies addressed below were developed to take the analysis a step further (i.e., to establish the relationship between tax incentives, one of which is the investment tax credit, and investment). Tax incentives are introduced into these models via their effect on a predetermined variable (e.g., the cost of capital services, profits, or the internal cash flow). The discussion, however, makes very clear the fact that, as yet, there exists no undisputed way to explain the impact of tax policy-derived incentives upon the level of investment spending.

The bulk of the work in showing that the investment tax credit provides a positive impact revolves around the work by Hall and Jorgenson.[1967,1969, and 1971]. Hall and Jorgenson [1967] formulated a partial equilibrium investment model based on neoclassical economic theory and examined the impact of the investment tax credit on that model. In the model, producers are said to maximize profits and to take account of an implicit rental price of capital. It is assumed that the underlying production function is of the Cobb-Douglas type, where output is considered to be a function of labor and

capital, and that the elasticity of substitution between labor and capital is equal to unity. Further, they assumed that perfect competition exists, profits are maximized over the long run, perfect rationality is applied, and the economic depreciation rate is constant.

In this study, Hall and Jorgenson found that the investment tax credit resulted in a shift away from investment in buildings toward investment in equipment, and further, that the credit also contributed to the stimulation of investment in equipment substantially. The results of their tests indicate that 40.9 percent of the net investment in manufacturing equipment in 1963 can be attributed to the presence of the investment tax credit. They also found that while the impact of the investment tax credit on total investment was "less startling" than its impact on investment in equipment, the impact of the credit on total investment was "quite dramatic." The increased level of total investment resulting from the enactment of the investment tax credit was less noticeable in their tests because the total investment category included items for which the investment tax credit was not allowed and presumably not stimulated. There was no mention in the study as to whether the investment tax credit contributed to a substitution of capital for labor. However, they concluded that "there can be little doubt that an investment tax credit is a potent stimulus to investment expenditures." [Hall and Jorgenson, 1967, p.410].

Hall and Jorgenson concluded in their 1969 study that the investment tax credit had a definite impact on the level of investment spending. More specifically, their study indicates that with the repeal of the Long Amendment in 1964 (i.e., upon repeal, the basis of the qualifying asset no longer had to be reduced by the amount of the credit claimed), the effectiveness of the investment tax credit was substantially enhanced. [Hall and Jorgenson, 1969, p. 397].

Eisner studied the effectiveness of the investment tax credit and was generally skeptical as to its stimulative impact. He claims that the conclusions of some other researchers, particularly the research stemming from Hall and Jorgenson's work, are based upon assumption rather than empirical evidence. He believes because of the constraining assumptions specified, that it is impossible for Hall and Jorgenson to disentangle any possible influence of the investment tax credit. Eisner states that the analyses of "the empirical data ... do little to confirm the '... article of faith among both policy-makers and economists' regarding '...the effectiveness of tax policy in altering investment behavior.'" [Eisner, 1969, p. 379]. Moreover, Eisner's analysis showed that Hall and Jorgenson's conclusions stemmed directly from the assumptions of the neoclassical model employed and had relatively little to do with the data. [Eisner, 1969, p. 380].

In Christensen's study of the investment tax credit, the author concluded "that judging the effectiveness of tax policy requires more attention to the development of an appropriate macroeconomic context." In his pursuit of considering the issue in the context of a simple macroeconomic model, he suggested that a complete specification of government policy is a necessary prerequisite to drawing any conclusions regarding the effectiveness of a single policy tool and that previous studies lack such specification. The research indicates that "studies which claim to demonstrate the effectiveness of investment incentives probably entail strong assumptions about the (unspecified) supply side of the market for capital goods." [Christensen, 1970, p. 22].

Fralick [1970] conducted a microeconomic study to determine the effect of various tax provisions on individual firms. With respect to the investment tax credit, he studied the enactment of the investment tax credit, repeal of the Long Amendment, and suspension of the credit in 1966. He concluded that investment was higher after enactment of the credit than it would have been without it, apparently the Long Amendment had adverse impact on investment, and the average decrease in gross investment due to the suspension of the credit in 1966-1967 was approximately two percent per year. [Fralick, 1970, pp. 134-144].

Johnson and Carey studied the issue of the effectiveness

of the investment tax credit by analyzing the sensitivity of a series of equipment replacement decisions to the availability of the investment tax credit at various assumed rates. Their sensitivity tests were conducted in a capital budgeting context in which a net present value model was utilized. The purpose of the study was to determine the investment tax credit percentage that would cause various assumed investment proposals to become acceptable. The primary economic variables pertinent to their model were cash flow and interest rates. The results of the "study showed that, in general, the equipment replacement decision was relatively insensitive to an investment tax credit of 7 percent or below." The study indicates that an investment tax credit above 7 percent may impact upon the investment decision. [Johnson and Carey, 1970, p. 311].

In another study conducted by Hall and Jorgenson [1971] in which the neoclassical economic theory was applied, their econometric model of investment behavior was reestimated by taking into account data and newly developed methods of estimation that had not been available when they conducted their earlier studies. The set of variables that they used in their study included measures for output, profits, interest rate, rental price of capital, capital stock, and technical change. Results similar to those of their earlier studies were obtained. In the study, the parameters of their model were estimated from annual data for investment in

manufacturing industries in the United States for the period 1962-1965.

In the portion of their study related to the impact of the investment tax credit, they only considered the potential impact on investment in equipment rather than considering the impact on investment in equipment and on total investment. Nonetheless, they did find that the investment tax credit had a substantial positive impact on gross investment, net investment (i.e., gross investment less replacements), and capital stock in equipment. The authors concluded that the increases of investment in equipment resulted because the presence of the investment tax credit brought about a reduction of the rental price of capital services. [Hall and Jorgenson, 1971, p. 51].

Moreover, Hall and Jorgenson found that tax policy can be highly effective in changing both the level and timing of investment expenditures. They concluded that the investment tax credit has had a greater impact than any of the other changes in tax policy during the postwar period, especially after the repeal of the Long Amendment in 1964. Hall and Jorgenson also concluded that the suspension of the credit from late 1966 to early 1967 had an important restraining effect on the level of investment. [Hall and Jorgenson, 1971, p. 59].

Charles Bischoff's model [Bischoff, 1971(a), pp. 61-130] of the investment process is similar to the Hall and

Jorgenson model. However, he criticized some of Hall and Jorgenson's assumptions as being too restrictive and then develops his own set of assumptions that are purportedly less restrictive. One of Bischoff's major assumptions is that factor (labor and capital) proportions may not be freely variable at all times, but only before fixed capital goods are put into place. This assumption is the basis for the "putty-clay" hypothesis, under which the machinery is made of "putty," which can be shaped into any form until it is put into place, after which it becomes hard-baked "clay." This approach assumes that measures which alter the relative price of capital services (such as tax credits, depreciation expense, and profits taxes) should affect capital goods spending more gradually than do changes in output. Bischoff did, however, utilize surrogates for the same variables in his investment model as did Hall and Jorgenson in their 1971 study (i.e., output, profits, interest rate, rental price of capital, capital stock, and technical change). Bischoff used quarterly data of investment in producers' durable equipment for the period 1951-1965. He concluded that changes in relative prices of capital goods (including changes resulting from the investment tax credit) appear to have a statistically significant effect on investment spending. Additionally, he stated "that the investment tax credit adopted in 1962 has probably directly stimulated more investment spending than the policy has cost the government in taxes." [Bischoff, 1971(a), p. 125].

Robert Coen studied the issue of the investment tax credit's effectiveness, and in his work, he initially assumed that the investment tax credit influences capital expenditures in two ways: First, by reducing the implicit rental price of capital, the desired stock of capital is increased. Second, by increasing the internal flow of funds, businesses facilitate adjustments of capital stocks to desired levels. More specifically, measures for output, profits, cashflow, interest rate, rental price of capital, and capital stock were incorporated into his investment model.

Upon the completion of his study, Coen suggested that a decisive judgement cannot be made as to the effectiveness of the tax incentives studied. (He also studied the impact of accelerated depreciation on the level of capital expenditures.) While commenting on his work and the work of others, Coen concluded that in order to make a decisive judgement on the effectiveness of the investment tax credit as a tax incentive, one has to be willing to pass judgment on the merits of the models involved. Nonetheless, he stated that his estimates suggest that the "performance of tax incentives has been quite disappointing.... The policies that produced an estimated $8.6 billion in tax savings from mid-1962 through the third quarter of 1966, increased expenditures by only $2.8 billion." [Coen, 1971, p. 179].

Klein and Taubman [1971] studied the investment tax credit's effect in a three dimensional framework. Their focus was on what investment would have been for an eight-quarter period, beginning with the fourth quarter of 1966, given:

1. No suspension of the investment tax credit
2. Permanent suspension of the credit
3. Temporary suspension of the credit

Further, within this structure, they incorporated the following variables in their investment model: output, profits, cashflow, interest rate, capital stock, and capacity utilization. They also commented upon two other variables that had often been used by other researchers: the rental price of capital and indicators of technical change. They recognized their importance and their possible explanatory power; however, they did not attempt to include them in their models because of their perception that reliable and valid surrogates did not exist and due to their perception that weaknesses were present in the computation of these surrogates.

With a permanent suspension, there is a slower rate of growth in the value of output during early 1967, but a rapid recovery in the latter part of the year and continued growth during 1968. They concluded that the final position of the economy was approximately what it would have been without any suspension. [Klein and Taubman, 1971, p. 234].

Pitts and Whitaker [1971] conducted a study of the effectiveness of the investment tax credit within the chemical industry. They concluded that from 1962-1965 the investment tax credit had a measurable impact on investment behavior and attributed 8.3 percent of the gross investment spending in the chemical industry to the investment tax credit's availability. [Pitts and Whitaker, 1971, p. 58].

In a later effort by Eisner, he concluded that the investment tax credit does not significantly increase investment. While his estimates of the impact of the investment tax credit were significantly less than other researchers, he claimed that the investment tax credit may "essentially only alter the mix of investment spending -- towards the corporate business sector and expenditures for plant and equipment." [Eisner, 1973, p. 399]. While he did not support this statement by including a detailed analytical analysis of investment theory or an empirical exercise, he did base the statement upon his review of theoretical analysis and empirical study of others and the responses of businessmen in surveys.

In a study by Sunley, the "neutrality" of the investment tax credit was examined. He viewed the investment tax credit in isolation and did not consider other variables that could differentially affect investment in different industries; however, he concluded that the "effective investment tax

credit rate" is "far less than the 7% nominal rate" [Sunley, 1973, p. 217] allowed. Although he did discuss the rental price of capital variable in an analytical section of his paper, he did not use it or any other of the economic variables mentioned above in an investment model. He utilized statistics computed by the Internal Revenue Service based upon a sample of corporation income tax returns to complete the empirical portion of his study. His study categorized the effective investment tax credit by industry group and concluded that based upon the 1968 data used, the effective investment tax credit rate ranged from a low of 2.84% in the "communication services industry group" to a high of 6.97% in the "lumber and wood industry." He claims that the nominal rate was reduced because of various factors which are part of the investment tax credit provisions (e. g. short-lived property, public utility property, carryover of unused credits, net income limitation, and recapture of prior credit), and as a result, the actual impact of the credit on investment cannot be as intended.

The General Accounting Office (GAO) recently studied the issue of the investment tax credit's effectiveness. They critically assessed a group of important studies that have analyzed the investment tax credit's effects, point out the weaknesses in the analyses, and suggest the direction of future research. The studies included in their review were ones cited above conducted by Hall and Jorgenson [1971],

Bischoff [1971(a)], Coen [1971], and Klein and Taubman [1971].

The GAO is apparently very dubious as to the credit's effect in stimulating investment because of the specification of the credit's provisions. They suggest that:

> ... the largest portion of the tax credit goes to reward investment that would have been undertaken in any case. Thus, while a company may increase investment outlays by only 5 percent over what was planned without the credit, they will receive a credit benefit on the full 100 percent of their investment. [Report by the Comptroller General, 1978, p. 3].

They also reviewed two studies that attempted to appraise alternate econometric models of investment behavior. Both of the studies that they reviewed, the Jorgenson, Hunter, and Nadiri [1970] study and the Bischoff [1971(b)] study, were discussed above. Based upon their review, they felt that reliable comparisons of alternate econometric models could not be made because of the lack of sufficient information.

Further, they commented on the current state of the research of this issue and the prospects for the future:

> In fact, the controversy over the extent to which business managers do respond to tax incentives extends to both the theoretical and the empirical levels of analysis. Though the research performed to date has failed to provide policymakers with exact, quantitative answers, definite progress has been made in classifying the basic issues. Although the definitive investment model has not yet and may never be developed, the existing models

> and empirical studies do provide valuable information for the policymaker. [Report by the Comptroller General, 1978, p. 6].

Richard M. Bird [1980] recently reviewed several dozen studies of tax incentives, including studies which examine the investment tax credit. The studies that he reviewed attempted to capture the impact of tax incentive provisions enacted primarily in the United States and Canada. Included in his review were several studies that are also included in the review of literature above. The studies which are of common interest were ones conducted by Hall and Jorgenson [1967 and 1971], Bischoff [1971], Coen [1971], Klein and Taubman [1971], and Eisner [1973 and 1978]. Since his study also encompassed other types of tax incentives (e.g., accelerated depreciation, reduced tax rates, research and development incentives, and savings incentives) and since his review also included studies of incentives enacted in Canada as well as the United States, Bird's review included a number of research efforts that are not of direct interest to this study. The primary conclusions reached by Bird are that (1) economists and other researchers know amazingly little about the effectiveness and efficiency of tax incentives, (2) the available research techniques are incapable of improving this lack of knowledge very much, and (3) the available evidence suggests that tax incentives do not effectively or efficiently achieve most of the objectives for which they were supposedly introduced. [Bird, 1980, p.2].

Hendershott and Hu have examined the issue and concluded that a resultant change occurs in the cost of capital from the establishment or increase of the investment tax credit. The variables that they included in their investment model were output, profits, interest rate, rental price of capital, capital stock, capacity utilization, and technical change. However, they indicate that the estimates resulting from their model "overstate the actual increase in investment because other variables would probably change in an offsetting manner; in particular, interest rates would rise unless capital were available in unlimited quantities at a constant interest rate." [Hendershott and Hu, 1981, p. 116]. It is suggested by Hendershott and Hu that many of the previous studies tend to consider only a portion of the picture: they examine only the effect of the investment tax credit on the investment function in a closed system and not the net effect on investment expenditures in an open system. "Analysis of a full model of the investment saving matrix, relative prices, and financing rates and explicit assumptions regarding both the response of macroeconomic policy and the method of financing the (tax credit) are necessary to obtain a reasonable estimate of the change." [Hendershott and Hu, 1981, pp. 116-117]. That is, there may be many other factors that affect the level of investment expenditure in the economy other than the cost of capital. They point out that in fact, "von Furstenberg has argued that capacity

utilization rate is the dominant determinant of nonresidential fixed investment." [Hendershott and Hu, 1981, p. 102].

In a study conducted by Lawrence Summers, the author concluded that little is known about the relative effectiveness of alternative investment incentive devices, including the investment tax credit; however, it is generally accepted by tax policy researchers that incentives to spur investment should be designed to maximize the additional investment generated per dollar of forgone revenue. Therefore, the design of the incentive, and not just the size of the increased investment stimulus is an important issue. Additionally, Summers concluded that the consideration of interactions between tax policy and inflation is essential to policymaking because of the impact of inflation on taxation and investment. [Summers, 1981, pp. 118-119].

The studies reviewed above illustrate the point that a clear understanding of the effectiveness of the investment tax credit has not been reached. Various theoretical approaches and various nuances thereof have served as the basis for the studies. Further, different studies have considered various subsets of economic variables that are believed to influence investment behavior. Moreover, the relationships of these explanatory variables to each other have varied. These factors have undoubtedly contributed to this lack of clear understanding of the investment tax credit's effectiveness.

Primary Economic Variables Influencing Investment Spending:

This study, which is conducted at the macro level, must rely upon micro investment theory because a theory at the macro level remains undeveloped. However, upon the examination of the micro investment theory, as previously discussed, it is apparent that this theory is not fully developed, either. Nonetheless, as discussed earlier, macro level studies often rely, at least to some extent, on micro level economic theory. This dissertation also relies upon micro economic investment theory, but in very general terms.

The purpose of this dissertation is not to attempt to make a conclusion as to the most appropriate structural theoretical approach to understanding investment; but rather, its purpose is to use the theory that has been developed to date as a broad base for exploring the issue of the effectiveness of the investment tax credit by utilizing a methodological approach that has not been previously used. This study utilizes micro investment theory for purposes of selecting the major economic factors that appear to influence investment spending. As a result, the various attributes held to be important in the theories and the resultant empirical work related to investment spending are considered for purposes of this study.

Even though various subsets of economic variables appear in the theoretical and empirical literature reviewed, the variables have continually appeared, disappeared, and reappeared. The variables that have been noted in the theoretical background and literature review portions of this chapter which over time have seemed to be important in explaining investment behavior are: output, profits, cashflow, interest rate, rental price of capital, capital stock, capacity utilization, and indicators of technical change. Because of their perceived importance in explaining investment activity, these factors are considered for inclusion in this study.

Klein and Taubman [1971] also concluded that these variables were important factors in influencing investment. They stated that "nearly all investigators have settled on ... (these variables as being) the relevant set of variables for investment functions.... Most investigators refer to the same list of variables and usually select some subset for their own studies.... [Klein and Taubman, 1971, p. 198]. Their conclusions regarding the set of influential economic variables came after a flurry of several major studies (by Hall and Jorgenson, Coen, Bischoff, and others) had been conducted in the late 1960's. Their evaluation as to the variables which show great impact upon investment is considered still to be relevant for purposes of this study based upon the review of theory and the literature as

discussed above and because it would appear from a review of the investment literature, that studies since that time have not developed or produced significant new theoretical enlightenment.

Based upon a review of the relevant major theoretical and empirical studies in the literature, it is clear that the answers are by no means entirely satisfactory nor have all of the questions been addressed and examined. If any general conclusion can be drawn from the literature in this area, it would be that the subject is far from settled. However, the previous research has made a contribution in developing a basic understanding of the effects of various economic factors on investment (i.e., the eight economic variables mentioned above which are considered for this study). A detailed discussion of their utilization follows in Chapter 4.

Summary:

The state of the theory of investment and related empirical knowledge are very uncertain and replete with unknowns and questions. There is no one all-inclusive theory which satisfactorily explains investment activity. As a result, a decisive judgment on the effectiveness of tax incentives can not be made when utilizing the traditional econometric models unless one is willing to pass judgment on

the merits of the models available. The results coming from such studies have to be characterized as being conditional upon the particular investment model employed. The varying results produced by empirical studies in which the effectiveness of the investment tax credit was examined can be attributed, at least in part, to the fact that different investment specifications have been utilized.

Nonetheless, the essence of the basic theory of investment points to a gradual adjustment of the capital stock to a desired level which is dependent upon the expected level of output. Further, it has been noted that interest rates have shown up in quarterly econometric models as an important determinant of investment. However, internally generated cash and profits have also been noted to have an effect on investment for given levels of output, capital stock, and interest rates. Other variables considered important in the process are rental price of capital, capacity utilization, and indicators of technical change.

The above characterization of the current state of the theory of investment, however, is very much of a generalization. In reality, there are a whole host of alternative theories of investment behavior which differ as to the determinants of the desired level of capital, the time structure of the investment process, the treatment of replacement investment, and so on. The econometric work which follows from the theory is always, by necessity, based

upon highly simplified models. As a consequence, the "number of possible explanations of investment behavior, which is limited only by the imagination of the investigator, is so large that, in any empirical investigation, all but a very few must be ruled out in advance." [Jorgenson, 1967, p.130].

If a truly realistic theory could be developed it would be very complex and may be of only questionable usefulness. As Eisner [1978] suggests:

> If relations could be specified correctly and disturbances all had appropriate properties for estimation, we would presumably come up with similar parameter estimates from the various types of regressions our data allow. This, however, is frequently not the case, a matter all too often ignored by econometricians who take a given body of data ... and assume that somehow the statistics they derive will be unbiased estimates of structural parameters describing a firm's behavior or the aggregate of the firm's behavior. Yet there may be no stable relation among aggregates independent of microeconomic relations and the varying ways they may interact in different situations. [Eisner, 1978, p. 12].

At this early stage of the development of the theory of investment, it may be considered inappropriate to reject any reasonable proposition that may be helpful in understanding investment spending since the predictive and explanatory capacity of existing theory is far from perfect.

> If empirical studies are forced prematurely into a theoretical straitjacket, attention may be diverted from historical and institutional considerations that are essential to a complete understanding of investment behavior. On the other hand, if theoretical work is made to conform to "realistic"

> assumptions at too early a stage in the development of empirical work, the door may be closed to theoretical innovations that could lead to improvements in empirical work at a later stage. [Jorgenson, 1967, p. 130].

It should be clear from the above, that tax policy issues such as the impact of the investment tax credit have not been settled due, in part, to the inconclusive nature of the underlying theory of investment behavior. Therefore, until the complex nature of the investment function is better understood, a continual reapplication of the basic specific theory based testing procedures of the past must be viewed as having limited worth.

New testing procedures and research methodologies must be developed and utilized in which the tests of the effects of tax policy upon investment are not constrained by the possible misspecification of economic theory. The test results can be no more conclusive than is the underlying theory of investment behavior. Moreover, while theory may tell us how investors should behave, it does not necessarily follow that this describes how real-life investors do in fact behave. The research that is conducted and described in the chapters which follow is an attempt to break from the constraints of the embryonic and controversial investment theoretical framework that currently exists yet remain grounded upon the basic economic relationships that are believed to have some import upon investment decisions. By

being constrained only to the extent that a limited number of economic determinants of investment are being considered, it is believed that a clearer understanding of the impact of the investment tax credit upon investment spending is achieved. The following chapter fully describes how the theory-based economic variables discussed above are utilized in this study, which applies a methodological technique that is new to the study of the investment tax credit.

CHAPTER 4

DISCUSSION OF METHODOLOGY AND TESTS PERFORMED

Introduction:

The above discussion elucidates the fact that, as yet, there exists no undisputed way to explain investment behavior and as a result, the answers that have been previously obtained to research questions similar to those at hand are largely inconclusive. This research addresses a set of questions that have been raised before; however, it is appropriate to study the questions again because a methodological approach is utilized which has not previously been utilized with respect to this issue. The approach taken is less theoretically constraining than the other efforts pursued yet the research is based on fundamental economic precepts. This research is based upon an ad hoc model, which thereby avoids the constraints caused by possible misspecifications of more complex structural econometric models noted in the economics literature.

Previous research has not been completely successful in analyzing the issue through the use of structural models in which investment and the investment tax credit are explicitly related to other economic variables. The analyses which follow track the movement of investment, not by relating it to a set of other variables in a causal framework, but by basing the models of the study solely upon the past behavior of various important economic variables.

The specific research questions to be examined are:

1. Has the availability of the investment tax credit provisions given rise to an increased level of investment expenditures within the United States economy over the level of investment expenditures that would have been expected without the availability of the provisions, and

2. Has an increase in the rate of the investment tax credit given rise to an increased level of investment expenditures within the United States economy over the level of investment expenditures that would have been expected had the investment tax credit rate not been increased?

The main null and alternative hypotheses that result from these research questions are:

Ho1: The availability of the investment tax credit provisions has not increased the level of investment spending within the United States economy over the level of investment spending that would have been expected without the availability of the investment tax credit.

Ha1: The availability of the investment tax credit provisions has increased the level of investment spending within the United States economy over the level of investment spending that would have been expected without the availability of the investment tax credit.

Ho2: The increased investment tax credit rate has not increased the level of investment spending within the United States economy over the level of investment spending that would have been expected had the investment tax credit rate not been increased.

Ha2: The increased investment tax credit rate has increased the level of investment spending within the United States economy over the level of investment spending that would have been expected had the investment tax credit rate not been increased

This study examines the association or relationship between the investment tax credit and investment activity. From this effort, statements are made relating to the effectiveness or the impact of the credit in stimulating investment. There is no effort made in this research to assess the efficiency of this tax incentive in terms of its own costs and benefits or its relative efficiency in relation to other tax incentives which have been designed to stimulate capital formation. Finding a significant relationship between the credit and investment does not necessarily indicate that the investment tax credit is the most efficient method available to stimulate investment. These questions relating to efficiency are left for future research activity.

For purposes of this research, the term "investment"

includes depreciable business assets which have useful lives of more than one year, such as plant and equipment. A subset of investment which is considered is "qualified" investment. Purchases of qualified assets, as specifically defined in section 48 of the Internal Revenue Code (see Appendix A), provide taxpayers the opportunity to claim the investment tax credit. In general, property eligible for the credit is depreciable tangible personal property used in the United States (e.g., machinery, equipment, and automobiles). Neither the term investment nor qualified investment includes the acquisition of physical capital by non-profit institutions, or by governmental entities. Moreover, the term does not include the acquisition of durable goods by households or any form of intangible assets such as research and development or human capital. A more complete discussion of the nature of qualified investment and how its definition has changed over time was presented in Chapter 2.

It is also important to reiterate at the outset of this chapter that this study is a macro level study in which the focus of attention is investment activity at an economy-wide level. Investment activity of a particular firm or series of firms is not considered in this research, except to the extent that such micro investment activity data are a component part of the macro data utilized.

The following statement from Anderson [1967] provides a good summary of the reasons why a study at the macro level such as this one is valuable:

> I grant that because of collinearity, simultaneity, aggregation bias, and shortage of data points, variables (that) are aggregated as those in the national accounts are not a very rich testing ground for economic hypotheses. Nonetheless, there are two good reasons for continuing to use them.
>
> The first is that the less aggregate the approach to hypothesis testing is, the greater are the dangers that model building will degenerate into particular explanations for particular cases and that description shall masquerade as theory. Broadly aggregated data provide a useful check on the generality of propositions established from less aggregative data.
>
> The second reason is that policy formulation and forecasting often require quick and dirty estimates of economic parameters. If a policy maker needs to know the size of an accelerator, it is little help to him to be told that it is one value for manufacturing, another for public utilities, and some wholly unknown value for the remainder of industry which no one has yet bothered to investigate. Without a complete disaggregative model which is set up to yield quick answers, aggregate models will continue to be very useful. [Anderson, 1967, pp. 414-415]

The Basic Research Design:

The first research question, the impact of the availability of the investment tax credit on investment, utilizes quarterly macro-economic data for a period of time which includes the January 1, 1962 date. Basically, if the level of investment activity is different after January 1, 1962 (the effective date for the provisions originally allowing the credit) than before January 1, 1962, after

allowing for the effect of certain factors, the difference is attributed to the presence of the investment tax credit.

The second research question takes an approach similar to the first except that the quarterly data considered are from around the January 21, 1975 date (the effective date for

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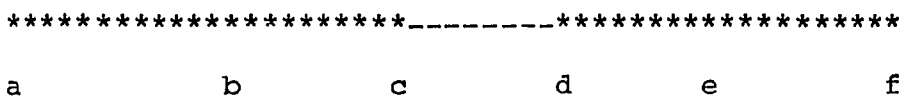
FIGURE 4.1

TIMELINE OF RESEARCH SCOPE



***** - Time period included in tests

----- - Time period not included in tests

a - April 1, 1954 -- The beginning of the first period tested

b - January 1, 1962 -- Date of intervention of the first period tested

c - September 30,1966 -- The end of the first period tested

d - October 1, 1971 -- The beginning of the second period tested

e - January 21, 1975 -- Date of intervention of the second period tested

f - December 31, 1980 -- The end of the second period tested

the provisions which provided that the maximum investment tax credit rate would be increased from seven to ten percent). If the investment activity variable behaves differently after the intervention date than before the intervention date, the difference is attributed to the rate change of the investment tax credit.

The time periods and critical dates associated with these time periods which are included in this study are diagrammed in Figure 4.1, above. As indicated earlier, the dates of intervention tested are the effective dates for two pieces of investment tax credit legislation. The specification of a particular date of intervention is not absolutely critical, however, because as explained later, the possibility of an intervention impact at other points around the effective dates also is explored.

Furthermore, each research question is addressed at two levels: at the level of qualified investment activity and at the level of overall investment activity. The questions at the first level are designed to provide some insight as to the investment tax credit's effect on expenditures for assets that qualify for the credit. The questions at the second level are designed to provide insight relating to the effect of the investment tax credit on overall investment activity. By examining the issue of the investment tax credit's effectiveness at the overall level, the study not only addresses the question of whether total investment activity

has increased, but the question of whether funds were diverted from nonqualifying to qualifying investments is also implicitly addressed, upon considering the overall investment series in conjunction with the nonqualified investment series. Overall investment activity includes both acquisitions of assets that qualify for the credit and assets that do not qualify for the credit.

It is important to ask each of the research questions at the different levels for two reasons:

1. At least one empirical study has concluded that the investment tax credit has created a shift of preference by businesses; it has been claimed that the credit has merely caused a shift towards investment in assets that do qualify for the credit and away from investment in assets that do not qualify for investment. [Hall and Jorgenson, 1967, p. 392].

2. The investment tax credit was enacted with the expectation that not only would "qualified" investment activity be greater but total investment activity would also be expanded. That is, any stimulation of expenditures for machinery and equipment attributable to the investment tax credit would likely also generate an increase in expenditures for plant.

> Since the investment tax credit is applicable to many firms, it will, if it is to be a successful policy, have a significant effect on the economy as a whole. Tests of the effectiveness of the investment tax credit should be put in a context that takes into account the interrelatedness among investment spending of all types. [Report by the Comptroller General, 1978, p. 20].

Therefore, in order to judge properly the impact of the credit, the combined package of plant and equipment investment must be examined in addition to qualified investment.

Specification of the Research Methodology:

From the discussion in Chapter 3, the conclusion was made that there is no one all-inclusive theory which satisfactorily explains investment activity and as a result, many of the conclusions coming from the empirical studies where investment (and the investment tax credit) were studied had to be characterized as being conditional upon the particular investment model employed. It has been suggested that many of the varying conclusions resulting from studies of the effectiveness of the investment tax credit can be attributed to the fact that different investment specifications have been utilized (see Chapter 3).

This study avoids the constraints of being tied to any one particular theory of investment behavior. This work employs a model in which several of the common attributes of the various economic theories of investment spending described earlier are utilized. The variables utilized in this study are the ones discussed in Chapter 3 as being important in investment decisions. However, two of the variables discussed (e.g., rental price of capital and indicators of technical change) are not included in the current study because of the difficulty of making them operational at a macro level. (More discussion of this exclusion follows.) The variables that are included in this study are assumed to be linearly related to investment activity. As such, investment activity is modelled as a linear function of the various economic variables. The variables employed represent a distillation of much of the econometric literature on investment activity which was discussed in the previous chapter. This work is an attempt to avoid much of the structural sophistication of earlier efforts which, as Klein and Taubman suggest, "can lead to a too great departure from the real world." [Klein and Taubman, 1971, p. 206].

Fundamentally, the research methodology consists of two major steps in which ex-post quarterly macro-economic data are analyzed for purposes of the hypothesis testing: a multiple regression analysis step and an intervention analysis step.

The first of the two steps isolates the fluctuations in the flow of investment from quarter to quarter during each of the two time periods into two parts: the portion of the investment activity explained by the economic variables and the portion of the investment activity not explained by these economic variables. This unexplained segment of investment activity is called the "residual."

In the second major step, the time-series pattern of the residual is examined around two intervention dates (i.e., January 1, 1962 and January 21, 1975). If either or both of the residual series behave differently after the intervention than before the intervention, the statement is made that the difference is attributable to the presence of the intervention.

For each of the two time periods tested and at each of the two levels of investment activity, a control group is utilized to further isolate exogenous influences which are not explicitly accounted for in the regression equations (i.e., in the multiple regression analysis step) and which are believed to impact upon investment activity. The nonqualified investment activity series described below serves as the control group in this study. The utilization of a control group is particularly beneficial in this instance because of the difficulty in isolating the effects of taxes and the investment tax credit from other influences

and because of the lack of complete knowledge as to the nature of the investment function. By utilizing a control group, influences such as general economic conditions, the 1973-1974 oil embargo, the Vietnam War and defense spending, expectations, and Japanese competition, are minimized since these factors affect both the experimental and control groups. Moreover, the effects of a number of other tax policy changes which ostensibly impact upon investment activity, such as the enactment of the Class Guideline Lives depreciation system, the depreciation recapture provisions, and the tax rate structure changes, are controlled by using this research design because these factors impact upon both the experimental and control groups.

The utilization of a control group will also help mitigate the potential difficulty of historical invalidity. Normally, a change in a time-series which coincides with the occurrence of an intervention is presumed to be the effect of the intervention. However, in ex-post experiments, such as this one, it is no simple matter to sort out the effect of one intervention from the effects of many other simultaneous interventions targeted toward aspects of the same problem. The historical invalidity difficulty is averted by analyzing the results of the tests performed on the experimental group in conjunction with analyzing the activity of the control group.

Although the utilization of the control group in this

study aids in accounting for factors that would ordinarily be hard, if not impossible, to include in a model, it does not represent an ideal control group because the experimental groups may not be independent of the control group. For instance, it was asserted earlier that if qualified investment was stimulated, nonqualified investment also may be stimulated to a degree. The degree to which the experimental groups and the control group move together, either simultaneously or in a lagged fashion, is monitored in this study. Plausible explanations can be provided for such co-movement, if necessary.

Recall that in this project the experimental groups are the qualified investment activity and overall or total investment activity variables. The control group utilized is nonqualified investment activity (i.e., investment activity for which the investment tax credit is not available). The nonqualified investment activity variable is derived by computing the difference between overall investment activity and qualified investment activity. Basically, this control group primarily encompasses the investment activity in commercial and industrial buildings (e.g., stores, offices, warehouses, etc.) for a given time period.

Surrogation of the Economic Variables-

A set of possible relevant variables for specifying the

investment function was identified in the previous chapter. Various investigators have selected for their studies subsets of one or more of the elements from this set as being primarily responsible for explaining investment behavior. Each of the theoretical approaches that has been utilized by these researchers is conceptual in the sense that the variables of the model and the relationships among variables are based on either economic theory or at least some a priori hypothesis concerning investment behavior. In order to utilize each model as a research tool the conceptual variables have had to be surrogated by "real-world" data. This research likewise requires the utilization of surrogates to represent the conceptual attributes which influence investment activity. The sources of the "real-world" macro-economic data that are used in this study are the U.S. Department of Commerce, Bureau of Economic Analysis; U.S. Department of Commerce, Bureau of the Census; and the Board of Governors of the Federal Reserve Board. A description of the surrogates selected as the dependent and independent variables for this study is given below.

As explained below, surrogates are selected for all of the economic variables listed in Chapter 3 except for the rental price of capital and indicators of technical change attributes. In the case of these two independent variables, reliable and valid surrogates are not considered to be available. Based upon the literature reviewed previously,

earlier attempts to surrogate the variables encountered difficulties because of the uncertainty involved in deciding upon their appropriate specification.

More specifically, with respect to the rental price of capital variable, a surrogate of this attribute is not included in the study because of the lack of agreement as to its appropriate theoretical and operational specification. Henderhott and Hu commented that "considerable controversy exists" over the appropriate specification of this factor. Their conclusion is based upon their study noted above which included general comments about various specifications of the variable. [Hendershott and Hu, 1981, p. 87]. Moreover, Goldberg concluded that this variable did not seem to "work" in macro-economic studies because of factors such as measurement error, aggregation bias and/or inadequate information on expectations. [Goldberg, 1979, p. 118].

The omission of the indicators of technical change variable from this study is not considered significant for several reasons: (a) Any variance attributable to this variable, which generally encompasses the independently or exogenously determined changes in the production process, may be factored out upon the utilization of the control group as called for in the methodology described in this chapter. (b) As mentioned in Chapter 3, the factor tends to affect the timing of investment expenditures, and as a result, investment can be both stimulated and restrained at the same

time. Therefore, the net effect of the variable's omission may be negligible. (c) Since technological advance can relate to both labor and capital saving techniques, the inclusion of this variable could convolute the results because of the fact that it does encompass labor as well as capital saving technology. Ideally, if the factor was to be included in this study, a surrogate would be needed that only considered the capital saving aspects.

Therefore, the six economic determinants that are surrogated for this study are output, profits, cash flow, the interest rate, capital stock, and capacity utilization. The surrogates of the dependent and independent variables that are used in the testing are as follow. Further, the actual observations of the following surrogates are provided in Appendix B.

1. Qualified Investment Activity. "Value of Manufacturers' New Orders, Capital Goods Industries, Nondefense," in constant (1972) dollars, seasonally adjusted, Source: U.S. Department of Commerce, Bureau of the Census, Business Conditions Digest. A new order is a communication with the intention to buy for immediate or future delivery. The new orders in the series are supported by legal documents, including signed contracts, letters of intent, and letters of awards. The series includes

new orders less cancellations. New orders is equal to the current value of shipments plus the change in unfilled orders. The series is not seasonally adjusted independently but is derived from seasonally adjusted shipments and unfilled orders series. Included in the series reported by a group of durable goods manufacturers are nonelectrical machinery (e.g., engines and turbines; construction, mining, and material handling equipment; metal working machinery; special and general industry machinery; and miscellaneous nonelectrical equipment), electrical machinery (e.g., electrical transmission and distribution equipment, electrical industrial apparatus, other electrical machinery excluding household appliances, and railroad equipment), and the nondefense portion of communication equipment, shipbuilding and aircraft and their parts. This series, which is derived from a series stated in terms of current dollars, is presented in terms of constant (1972) dollars. The series is determined by multiplying the seasonally adjusted current-dollar series by the seasonally adjusted wholesale price index for machinery and equipment.

2. Overall Investment Activity. "Contracts and Orders

for Plant and Equipment," in constant (1972) dollars, seasonally adjusted, Source: U.S. Department of Commerce, Bureau of Economic Analysis, Business Conditions Digest. This series measures the value of new contract awards for commercial and industrial construction contracts (e.g., offices, stores, warehouses, garages, and manufacturing buildings), for contracts for privately-owned non-building construction (e.g., streets, bridges, dams, utility systems, pipelines, and watersupply systems), and for manufacturers' new orders in capital goods, nondefense industries (this portion of the series is the same as the series described above for qualified investment activity).

3. Nonqualified Investment Activity. This series is derived from the two series described above. The series, which includes building and nonbuilding construction, is computed by taking the difference between "Contracts and Orders for Plant and Equipment" and "Value of Manufacturers' New Orders, Capital Goods Industries, Nondefense." This series represents new orders or contracts for assets that do not qualify for the investment tax credit.

4. Output. "Total Manufacturing Output," expressed as

a percentage of 1967 output (1967 = 100), seasonally adjusted, Source: Board of Governors of the Federal Reserve Board. This index is designed to measure the monthly changes in the nation's output of industrial production, except for the output related to mining and utility operations. Additionally, the index does not include production on farms, in the construction industry, in transportation, or in various trade and service industries. The index is based on data supplied to the Board of Governors of the Federal Reserve System by government agencies and various trade organizations. It is a combination of more than 200 individual output series with value added weights. The weights used are based on the value added by manufacturers (the difference between the value of production and the cost of material or supplies consumed) in individual industries for selected base years. The components of the index are adjusted for two kinds of short-term recurring fluctuation: for differences in the number of working days from period to period and for seasonal variation.

5. Profits. "Corporate Profits after Taxes with Inventory Valuation Adjustment and Capital Consumption Adjustment in 1972 Dollars," seasonally

adjusted, Source: U.S. Department of Commerce, Bureau of Economic Analysis, Business Conditions Digest. This variable is a measure of the amount of earnings, by corporations organized for profit, which accrue to U.S. residents. This amount is the result after subtracting federal and state income tax liabilities. The definition of profits generally agrees with the Internal Revenue Service's definition of taxable income with a few exceptions (e.g., bad debt expense is measured by actual losses instead of additions to the reserve). The inventory valuation adjustment is the change in the physical volume of inventories valued at prices of the current period less the change in the book value of inventories as reported by the businesses (i.e., the excess of the replacement cost of inventories used up over their historical acquisition cost). This adjustment is considered necessary because the change in the book value of inventory generally differs from the change in business inventory. The capital consumption adjustment converts tax return-based capital consumption allowances to a replacement cost valuation (instead of being at a historical cost valuation) and to uniform service lives and depreciation formulas. This series, which is derived from a series stated in terms of current

dollars, is presented in terms of constant (1972) dollars. The determination of this constant dollar series is based upon the following two steps: (1) the current dollar series is separated into two components: (a) dividends after taxes, and (b) undistributed corporate profits after taxes with inventory valuation adjustment and capital consumption adjustment; and then (2) the dividends component is multiplied by the implicit price deflator for personal consumption expenditures and the other component is multiplied by the deflator for nonresidential fixed investment. The summation of these two deflated components results in the series used for this study.

6. Cash Flow. "Net Cash Flow, Corporate, in 1972 Dollars," seasonally adjusted, Source: U.S. Department of Commerce, Bureau of Economic Analysis, Business Conditions Digest. This series is derived from information implicit in the corporate profit series. This cash flow series is the sum of undistributed profits (i.e., the portion of profits remaining after taxes and dividends have been paid) plus the capital consumption allowances that were netted in arriving at corporate profit numbers (i.e., the total of depreciation charges and

accidental losses to fixed capital). This series, which is derived from a series stated in current dollars, is presented in terms of constant (1972) dollars. The series is obtained by dividing the current dollar series by the implicit price deflator for nonresidential fixed investment.

7. Interest Rate. "U.S. Government Treasury Notes - Constant Maturities, 5-Year," Averages of daily figures, Source: Board of Governors of the Federal Reserve Board. Based upon recently issued and actively traded securities only.

8. Capital Stock. "Total Manufacturing Capacity," seasonally adjusted, as a percentage of 1967 output, Source: Board of Governors of the Federal Reserve Board. This variable is based on the concept of the maximum output that can be produced during a given time period with existing plant and equipment and with a normal operating schedule. A normal operating schedule reflects the usual number of full-time hours per shift, shifts per day, days per week, overtime hours, vacation hours, and hours of downtime for repair and maintenance; it is assumed that supplies of labor and other input are unlimited. Basically, capacity output or the actual

level of capital stock for a given industry is determined implicitly by trend- and level-adjusting the McGraw Hill annual year-end level of capacity and a gross capital stock series. An average of the two series is taken to determine annual capacity which then is linearly interpolated between year-end estimates to obtain quarterly estimates.

9. Capacity Utilization, "Rate of Capacity Utilization, Manufacturing," seasonally adjusted, Source: Board of Governors of the Federal Reserve Board. This series measures the degree to which the manufacturing sector is realizing its output potential. The series is based on a derived measure of capacity utilization rather than on the survey approach. This capacity utilization variable is the ratio of actual output to capacity output, determined by dividing the quarterly seasonally adjusted Federal Reserve Board actual output compilation for total manufacturing by the derived quarterly capacity output for total manufacturing (described above under Capital Stock).

The Utilization of Investment Orders-

As mentioned in the previous section, the three

surrogates selected to represent investment activity were measures of investment orders rather than measures of actual investment expenditures. By utilizing an orders series, problems associated with timelags between an investment stimulant and an investment expenditure such as those discussed below are mitigated. In fact, as suggested in the discussion which follows, an orders series is considered to be preferrable to an expenditures series in studies such as this one.

Upon considering capital expenditure decisions at an aggregate level, complications to the lag scheme are introduced because of different speeds by which different firms respond to a given situation. Moreover, different firms require different assortments of capital goods; the information, decisionmaking, ordering, queuing, and production period components of the lag scheme may vary over time. [Report by the Comptroller General, 1978, p.9].

Alan Greenspan [1979] provides the following comment about lag structures and their interface with investment modelling:

> What I know about investment decisionmaking causes me to doubt statistical procedures that make plant or equipment expenditures the dependent variable and then estimate distributed lags on a number of explanatory variables. Can such equations track the process that actually occurs? Capital expenditures committees of corporations act on appropriations [i.e., new orders] in light of variables such as cash flow ... or some accelerator measure. The lag between those factors and

> appropriations is short. And then expenditures flow from appropriations with varying lags.... By making investment expenditures the dependent variable and linking them by a fixed lag distribution to the factors that actually determine capital appropriations, the models waste information and turn into reduced forms rather than structural explanations. [Greenspan, 1979, pp.115-116].

Klein and Taubman [1971] conclude that while a general pattern has emerged from past studies which shows that a lag process is involved and that the shape of the distribution is humped, the exact shape of this pattern varies by firm, industry, and product. Further, agreement has not been reached on the method of estimating the lag distribution and, as a result, the parametric specifications of the lag functions remain somewhat arbitrary. [Klein and Taubman, 1971, p. 207].

Klein and Taubman [1971] suggest that the demand for investment goods is reflected in orders, while the lag that exists until receipt reflects supply phenomena. They add that when a macro approach is used, as in this study, an investment orders variable may be more appropriate to use rather than an actual expenditures variable because of several reasons: the lag structure varies by industry and product, the lag has been shown to stretch out as capacity utilization rises in the supply industry, and the lag may expand and contract over time. [Klein and Taubman, 1971, pp. 217-218].

Hendershott and Hu [1981] also support the contention that orders is preferable to investment expenditures as the dependent variable when using macro-level data because of the differences in the length of the lag in different industries. They further contend that with practically any aggregation of investment outlays, the lag will vary over time as the composition of orders among the various industries included in the aggregation change. They conclude the use of lags tends to unnecessarily complicate both the estimation and interpretation of the results. [Hendershott and Hu, 1981, p. 87].

Therefore, because of the problems associated with selecting an appropriate timelag scheme for capital expenditures in an aggregate or macro setting, investment orders series are used in this study rather than investment expenditures series. Further, in utilizing orders series, the assumption is made that there is a direct positive correlation between investment orders and investment expenditures. That is, an investment order will generally result in an investment expenditure.

General Specification of the Models-

The major testing performed in this study is conducted by completing two major steps. In each of the steps, a different research tool is used in order to achieve a

different purpose. In the first step, multiple regression analysis is used to determine the portion of investment activity that is explained structurally by the six economic factors discussed above, and then conversely, to determine that portion of investment activity that is not explained by the six economic factors. In the second major step, a time-series analysis procedure, called intervention analysis, is conducted on the unexplained portion derived from the first step to determine if the investment tax credit is an additional factor that perhaps is "buried" in the unexplained portion which helps account for investment activity.

As discussed, the methodology in this dissertation is comprised of two major analytical techniques: multiple regression analysis and time-series analysis. Pindyck and Rubinfeld suggest that a research design in which both regression and time-series techniques are utilized is likely to provide a better representation of the flow of investment spending than the regression equation alone, or a time-series model alone. This is the case, they assert, "since it includes a structural (economic) explanation of that part of the variance of (a time-series of data) that can be explained structurally, and a time-series 'explanation' of that part of the variance of (the series) that cannot be explained structurally." [Pindyck and Rubinfeld, 1976, p. 539]. In this methodology, the regression analysis is utilized to explain the deterministic part of the investment generating

process (i.e., the economic factors). The intervention analysis procedure then is used to further refine the components of several regressions' residual series by modelling the stochastic process. The details of these techniques are presented below.

Although the major focus of the study is encompassed by the two steps mentioned, preliminary testing is conducted on the raw economic data to determine if a significant level of interaction exists between the economic variables utilized and the investment tax credit; and an ancillary test is also conducted to confirm the direction of any investment tax credit impact noted upon completing the multiple regression and intervention analysis steps. These preliminary tests, in which a modification of the economic data is considered, and the ancillary test, along with the multiple regression and intervention analysis steps are discussed in detail in the sections which follow. The data used for purposes of the preliminary tests and multiple regression analysis steps are presented in Appendix B.

The Possible Modification of the Raw Economic Data:

The possibility that a degree of interaction or dependence may exist between the six influential economic variables utilized in the study and the investment tax credit is recognized. Further, it is recognized that if such interaction does exist and if its degree is significant, this

interaction could convolute the results of the regression analysis (described below), and for that matter, the results of the entire study. Therefore, before performing the regression analysis, a possible modification of the raw economic data needs to be considered.

The modification of the raw economic data would be intended to remove any existing interactive effect between the independent variables and the investment tax credit. This interactive effect, if present and not removed, could mask any impact that the investment tax credit may have upon investment activity. For instance, upon the enactment of or rate change in the investment tax credit provisions, the interest rate or level of output could have fluctuated solely because of the presence of or changes in the investment tax credit rules. That is, the interest rate and level of output could fluctuate as an indirect result of the investment tax credit provisions impacting upon the economic variables that interact with the interest rate and output (e.g., the money supply, demand, etc.).

Therefore, preliminary tests which are more precisely described in a section below, are performed to determine if a significant level of interaction exists between the six influential economic variables and the investment tax credit. If significant interaction is found, then an appropriate "cleansing" modification to the economic data is conducted for utilization in the regression analysis. On the other

hand, upon conducting the above tests, if the conclusion is reached that significant interaction is not present, then modification of the economic data is not considered necessary.

Multiple Regression Analysis Step:

In the regression analysis step, investment activity is modelled as a linear function of the six economic variables described above because these variables are considered important influences to investment activity. The model is used to estimate the true functional relationship between investment activity variable (i.e., the dependent variable) and the economic variables (i.e., the independent variables). The functional form of the model which results is defined by the model parameters, or the regression coefficients.

In this step, a multiple regression analysis is conducted for each type of investment activity variable for each period included in the examination (i.e., 1962 and 1975). The investment activity variables modelled include the surrogates described above for qualified investment, total investment, and nonqualified investment.

The "Value of Manufacturers' New Orders, Capital Goods Industries, Nondefense" series is utilized as the surrogate for qualified investment activity. As discussed above, this surrogate is used rather than an "actual expenditures" surrogate because of problems associated with determining

specific lag relationships between an investment stimulus and an actual expenditure.

The variable "Contracts and Orders for Plant and Equipment" acts as a surrogate for overall or total investment activity. An "orders" variable rather than an "expenditures" variable is utilized here also because of problems associated with lag relationships.

A regression is also performed with nonqualified investment for control group purposes. The surrogate for nonqualified investment activity is derived from the qualified investment and total investment surrogates. The nonqualified investment series is obtained by subtracting the qualified investment series from the total investment series.

In each regression analysis, the set of economic variables (i.e., the independent variables) used are those described above. The set remains unchanged or constant throughout the testing. That is, various subsets from the set of the above six economic factors are not tested in the regressions. The purpose of this study is not to test empirically the relative influence of various combinatons of economic factors on investment, but rather, to study empirically the effect of the investment tax credit on investment. Therefore, to meet this end, the economic factors which are considered to influence investment are accepted for testing at this stage with equal weight and without considering any preconceived structural

interrelationships. However, as a result of the regression analysis, the parameters (i.e., regression coefficients) and their respective standard errors which result could be used to test the value or usefulness of each of the independent variables in the model. Although such additional testing would perhaps be interesting, it is not included within the scope of this study.

Upon modelling investment as described above, the results will show that investment is dependent upon the economic variables considered and some unknown and/or exogenously determined factors (e.g., the investment tax credit). This unknown portion is called the residual. The primary purpose of this step is to determine the portion of investment activity that can not be explained by the economic variables and/or that portion that is influenced by exogenous forces that are not included in the model. This "unexplained" portion of each investment activity observation, or residual series, is the data analyzed in the intervention analysis step.

Intervention Analysis Step:

This step involves the application of a time-series analysis technique on the unexplained portion or residual series from the regression analysis step to determine if the pattern of the residual series after the institution of the investment tax credit in 1962 and after the rate change in

1975 are significantly different from the series before the investment tax credit becomes available and before the rate changes, respectively. If the pattern of the residual series after the intervention is different than before the intervention, the difference is attributed to the impact of the investment tax credit. In essence, this technique is used to "break down" and refine the residual series derived from the regression analysis in order to determine if the investment tax credit contributes to or stimulates investment activity. The time-series experiment, in this case, an interrupted time-series experiment, is an "unplanned experiment" used to evaluate governmental reform. [Glass et al p. 3]. The time-series design offers a unique perspective on the evaluation of intervention effects of the investment tax credit on investment spending. "Interventions into societies ... do not have merely 'an effect' but 'an effect pattern' across time." This technique is valuable in studying the impact of the investment tax credit and of the rate changes in the provisions in the sense that the effects can be observed as being immediate or delayed, increasing or decaying, etc. [Glass et al p. 5].

Contrary to the typical econometric approach in which a researcher postulates and tests a structural model for the generating process (e.g., the process of making investment decisions) on the basis of prior theory, the time-series methodology identifies an appropriate form of the model for

the generating process on the basis of the statistical attributes of the data. In the time-series analysis utilized, there is no need to be concerned explicitly with the structural real-world causal relationships that effect the variable of interest except with respect to the structure of the intervention effect as discussed below. Therefore, no preconceived structural interrelationships between the six economic variables were considered in the multiple regression analysis step. The time-series methodology is used to extract all explainable information from the data such that the observations are transformed into uncorrelated residuals. This procedure allows the data to "speak for themselves" in that the data are used to suggest possible models instead of hypothesizing likely models and then testing them.

A Discussion of the Time-Series Technique Utilized-

The general time-series model adapted for this purpose is based upon the Box-Jenkins [1976] (BJ) technique. This technique recognizes that all time-series have two basic components: the deterministic and stochastic components. The deterministic component describes the systematic behavior of a time-series. Much of the systematic behavior in the investment activity series is accounted for in this study by considering the effects of the six economic variables in the regression analysis. The stochastic portion describes the underlying process of unobserved errors. An explanation of

the relationship between the stochastic portion and the time-series residuals is provided later in this section.

Deterministic parameters do not perfectly predict the values of any particular time-series because a given observation will always deviate from its expected value, even though the process may be systematic on the average. Therefore, the stochastic component is used to capture the unobserved reasons for the unpredictable nature of a time-series.

The stochastic component of a time-series is comprised of two portions: the systematic and unsystematic portions. The systematic portion is responsible for the autocorrelation in the model. The autocorrelation of a time-series is a measure of the relationship of the time-series to itself at various lags. The autocorrelation function is used to determine the structure of the systematic part in the stochastic component. The unsystematic part of the stochastic portion is the only part unaccounted for by the time-series model. However, as a result of appropriately modelling the stochastic component, unbiased estimates of the standard deviation can be calculated and inferences can be drawn from significance tests. That is, serial dependence endogenous to the time-series or interrelationships existing between the observations has been accounted for. As discussed below, the removal of the serial relationships allow inferences to be made about the time-series being observed.

The BJ methodology uses an autoregressive-integrated-moving-average (ARIMA) format to model the stochastic portion. The systematic or structural parameters used to model the stochastic component capture the direct relationship between adjacent observations within a series (the autoregressive parameter), the degree of differencing required to insure stability within a series (the differencing parameter), and the degree to which a time-series is characterized by the persistence of a random shock or unsystematic movement from one observation to the next (the moving-average parameter). Using a minimization of least squares criterion, the methodology fits the data to an autoregressive (AR) model (which characterizes the data as a function of its previous observations), a moving-average (MA) model (which characterizes the data as a function of the previous random shocks), or a combination of these two models. In order to insure stability of the time-series around a given mean, the data are fit either in the original form or in a differenced form. The "I" represents the degree to which the data are differenced. Further explanation of the nature of and the reason for differencing is provided below in the section in which the intervention analysis step is specified mathematically. Additionally, the BJ methodology adjusts for seasonality by forming the model as a multiplicative combination of a seasonal model and an adjacent period model.

In testing the adequacy of the resultant model, the residuals of the time-series model are examined. A model is considered adequate if the residuals (which are estimates of the error component or the unsystematic portion of the stochastic component) are uncorrelated at any lag and are approximately normally distributed with mean zero and variance estimated by residual mean square. That is, the residuals should be independent with respect to their distribution and homoscedastic with respect to the size of their variance. As a point of clarification, the residuals resulting from the time-series models discussed here and the residuals resulting from the multiple regression step are not the same. A residual from the regression represents the deviation of the actual investment activity observation from the estimate of the investment activity based upon the regression equation (and its six economic independent variables). On the other hand, the residuals of a time-series model result upon modelling a time-series using the BJ methodology. The time-series procedures of this step are performed on the residuals from the regression analysis and thereby the residuals from the regression step are refined further. As described above, this refinement involves determining the systematic and the unsystematic portions of the stochastic component of the time-series. In testing the adequacy of the resulting time-series models, the

unsystematic portion, also called the residuals of the time-series model, is examined.

An adaptation of the above BJ technique, called intervention analysis, is utilized in this research. Intervention analysis was introduced by Box and Tiao [1965 and 1975] and is capable of describing a process that involves an intervention, such as the enactment or rate change of the investment tax credit. This adaptation of the general time-series technique is designed to capture any effect pattern, whether it be immediate, delayed, or gradual, which may be associated with an intervention such as the investment tax credit. The technique has been used previously in the social sciences area, and it has also been noted to have been used previously in the accounting and finance literature. [Glass, Tiao, and Maguire, 1971; Box and Tiao, 1975; Deakin, 1976; and Larcker, et al, 1980].

From the tests described above, the issue of whether there is an association between the investment tax credit and investment activity can be resolved. This resolution can be made by satisfactorily modelling the time-series as described above, and testing the significance of the term in the model which captures the effect of the intervention. The appropriate test of significance involves utilizing the Student t statistic. Greater detail of the procedures followed when utilizing this time-series approach is provided later in this chapter.

The procedures which are normally utilized for estimating and testing for a change in mean would not be appropriate in this case. They would be inappropriate because of the serial dependence that normally occurs in the successive observations within a time-series and because of the inability to randomize. Further, with the time-series involved, the regression residuals could be unstable and could indicate strong seasonal effects. Therefore, the time-series technique is selected to test for the effects of the interventions because it is able to account and/or adjust for any dependence, nonstationarity, and seasonal effects in the modelling process. Upon accounting and correcting for these factors, the intervention effects can be estimated and tested with standard techniques which assume independent observations.

Ancillary Test:

The Necessity of an Ancillary Test-

Upon completing the intervention analysis procedure described above, a statement can be made as to whether the investment tax credit impacts upon investment activity. However, the main research questions of whether the investment tax credit has caused an increase in investment activity can not be directly answered because the intervention analysis is not conducted on the investment activity series, itself. Instead, the main analysis is

conducted on a residual series derived from the regression step which represents the investment activity not explained by the economic variables. The determination that an impact exists within the residual series does not by itself provide direct evidence that the impact on investment is positive and that investment activity has increased as a result of the investment tax credit.

However, based upon the investment theory as discussed in Chapter 3, it seems to be clear that an impact is either non-existent or positive. That is, economists have not suggested that any negative impact upon investment could arise from the investment tax credit. Therefore, upon noting any investment tax credit impact from completing the regression and intervention analysis steps it could safely be assumed that the impact represents a positive effect upon investment activity.

Although the above reasoning is well founded, a supplemental or ancillary test is performed to strengthen and support the link between the notion that any impact in the residual series noted would necessarily mean that the impact translates into a positive impact upon investment.

Further, it is stressed that the ancillary test is confirmatory in nature and that the research questions could not be answered with as much confidence by conducting an intervention analysis only upon the three investment activity series, as opposed to conducting an intervention analysis on

the residual series coming from the regression analysis as is done in this study. A positive impact from such intervention analysis would not have as much meaning as it could have because the influences of the deterministic factors (i.e., the six economic variables) have not been removed. This is the point that was made above which is attributed to Pindyck and Rubinfeld [1976]: that the investment activity series can be represented better by first conducting a regression analysis, to explain the part of the variance that can be explained structurally, and then conducting a time-series analysis, to explain the part of the variance that can not be explained structurally. It is because the economic factors which contribute to investment have not been removed when conducting the ancillary test that the test can play only a supplementary and confirmatory role. However, this test strengthens the statement that any noted intervention impact from analyzing the residual series from the regression step is strong evidence that the level of investment activity increased as a result of the presence of or a change in the rate of the investment tax credit.

Description of the Ancillary Test-

A supplementary intervention analysis is performed on the orders of qualified investment, orders of total investment, and orders of nonqualified investment series. These intervention analyses are conducted for both the 1962

and 1975 time periods, using the same calendar quarters as in the earlier tests. Upon being able to conclude that the intervention impact on the raw investment series is positive, the statement can be made that any impact in the residual series noted from conducting the regression and intervention analysis steps described above must mean that the investment tax credit has given rise to an increased level of investment activity.

Although a "positive impact" is expected to be seen in the intervention analyses of the qualified and total investment series, results of "no impact" would not necessarily invalidate the results of the earlier tests. Positive results would clearly provide greater support for the statement that the investment tax credit has had a positive impact upon investment spending than results of no impact. However, if "no impact" were to result, a possible explanation for the finding could be (a) that the intervention analysis technique is not sensitive enough to pick up the impact in this situation because of the presence of the economic variables in the analyses and their influence upon investment activity, or (b) that the economic variables caused an opposite effect in investment, thereby, washing out the observability of the effect of the intervention (i.e., investment may have gone down if it had not been buoyed by the investment tax credit).

Summary:

This section has attempted to explain in a relatively non-technical way some of the pertinent details of the tests performed in this dissertation. The general specification of the models and procedures conducted when considering modification of the raw economic data, in the regression analysis step and the intervention analysis step, and in the Ancillary Test are presented. A more detailed and specific description of the tests performed are presented in the next section.

Mathematical Specification of the Models-

A description of the mathematical specification of the models developed for this study which is based upon the above discussion follows.

The Possible Modification of the Raw Economic Data:

As mentioned above, before the multiple regression analysis procedures are performed, a preliminary analysis is conducted to determine whether significant interaction is present among the independent variables. The economic data analyzed for possible interaction are presented in Appendix B. To test for such interaction, the following analysis is conducted before performing the regression procedure:

1. Firstly, the determination is made whether any significant interaction exists among each of the independent variables and the investment tax credit. The existence of any such interaction is discovered by:

   a. regressing each variable for each quarter in each period tested against its immediately preceding observation and the observation four quarters preceding the current period, and

   b. testing for the homogeneity of the variances of the residuals (determined from this regression) before and after the intervention dates by utilizing the Bartlett-Box F test. This test, which is a widely used procedure to test the homogeneity of variances, involves computing a statistic whose sampling distribution is closely approximated by a chi-squared distribution with (a-1) degrees of freedom when the (a) random samples are from independent normal samples. The sample sizes (i.e., the number of residuals from the regressions before and after the intervention dates) need not be equal for purposes of this test. The mathematical specification of the Bartlett-Box F test is given in Appendix C.

Upon determining that the variances of the residuals from before an intervention date are not homogenous with the variances of the residuals from after an intervention date, it is concluded that the investment tax credit and the independent variable tested do interact.

2. Upon discovering the existence of any interaction among the the independent variables and the investment tax credit, the independent variables are "cleaned." In this procedure, the "cleaned" independent variables which would result would be estimates of the variables' values after removing the increase or decrease in its value attributed to the presence of or increased rate of the investment tax credit. In other words, this modification would produce estimates of the economic variables that could have been observed had the investment tax credit not been present or had the investment tax credit's rate not increased. In the procedure, each variable is regressed against its immediately preceding observation, the observation four quarters preceding the current period, an indicator or dummy variable for each of the two previous observations, a constant, and an indicator or dummy variable for

the constant term. The regression equation takes the form:

$$Xij = B1Xij-1 + B2GXij-1 + B3Xij-4 + B4GXij-4 + d + Gd + Eij$$

where:

Xij = the observation of the economic variables involved in the investment making decision in period j (i.e., output, profits, cash flow, interest rate, capital stock, and capacity utilization).

G = 0 if the investment tax credit is not available (for testing the first intervention) or if the investment tax credit rate is 7 percent (for testing the second intervention).

G = 1 if the investment tax credit is available (for testing the first intervention) or if the investment tax credit rate is 10 percent (for testing the second intervention).

d = parameter

B1,...B4 = regression coefficients

Eij = the residual or error term; the fluctuation of Xij that is not accounted for by the regression equation.

After determining that the variables included to capture the effect of the investment tax credit in the above equation (i.e., the dummy variables) are significant, the "cleaned" independent variables that would be used in the regression step would be computed. The F statistic, whose specification is given in Appendix C, is used to test the

significance of the dummy variables. The significant dummy variables are then utilized to calculate the "cleaned" variable as follow:

"Cleaned Variable" = Xij - B2GXij-1 - B4GXij-4 - Gd

The above adjustment would remove the impact of the interaction of the investment tax credit with each of the independent variables. That is, each variable would be "cleansed" of the effect of the investment tax credit upon it.

In both of the interaction analysis steps described above, each variable's current period observation was specified as being a function of the previous quarter's observation and the fourth preceding quarter's observation. Foster (1977) similarly modelled quarterly earnings, sales, and expenses and Griffin (1977) similarly modelled quarterly earnings, as functions of an adjacent quarter to quarter component and a four-period seasonal component. Their models were then successfully used as one-step ahead predictors for each of the series. From their studies they concluded that there is strong evidence that the series tested rely upon both the adjacent and seasonal components (i.e., j-1 and j-4) and that more accurate forecasts of the series result when both components are used in the models in lieu of using only one of the components.

Based upon the Foster and Griffin work, it is reasonable

to specify each of the economic variables examined in this interaction analysis with an adjacent and seasonal component. Further, upon modelling each of the variables as indicated, each of the components (or independent variables) in the resulting regression equation is examined to determine if they are, indeed, valuable in explaining the fluctuation of the particular economic variable being analyzed. This examination is conducted to provide an additional degree of confidence that such a specification is not inappropriate.

Therefore, the above procedures are conducted to determine if there is a significant level of interaction between each of the economic variables and the investment tax credit. If interaction is found, then additional steps, as described above, are taken to remove such interaction. If significant interaction is not found, then no modification would presumably be necessary.

Multiple Regression Analysis Step:

Following from the diagnostics and possible modification described above, fifty quarterly observations are taken from the time-series of the dependent and independent variables surrounding the January 1, 1962 date and 37 observations are taken from the time-series of the variables surrounding the January 21,1975 date. More specifically, for testing around the 1962 date, data are taken from the 31 quarters preceding the January 1, 1962 date (beginning with the second quarter

of 1954) and data are taken from the 19 quarters following the January 1, 1962 date (ending with the third quarter of 1966). Observations for this series cannot be taken from beyond the third quarter of 1966 because the investment tax credit provisions were suspended as of October 10, 1966. For testing around the January 21, 1975 date, data are taken from the 13 quarters preceding the January 21, 1975 date (beginning with the fourth quarter of 1971) and data are taken from the 24 quarters following the January 21, 1975 date (ending with the fourth quarter of 1980). The range of observations from this series is limited to the period stated above because of changes in the investment tax credit provisions -- the investment tax credit was not available for a period prior to the fourth quarter of 1971 and the provisions were liberalized in 1981, effective for acquisitions made on or after January 1, 1981. These observations of the various dependent and independent variables, subject to the possible modifications described above, are then used in the multiple regression analyses specified below.

$$E_{ij} = Y_{ij} - (B0 + B1X1j + B2X2j + \ldots + B6X6j)$$

where:

$Y1j$ = the amount of qualified investment activity in period j

$Y2j$ = the amount of overall investment activity in period j

Y3j = the amount of nonqualified investment activity in period j

B0,...B6 = regression coefficients

X1j, X2j,..., X6j = the observation of the economic variables involved in the investment making decision in period j (i.e., output, profits, cash flow, the interest rate, capital stock, and capacity utilization); the observations, however, are subject to the possible modification described above for purposes of removing significant interaction between each of the variables and the investment tax credit

Eij = the level of qualified investment activity, overall investment activity or nonqualified investment activity not explained by regression (that is, not explained by the economic variables)

The values of all of the dependent variables and independent variables used in the three regression analyses conducted for each of the two periods (i.e., 1962 and 1975) are presented in Appendix B.

The primary purpose of this step is to determine the portion of investment activity that can not be explained by the economic determinants of investment. This "unexplained" portion of any particular investment activity observation is represented by the term Eij. The Eij's or residual series are obtained by subtracting the estimated values of Yij from its actual values. This step is an intermediate step in this study in the sense that the results from the regression analyses are used as the basis for further analyses in the intervention analysis step.

Intervention Analysis Step:

The regression equation from the first step has an implicit additive error term (Eij) for each calendar quarter included in the regression analysis that accounts for unexplained variance in the regression equation. This Eij residual series created by the regression analysis step is further refined in the intervention analysis step. As a part of this refinement, a time-series model is constructed for the residual series. Upon using the BJ technique, the time-series model would take the following general multiplicative seasonal form.

$$\phi(B)\phi(B^{s})E'ij = \theta(B)\theta(B^{s})Aij$$

where:

B = the backward shift operator on E'ij

E'ij = the residual term differenced to the "dth" degree to achieve stationarity

Aij = the random error with mean zero and variance σ^{2}

$\phi(B) = 1 - \phi 1B - \ldots - \phi pB^{p}$

$\phi(B^{s}) = 1 - \phi sB^{s} - \ldots - \phi psB^{ps}$

$\theta(B) = 1 - \theta 1B - \ldots - \theta qB^{q}$

$\theta(B^{s}) = 1 - \theta sB^{s} - \ldots - \theta qsB^{qs}$

$\phi 1, \ldots \phi p$ = non-seasonal autoregressive parameters

$\phi s, \ldots \phi ps$ = seasonal autoregressive parameters

$\Theta 1, \ldots \Theta q$ = nonseasonal moving-average parameters

$\Theta s, \ldots \Theta qs$ = seasonal moving-average parameters

S = order of seasonal difference

This model is of order (p,d,q) x (P,D,Q)

For purposes of the testing involved in this step, an adaptation of the above general BJ procedures is necessary because the general BJ model does not consider the possibility that an intervention is present in the time-series being examined. The adaptation, which results in a technique called intervention analysis, incorporates a refined version of the above multiplicative seasonal form of the time-series model in order to capture the intervention effect. The refinements that are a part of intervention analysis are designed to capture the additional effect of the intervention over and above the noise element or random movements within the series. An outline of the necessary refinements follow.

From the above BJ equation, $E'ij$ is restated as

$$E'ij = \frac{\Theta(B)\Theta(B^S)}{\Phi(B)\Phi(B^S)} Aij$$

The above quotient $[\frac{\Theta(B)\Theta(B^S)}{\Phi(B)\Phi(B^S)} Aij]$ is sometimes also denoted as Nij. The above unmodified version of the BJ time-series

model implicitly assumes that there is no intervention in the residual series and that upon properly modelling the series, the variance that remains represents random movement or white noise. However, in this research, since an intervention is to be modelled in each residual series, an intervention term must be added to the model. Moreover, since it is known that an intervention is present in the series being modelled, the variance resulting from any such time-series would not likely be characterized as white noise or random movement without properly including an intervention term. This is important to note because as explained above, in testing the adequacy of a modelled time-series, the nature of the unsystematic portion of the series must be random for the model to be considered adequate. Therefore, to account adequately for an intervention effect, the following modification to the definition of $E'ij$ is required.

$$E'ij = Nij + Iij$$

where:

Nij = stochastic background or variation

Iij = wBTij -- the intervention term in which the the shape of the intervention effect is assumed to be sudden and constant over time after the intervention

Interventions in a time-series can have several possible effect patterns on the series. In general, an intervention can be attributed to one of two basic types of reactions: an

intervention can give rise to a long-lasting or permanent shift in the series or the reaction can be only short-lived or temporary. Deakin [1976] suggests that the occurrence of a long-lasting intervention would tend to be a rare event, although substantial shifts in economic policy or in the structure of the market could result in a permanent shift in a series. [Deakin, 1976, p. 593]. The form of the intervention to be tested in this research is that of a long-lasting or permanent shift in the series because the investment tax credit was ostensibly billed by its proponents as causing an upward ratcheting of the level of investment spending.

With the intervention model specified above, the term Tij, which is defined below, is inserted into the model:

```
T1j = 0,  j < January 1, 1962
      1,  j >= January 1, 1962

T2j = 0,  j <= January 21, 1975
      1,  j > January 21, 1975
```

The "T1j" term is inserted into the above model when Ho1 is being tested and the "T2j" term is inserted into the model when Ho2 is being tested. The "Tij" terms are indicator variables which take the values 0 or 1 and which denote, in the case of the 1962 test period, whether the investment tax credit is available or not during any particular period

within the time-series; and in the case of the 1975 test period, whether the increased investment tax credit rate (i.e., 10 percent as opposed to 7 percent) is available or not during any particular period within the time-series.

A type of lag which is not encompassed in the previous discussion also is considered in the research design of this study -- the lag between the effective date of the original investment tax credit provisions or the change in the rate of the investment tax credit and the enactment date of the statutes. In the two time periods included in this research, the effective dates of the statutes were made retroactive from the dates that the statutes became law. This type of lag could cause any impact of the investment tax credit to be delayed a calendar quarter or more from the effective date; that is, any positive impact may not be noticeable until around the time the legislation becomes law. This lag associated with the investment tax credit during the 1962 period was approximately nine and one-half months. The date the legislation became law was October 16, 1962, but the statutes were retroactively effective for purchases made on or after January 1, 1962. A similar lag existed between the effective date and the enactment date of the investment tax credit rate change in 1975. The lag during this period was approximately two months, as the changes in the investment tax credit provisions became law on March 29, 1975 but were made effective for acquisitions made after January 21, 1975.

In the intervention analysis stages of the research design, various plausible lag structures are assumed and tested upon identifying and estimating appropriate time-series models.

In conducting the intervention analysis procedure, the following three phases are conducted: identification, estimation, and diagnostic checking of the time-series model(s). Each of these three phases are briefly discussed below.

The model identification phase consists of two steps. The first step is to identify the degree of differencing required to obtain stationarity in the series. A stationary series is one that has no systematic upward or downward trend. The above time-series models are appropriate only if a series is stationary or if stationarity can be achieved by differencing the adjacent observations in a series. When a series is differenced, the first observation is subtracted from the second, the second from the third, the third from the fourth, and so on. A new series results; a series becomes stationary upon completing the differencing step enough times. The differencing does not change any of the deterministic parameters endogenous to the time-series; it only affects the way they are represented in the model. The degree of differencing necessary is determined by examining the autocorrelation function for the original series and the differenced series (i.e., the new series which results from differencing), assuming the presence of seasonal and

nonseasonal elements within the differenced data. The choice of the appropriate number of times a series is to be differenced is made based on the notion that the series is stationary upon noticing a decay of the autocorrelation function at large lags.

After completing the first step, the choice of the appropriate degree of differencing, the model identification phase is ready for the second step. This step entails specifying the number of autoregressive and moving-average parameters of the model. This is done by examining the autocorrelation and partial autocorrelation functions of the appropriately differenced series. The theoretical foundation and basis for determining the number of autoregressive and moving-average parameters is well defined. [Box and Jenkins, 1970, pp. 174-178]. If a function has p autoregressive terms, then its autocorrelation function will tail off and its partial autocorrelation function will be effectively zero after lag p. If a function has q moving-average terms, then its partial autocorrelation function will tail off and its autocorrelation function will be effectively zero after lag q. A mixed autoregressive and moving-average process is suggested if both the autocorrelations and the partial autocorrelations tail off.

The above discussion briefly describes the first phase, or the identification process, of the time-series procedure. A discussion of the second phase, or estimation, follows.

The value of the parameters identified (i.e., the autoregressive and moving-average terms) in the first phase, are estimated in the second phase. The BJ methodology uses preliminary estimates of the parameters in an interactive program to derive values of the parameters that minimize the sum of the squared deviations of the estimates from the actual values of the time-series. Values of the autoregressive and moving-average terms and confidence intervals are provided in this phase which permit an assessment of their importance or whether they are significantly different from zero. In order for the model to be minimally adequate, the estimates of the parameters must differ significantly from zero.

The third phase of the procedure entails a diagnostic check of the model estimated in the second phase. The primary focus of the phase is to determine if the residuals of the fitted model are independently and randomly distributed around zero. If the residuals of the model are determined to be independently and randomly distributed, then the model is considered adequate. If the testing indicates that the residuals are not random, then the first two phases above are repeated until an adequate model is found.

Two different methods of diagnostic checking suggested by Box and Jenkins [Box and Jenkins, 1970, pp.289-293] are utilized in this study. The first method considers the autocorrelation function of the residuals or unsystematic

portion of the stochastic process being modelled. Box and Jenkins state that in an adequate model, the residuals are normally distributed with a mean of zero and the autocorrelations will be distributed "(n)ormally about zero with variance n^{-1}, and hence, with standard error $n^{-\frac{1}{2}}$." [Box and Jenkins, 1970, p. 290]. Therefore, the residuals are considered to be randomly distributed about zero if each autocorrelation is within two standard deviations of zero (that is, if autocorrelation remains in the residuals of the modelled series).

The second procedure used for testing for randomness in the residual series or the unsystematic portion of each time-series observation calls for an examination of the Box-Pierce Q (BPQ) statistic. This procedure is commonly called the portmanteau lack of fit test. The portmanteau lack of fit test considers the autocorrelation as a group rather than individually, as in the procedure described above, to see if a given number of autocorrelations in a row represent a random series. The BPQ statistic is chi-squared distributed and will be inflated if the residuals are not normally distributed about zero (that is, if autocorrelation remains in the residuals of the modelled series). The mathematical specification of the BPQ statistic is given in Appendix C.

Both of the procedures described above are utilized in deciding whether a given model is adequate for testing this study's hypotheses.

The three phases performed to attain an adequate time-series model, identification, estimation, and diagnostic checking, have been described above. Upon conducting these three phases and an adequate model(s) results, the coefficient of the intervention term is examined for significance. The intervention term is examined to determine if there is any "effect pattern" or association between investment spending and the availability or rate change of the investment tax credit. According to Glass et al., to determine whether the interventions have had an impact, the intervention term is tested for significance by the use of the Student t test. [Glass et al., 1975, pp. 124-125]. If an intervention impact is present in the series, the intervention term should be significantly different from zero. In using this test, it is assumed the correct model form is used and that the time-series model defined is stable. [Larcker et al., 1980, p. 269]. The mathematical specification of the Student t statistic is given in Appendix C.

Upon completing the intervention analysis step as described and noting that the intervention term in the time-series model is significantly different from zero, the conclusion is made that the investment tax credit has impacted upon investment activity and that there is an association between the investment tax credit and investment

activity. On the other hand, upon noting no significance in the intervention term, no such conclusion can be reached.

Ancillary Test:

As discussed above, the two step procedure is used to identify whether an association has existed between the investment tax credit and investment activity. However, upon noting an association, a direct inference can not be made that the level of investment activity has increased because of the investment tax credit. Such a direct inference can not be made because the intervention analysis described above is conducted on several residual series derived from the multiple regression analysis step instead of on investment activity series. Therefore, an ancillary test is conducted on several investment activity series to lend support relating to the direction of any impact noted upon completing the multiple regression and intervention analysis steps.

The mathematical specification and procedures of the ancillary tests are identical to those of the intervention analyses described above. The only difference between the ancillary tests and the intervention analysis step described above is the type or nature of the time-series being analyzed. With the intervention analysis step, a time-series of residuals from the regression analysis is examined; whereas, with the ancillary tests, unaltered time-series of

qualified, total, and nonqualified investment are analyzed. These tests, which are conducted around both the 1962 and 1975, are confirmatory in nature -- confirming the direction of any impact of the investment tax credit noted upon the completion of the intervention analysis step. The sign associated with the intervention term in the ancillary test will confirm the direction of any impact.

Summary:

This chapter has presented the methodology that is used to address the research questions of whether the presence of and/or the change in the rate of the investment tax credit has given rise to an increased level of investment activity over what the level would have been without the investment tax credit's presence or rate change. The methodology described is applied to the data provided in Appendix B for purposes of testing the hypotheses of this dissertation.

The methodology involves two major steps. Firstly, the impact that the major economic variables (as recognized by economic theory) have had on investment is removed by regression analysis from three different time-series of investment. Secondly, the resulting time-series of the regression residuals are modelled and tested by utilizing a technique known as intervention analysis. This two step approach is performed for two time periods, surrounding an

intervention, which, as in this case, is the introduction or change in the investment tax credit provisions. Upon noting a difference in the time-series after the intervention from before the intervention, a statement is made regarding the association of the investment tax credit and investment activity. Additionally, preliminary tests are described which consider the possible need to modify the raw economnic data used in the regression analysis; and an ancillary test is described which is designed to confirm the direction of any association between the investment tax credit and investment activity.

The next chapter presents the results upon conducting the tests which have been described in this chapter.

CHAPTER 5

RESULTS OF TESTS AND INTERPRETATION OF RESULTS

Introduction:

The empirical results obtained from testing the study's two hypotheses as described in the previous chapter are presented in this chapter. This chapter is divided into several sections. Firstly, a broad statement of the major results of the hypothesis testing is offered. The second section presents the results of considering the need to modify or "clean" the raw economic data before conducting the regression and time-series steps. The third section presents the results of the regression step and the fourth section presents the results of the intervention analysis on the residual series. In the fifth section, the results of the ancillary tests in which an intervention analysis was performed on each of the investment orders series are discussed. Lastly, a summary of the results of the tests is presented in the final section of the chapter.

The presentation of the details of the results in this chapter parallels the description of the methodology presented in Chapter 4. The results presented below that relate to the possible modification of the raw economic data and to the regression analyses are obtained by utilizing the appropriate procedures from the "Statistical Package for the Social Sciences" (SPSS). This computer package contains all of the procedures and statistical tests needed to apply the methodology of the preliminary and regression analysis tests to the raw data presented in Appendix B. Therefore, all of the results found in Tables 5.1 through 5.3 are based upon computations performed upon utilizing the appropriate SPSS routines. The results presented that relate to the intervention analyses and the ancillary test as described in the previous chapter are obtained by applying the "McKeown-Hopwood version of the 'Pack' time-series routine" to the data created by the regression analysis step of the methodology. All statistics and information presented in Tables 5.4 through 5.13 are computed by or based upon calculations from the McKeown-Hopwood time-series analysis routine. Additionally, the mathematical specification of the statistics which are a part of the computer packages and which are utilized in the study is presented in Appendix C.

Statement of Overall Results:

A broad overview of the major results of the hypothesis testing of the study is presented in this section. Greater detail of the results will be given in the latter sections of this chapter.

The major finding of the study is that there appears to be an association between the investment tax credit and investment spending. This statement is supported by noting that the investment tax credit has impacted upon the residual series of both qualified investment and total investment in the 1962 intervention period, which is when the investment tax credit was first enacted; and in the 1975 intervention period, which is when the investment tax credit's rate changed. No intervention impact was noted in the control groups of nonqualified investment for either the 1962 or 1975 periods which further supports the above claim that the investment tax credit is the primary source of the positive impact upon investment rather than other factors. Further, based upon the results of the ancillary tests, the association noted between the investment tax credit and qualified and total investment in both periods examined is a positive one. That is, the investment tax credit has led to an increased level of qualified and total investment activity.

Possible Modification of the Raw Economic Data:

This section of the chapter presents the results of the testing performed to determine if significant interaction exists between the investment tax credit and the various independent variables (i.e., economic variables) of the regression equation. As a result of the tests performed, no significant interaction attributable to the investment tax credit was noted and no modification of the economic data was necessary. The raw economic data utilized for purposes of these procedures are provided in Appendix B.

These favorable findings are supported by test results as follows. The Bartlett-Box F test of the homogeneity of the variances of residuals was performed to determine if the variances of the residuals from the regression equations involving the economic variables were different after the investment tax credit intervention than before the intervention. The residuals tested using this procedure resulted from regressions in which each independent variable was regressed upon earlier observations of itself. Upon noting instances where the variances from after the intervention were not homogeneous with those from before the intervention, the difference would, at least initially, be considered to be because of an interaction between the investment tax credit and the independent variable involved.

The results of the Bartlett-Box F test are presented in

Table 5.1 where the test statistic and significance level of the test for each economic variable of both the 1962 and 1975 intervention periods are given. The Bartlett-Box F test, as specified in Appendix C, was performed on residuals from regression analyses computed for each of the economic data series found in Appendix B. As indicated in Chapter 4, a regression analysis was performed on each economic variable for each of the two intervention periods tested (i.e., 12 regression analyses were performed). In each regression analysis, the economic variable was regressed against its observation in the immediately preceding quarter and the observation four quarters preceding the current period. From each of the regressions, the residuals were tested by use of the Bartlett-Box F test to determine if the residuals of after the investment tax credit intervention were different from those of before the intervention. If differences were noted, the conclusion would be made that there is an interaction between the investment tax credit and the variable tested. The information presented in the table relates to the performance of the Bartlett-Box F test on the residuals from the regression analysis on the variable indicated. The numbers in the significance column of the table indicate the chance of obtaining the result that was obtained if the variances of the residuals both before and after the intervention are actually the same. A low number in the significance column (anything below .05 or five

TABLE 5.1

RESULTS OF TESTS OF INTERACTION BETWEEN THE INDEPENDENT VARIABLES AND THE INVESTMENT TAX CREDIT: BARTLETT-BOX F TEST OF VARIANCE HOMOGENEITY

PERIOD	INDEPENDENT VARIABLE	BARTLETT-BOX F TEST STATISTIC	SIGNIFICANCE
1962	Output	17.80694	.000005*
1962	Profits	.40275	.526
1962	Cashflow	2.90496	.089
1962	Interest Rate	7.09915	.008*
1962	Capital Stock	2.24496	.134
1962	Capacity Utilization	18.53766	.00005*
1975	Output	17.91674	.000005*
1975	Profits	.18090	.671
1975	Cashflow	8.07906	.005*
1975	Interest Rate	2.22951	.136
1975	Capital Stock	3.86288	.05*
1975	Capacity Utilization	15.51256	.0004*

* Rejected at the 5 percent level of significance. As such, it can not be concluded that the variance of the residuals after the intervention is equal to the variance of the residuals before the intervention. Therefore, the statement is made that there could be interaction between the independent variable and the investment tax credit.

percent since a significance level of five percent was chosen) indicates that there is a low probability that variances after the intervention are the same as before the intervention. These percentages in the significance column are known as the alpha level or the confidence level.

Since in those cases in which the alpha level is below .05 the presence of interaction between the variable and the investment tax credit is indicated, further investigation of these variables, as discussed below, is required. Therefore, the results suggest that the output, interest rate, and capacity utilization variables of the first intervention period; and output, cashflow, capital stock, and capacity utilization variables of the second intervention period could be interacting with the investment tax credit. Consequently, at this preliminary stage of testing for interaction, since these variables are rejected at the five percent level, it can not be concluded that the variance of the residuals after the intervention is equal to the variance of the residuals before the intervention. As such, there is a possibility that interaction could exist between the investment tax credit and several variables involved in the testing. Therefore, at this stage of the interaction examination, the results of the Bartlett-Box F tests indicate that there may be interaction between the investment tax credit and three economic variables used for testing of the 1962 period and between four economic variables used for testing of the 1975

period. The results obtained from attempting to remove such interaction are described next.

Following from the Bartlett-Box F test of variance homogeneity, a "cleansing" process is applied to the economic variables specified above in which there is a suspicion that a significant level of interaction exists between themselves and the investment tax credit. As discussed in Chapter 4, this "cleansing" process was to remove the interaction existing between the investment tax credit and the independent variable involved. Each of the economic variables which may be interacting with the investment tax credit was regressed against itself of previous periods and dummy variables of previous periods. The dummy variables were intended to capture the interaction effect of these variables and the amounts of the interaction was then to be removed from the economic variable observations. Since in this "cleansing" process the dummy variables (GXj-1, GXj-4, and Gd) were to capture the interaction effect between the investment tax credit and the economic variable being regressed, it is important to test the dummy variables to determine if they actually do provide a significant contribution in explaining the fluctuation of the regressed economic variable. As indicated in Chapter 4 in the section in which the consideration of a possible modification of the data is specified mathematically, any significant interaction captured by the dummy variables is then removed from the

value of each of the economic variables, by subtracting the values of the related dummy variables from the economic variable, itself. A "cleaned" variable is the result of this process. The data on which these procedures were performed are presented in Appendix B; however, since this cleansing process is conducted only on those variables where possible interaction was detected by performing the Bartlett-Box F test in the previous step (i.e., output, interest rate, and capacity utilization of the 1962 period; and output, cashflow, capital stock, and capacity utilization of the 1975 period), only the portion of the data in Appendix B relating to these variables are used.

Table 5.2 presents the results of this effort to cleanse the economic variables by utilizing this procedure on the three economic variables from the 1962 period and on the four economic variables from the 1975 period. The significance of the dummy variables of the first and fourth preceding period and the constant dummy variable from each of the regression equations for the variouis economic variables analyzed are shown. The F statistic, whose specification is shown in Appendix C, is used to test this significance or contribution of the dummy variables in the regression equation. In no cases is an interaction amount, or coefficient of a dummy variable, significant at the five percent level. In other words, the decimals in the significance column of Table 5.2 are all well above the five percent significance level. The

TABLE 5.2

RESULTS OF TESTS OF INTERACTION IMPACT OF CERTAIN INDEPENDENT VARIABLES AND THE INVESTMENT TAX CREDIT: EXAMINATION OF THE SIGNIFICANCE OF DUMMY VARIABLES

PERIOD	INDEPENDENT VARIABLE	F STATISTIC	SIGNIFICANCE
1962	Output		
	GXj-1	.007312	.934
	GXj-4	2.046712	.160
	Gd	.148262	.702
1962	Interest rate		
	GXj-1	.207157	.651
	GXj-4	.241161	.626
	Gd	.094815	.760
1962	Capacity Utilization		
	GXj-1	.495902	.485
	GXj-4	.224467	.638
	Gd	1.067365	.307
1975	Output		
	GXj-1	.349349	.559
	GXj-4	.047985	.828
	Gd	.218184	.644
1975	Cashflow		
	GXj-1	.356005	.555
	GXj-4	.359835	.553
	Gd	.346857	.560
1975	Capital Stock		
	GXj-1	.012782	.911
	GXj-4	1.209171	.280
	Gd	1.233083	.275
1975	Capacity Utilization		
	GXj-1	.535057	.470
	GXj-4	.017024	.897
	Gd	.337478	.565

conclusion from the high numbers would be that the probability is high that the variables that were inserted to capture the interactive impact were unable to detect any interaction between the investment tax credit and the variable tested. Therefore, since no significant interaction was captured by the dummy variables, no modification of the economic data is considered necessary. That is, when attempting to clean the economic variables of an investment tax credit interaction effect, the amount of the interaction effect captured by this test is considered insignificant. Therefore, no modification to the economic data is made prior to its utilization in the regression analysis step which follows.

The results presented in Table 5.2 are contrary to what was expected, particularly in light of the positive results noted in Table 5.1 in the case of economic variables where interaction with the investment tax credit was indicated. Nonetheless, from the second test described above, the statement can not be made that there was a change in the level or slope of the variable over time (i.e., interaction) that can be attributed to the investment tax credit intervention. A possible explanation for the heteroschedasticity noted by the Bartlett-Box F test in several of the economic variables above could be that there are factors other than the investment tax credit that have contributed to such effect. Assuming that this is in fact

the case, these other factors are controlled in the tests which follow by the use of a control group as described in Chapter 4 (i.e., a regression analysis and an intervention analysis are performed on each nonqualified investment series). Since these other factors would be in both the experimental and control groups, any differences noted between the two groups could not be because of the heteroschedasticity of variance.

By not removing any possible interaction, the study is biased towards finding no effect of the investment tax credit within the residual series. The presence of this bias will, therefore, further strengthen the positive results which are noted below.

In conclusion, based upon the tests described above, there appears to be no interaction between anyone or more of the independent variables and the investment tax credit and as a result no cleansing or modification of the independent variables was necessary. Furthermore, any heteroschedasticity of variance that is present in the residual series that is therefore a part of the regression analysis and intervention analysis steps (such as the heteroschedasticity that may be caused by the effects of exogenous forces) is controlled because of the nature of the research design which includes the use of a control group.

Results From the Multiple Regression Analysis Step:

Three multiple regression analyses were performed for each of the two time periods in which the dependent variable was either orders of qualified investment, orders of total investment, or orders of nonqualified investment. In each of the six regressions, the dependent variable was regressed on six economic variables from the same periods as the dependent variable. The six independent variables were output, profits, cash flow, the interest rate, capital stock, and capacity utilization. Each of the variables, where appropriate, had been seasonally adjusted and stated in constant dollars by the governmental agencies supplying the data.

Although the regression step is only an intermediate step in terms of the ultimate question to be addressed, the step is nonetheless critical. The data obtained from the analyses are used for further manipulation in the intervention analysis step. The purpose of the regression analysis step is to produce a time-series of residuals which represents the fluctuation in the investment orders series which has not been explained by the six independent variables. This step is an attempt to remove the portion of the variance of the investment series that may be explained structurally or by deterministic factors.

Table 5.3 presents the residuals resulting from each of

TABLE 5.3

RESIDUALS FROM MULTIPLE REGRESSION EQUATIONS:

QUALIFIED INVESTMENT, TOTAL INVESTMENT, AND

NONQUALIFIED INVESTMENT

1962 AND 1975 PERIODS

	1962 PERIOD			1975 PERIOD		
QTR.	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.
1	-1.29723	-1.38271	-0.08547	1.61409	0.99276	-0.62134
2	-0.34049	-0.42242	-0.08192	0.50264	-0.21092	-0.71356
3	-0.35404	-0.14506	0.20898	0.18297	0.00802	-0.17495
4	0.82386	0.65823	-0.16562	0.55513	0.10389	-0.45124
5	-0.11376	0.07709	0.19086	-0.51041	-0.90941	-0.39900
6	0.32724	0.73639	0.40915	-0.81558	-0.76483	0.05074
7	0.51905	0.61726	0.09820	-0.48091	-0.31380	0.16710
8	-0.11370	0.11307	0.22677	-0.39775	0.44914	0.84690
9	1.08897	0.85309	-0.23587	2.57125	3.12448	0.55323
10	1.38032	1.25002	-0.13029	2.54040	1.88554	-0.65486
11	0.94315	0.31263	-0.63052	-0.45165	-0.45047	0.00117
12	1.01974	1.09291	0.07317	-1.00571	-0.76539	0.24031
13	-0.94463	-0.81407	0.13056	-1.33951	-0.47488	0.86462
14	-1.24043	-1.42368	-0.18325	3.12860	2.02921	-1.09939
15	-1.16861	-0.95972	0.20888	2.01320	4.40707	2.39386
16	0.12251	0.01349	-0.10902	-1.32928	-0.81746	0.51182
17	0.69908	0.58039	-0.11869	-2.69925	-4.57105	-1.87180
18	0.45544	0.68933	0.23388	-3.05869	-1.99512	1.06357
19	-0.42114	-0.62253	-0.20138	-2.32247	-2.71693	-0.39445
20	-0.11948	-0.17928	-0.05979	-0.98283	-0.47950	0.50333
21	-0.80129	-0.80957	-0.00828	-0.30609	-0.46795	-0.16186
22	0.89621	0.86656	-0.02964	-1.92632	-2.70078	-0.77446
23	0.82342	0.94949	0.12606	-1.09915	-0.27336	0.82578
24	-1.78768	-1.93199	-0.14431	-1.16017	-0.74632	0.41384
25	-0.43860	-0.33576	0.10283	-0.27888	-1.09177	-0.81288
26	-0.12738	0.19352	0.32090	-0.21588	1.17188	1.38777
27	0.58666	0.81809	0.23142	0.29913	-0.40967	-0.70881
28	1.24828	1.42134	0.17306	1.23139	1.98394	0.75255
29	0.33797	0.20547	-0.13250	1.37766	1.87127	0.49361
30	0.51479	0.15428	-0.36050	4.26574	4.62867	0.36293
31	-0.58825	-0.72482	-0.13656	0.24343	-0.01649	-0.25993
32	-0.19832	-0.06113	0.13718	-1.11797	-1.98353	-0.86556
33	-0.63467	-0.60933	0.02534	0.13921	0.24748	0.10826

TABLE 5.3 (CONTINUED)

RESIDUALS FROM MULTIPLE REGRESSION EQUATIONS:

QUALIFIED INVESTMENT, TOTAL INVESTMENT, AND

NONQUALIFIED INVESTMENT

1962 AND 1975 PERIODS

	1962 PERIOD			1975 PERIOD		
QTR.	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.
34	-1.15283	-1.18597	-0.03313	-2.50719	-3.10665	-0.59946
35	-0.26347	0.02650	0.28997	1.13948	-0.30707	-1.44656
36	-0.15473	-0.71920	-0.56447	3.04836	3.12082	0.07246
37	-0.47253	-0.43943	0.03310	-0.84698	-0.45075	0.39623
38	-0.39217	-0.83645	-0.44428			
39	-0.57397	0.26066	0.83464			
40	0.32128	0.15370	-0.16757			
41	1.01525	0.69048	-0.32477			
42	-0.07769	-0.15397	-0.07627			
43	0.32841	0.89358	0.56517			
44	-0.42772	-0.42917	-0.00144			
45	-0.51459	-0.43201	0.08258			
46	-0.73766	-0.87304	-0.13537			
47	0.48041	-0.13382	-0.61423			
48	0.75057	0.99849	0.24791			
49	0.55195	0.35755	-0.19440			
50	0.22253	0.64150	0.41896			

In the 1962 period, quarter number 1 was the quarter ended June 30, 1954; quarter number 32, the quarter ended March 31, 1962 included the effective date of the original enactment of the investment tax credit; quarter number 50 was the quarter ended September 30, 1966.

In the 1975 period, quarter number 1 was the quarter ended December 31, 1971; quarter number 14, the quarter ended March 31, 1975 included the effective date of the change in rate of the investment tax credit; quarter number 37 was the quarter ended December 30, 1980.

As indicated on the pages which follow, no conclusive statements are made regarding these residuals. For purposes of this research, these residuals are analyzed in the intervention analysis step which follows.

ADDITIONAL NOTES WHICH ACCOMPANY THIS TABLE ARE PRESENTED BELOW.

TABLE 5.3 (CONTINUED)

RESIDUALS FROM MULTIPLE REGRESSION EQUATIONS:

QUALIFIED INVESTMENT, TOTAL INVESTMENT, AND

NONQUALIFIED INVESTMENT

1962 AND 1975 PERIODS

NOTES TO ACCOMPANY TABLE 5.3

A summary of three vital diagnostic statistics based upon the six multiple regression analyses from which the above regression residuals are derived are given below. The information includes the Student t statistic for each of the economic (independent) variables and the constant term in the regression equations, the R^2 , and the Durbin-Watson test statistic for each of the multiple regression analyses performed for the 1962 period and the 1975 period.

	1962 PERIOD			1975 PERIOD		
	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.
Student t Statistic:						
output	1.487	.870	-1.541	.001	.248	.582
profits	-1.902	-2.041	-.543	-1.744	-1.239	.697
cashflow	1.849	1.721	-.185	1.119	.735	-.590
interest rate	-1.084	-1.666	-1.670	1.713	.874	-1.492
capital stock	-.690	.074	2.011	.261	.100	-.305
capacity utilization	.355	.982	1.732	.578	.337	-.402
constant	-.340	-.983	-1.773	-.675	-.437	.370
R^2:	.950	.950	.254	.914	.898	.299
Durbin-Watson test:	1.269	1.416	2.348	1.228	1.380	2.509

the six regressions performed in the regression analysis step as described in Chapter 4. The regression analyses were performed using the data (i.e., the various investment activity dependent variables and the economic independent variables) that are presented in Appendix B. The three regressions for the first period (i.e., the period which includes the 1962 investment tax credit intervention) each contain a time-series of 50 residuals. The first 31 residuals of each series are computed from the periods before the investment tax credit intervention. The remaining 19 residuals are from the periods after the intervention. The three regressions for the second period (i.e., the period which includes the 1975 investment tax credit intervention) each contain a time-series of 37 residuals. The first 13 residuals of each series are computed from the periods before the investment tax credit intervention. The remaining 24 residuals are from periods after the intervention.

At this point, no conclusive statements can be made regarding the residuals derived from the regression analysis as presented in Table 5.3. Even though some interesting analyses, in addition to the intervention analysis, possibly could be conducted on the residuals, such additional analyses are not within the scope of this study. Moreover, any additional analyses, other than the intervention analysis, may be difficult to make meaningful because of the likely presence of attributes in the residual time-series that are

common to time-series: serial correlation, nonstationarity, and seasonal effects. These factors were discussed in Chapter 4 and are discussed again below.

The residuals presented are useful in this study because they are refined in the intervention analysis step which follows. Conclusions relating to the research questions are not made until the intervention analysis and ancillary test steps have been completed.

Conclusions based upon the regression residuals in Table 5.3 could be misleading if an attempt was made to judge whether an intervention impact is present and no accounting and/or adjustment was made for the attributes common to time-series data (e.g., nonstationarity, serial dependence between the observations, and seasonal effects). As described in Chapter 4, if there was no serial correlation or dependence among the adjacent time-series observations or if there was stationarity and no seasonal effects within the series, the average value of the residual would be zero and inferences could be made based upon the residuals. However, as discussed earlier, since the time-series of residuals derived from the multiple regression analyses likely can be characterized as being serially dependent, nonstationary, and possessive of seasonal effects, and inferences relating to the impact of the investment tax credit can not be made from these residuals. It is because these factors are likely present that even tentative conclusions may be inappropriate

and why the intervention analysis technique is valuable in refining the residuals of these factors in order that inferences may be made.

Again, these time-series are refined by the intervention analyses by accounting and/or adjusting for these attributes common to time-series. As discussed below, because of the strength and sensitivity of the intervention analysis technique, an intervention impact was noted in the residual series presented in Table 5.3. However, a successful defense of this conclusion could not have been reached without conducting the intervention analysis step. As such, the second step of this study is of prime importance in addressing the issue of whether an intervention impact is present because it adjusts for that portion of the "noise" in the series that can be explained by prior observations on the series or by prior disturbances of the series which would tend to mask any intervention impact present.

Therefore, the residuals derived in the regression analysis step are used as the input data for the intervention analysis step, the results of which are described below in the next section of this chapter. The intervention analysis procedure is used to further refine this series of unexplained variance by factoring out other contributing forces (e.g., autoregressive or moving-average relationships) in testing for any impact of the investment tax credit upon investment activity.

Results From the Intervention Analysis Step:

This section of the chapter describes in detail the results of the study which directly interface with the research questions and hypotheses being addressed. Based upon the tests performed as described in detail in Chapter 4, the investment tax credit has had an association with or impact upon the level of investment spending in the United States. The impact of the investment tax credit was noted with respect to both qualified and total investment activity during both the 1962 period and the 1975 period; whereas, a lack of impact was noted with respect to the nonqualified series during each of the interventions periods. A detailed discussion of the results of the tests performed from which the above statements are derived is presented below.

The time-series models of the residuals of qualified, total, and nonqualified investment which resulted from the identification, estimation, and diagnostic checking phases of the intervention analysis step are summarized in Tables 5.4 through 5.9. The time-series models which follow are the ones which were considered to represent adequately the regression residual data from the two periods. As discussed below, to be able to make inferences from a time-series of data, the time-series model produced must be adequate. The time-series procedures entail building models based upon the characteristics of the data, themselves. The characteristics

considered in the model building process include serial dependence, nonstationarity, and seasonal effects. These tables present suitable time-series models obtained from modelling the residuals from the 1962 period and the 1975 period. Three models are shown for each period. The intervention analysis step which produces these models is conducted on each of the regression residual series resulting from the regression analysis step. The residual series on which the intervention analysis is conducted were presented in Table 5.3, above.

Tables 5.4 through 5.6 present the results of the intervention analyses for the 1962 period in which the impact of the original enactment of the investment tax credit on investment activity is examined. Furthermore, as discussed in Chapter 4, the time-series models presented adjust for the lag between the effective date of the statutes which provide for the investment tax credit and the date of the legislative enactment of the statutes. Since in the 1962 period the lag between the dates was approximately nine and one-half months, the assumption was built into each of the models for the 1962 period that there would be no significant effect until the quarter ended December 31, 1962 -- that is, there is a lag of four quarters built into the models from the last pre-intervention observation (i.e., December 31, 1961) to the period for which an impact is expected. This time lag is reasonable because even though the investment tax credit

legislation was effective for qualifying acquisitions made on or after January 1, 1962, the availability of the provisions was not certain until the bill became law in mid October 1962. Therefore, the strongest sudden impact of the provision would not be felt until after the bill was signed into law. As such, any impact would first be included in the investment activity numbers for the period ended December 31, 1962.

To be more confident that the lag as specified above is, in fact, the appropriate lag, various models were run for each of the 1962 residual series where the number of lags in the models were assumed to be either greater than or less than the one considered appropriate (i.e., a lag of four periods). In each case where alternate lags were built into the models, the results of the intervention analyses were not nearly as strong as those discussed below.

The consideration of this effective date - enactment date lag was not necessary in the earlier steps because the steps were not conducted in order that inferences relative to the investment tax credit's impact on investment be made. Since it is not until the intervention analysis step is conducted that the issue of the impact of the investment tax credit can be directly addressed, the notion of the presence of the lag need not be of concern until then.

As will be explained below, the results contained in Tables 5.4 through 5.6 are very similar to each other. The

three sets of models in the tables are all included in this discussion, even though they possess very similar results, to strengthen the conclusions coming from the study. That is, the conclusions from the study are considered stronger since several models point to the same conclusions in contrast to the possibility of being able to present perhaps only one model which supports the conclusions.

Tables 5.7 through 5.9 present the results of the intervention analyses for the 1975 period in which the impact of the change in the rate of the investment tax credit on investment activity is examined. These models also adjust for the lag between the effective date of the statute which provided for the change in the rate of the investment tax credit and the date of the legislative enactment of the statute. Since in the 1975 period, the lag between these two dates was approximately two months, the assumption was built into each of the models for this period that there would be no significant effect until the quarter ended June 30, 1975 -- that is, there is a lag of two quarters built into the models from the last pre-intervention observation (i.e., December 31, 1974) to the period when any impact is expected. This time lag is reasonable because even though the investment tax credit legislation was effective for qualifying assets acquired after January 21, 1975, the availability of the new provision was not certain until the bill became law in late March 1975. Therefore, the strongest

sudden impact would not be felt until after the bill was signed into law and as such, any impact would first be included in the investment activity numbers for the period ended June 30, 1975. As with the intervention analyses for the 1962 period, to be more confident that an appropriate lag is specified in the models, various time-series models were run for each of the 1975 residual series where the number of lags in the models were assumed to be either greater than or less than the one considered appropriate (i.e., a two quarter lag). In each case where alternate lags were built into the models, the results of the intervention analyses were not nearly as strong as those discussed below.

As with the results in Tables 5.4 through 5.6, the results in Tables 5.7 through 5.9 are also very similar to each other. The redundancy of discussing the results from several adequate models where each model gives rise to similar conclusions is conducted to strengthen the results of this study.

As discussed in Chapter 4, the time-series of data on which the intervention analyses are performed and for which the models presented in Tables 5.4 through 5.9 are based, consist of the residuals either from the regression analyses of the 50 quarterly observations from around the 1962 period or from the regression analyses of the 37 quarterly observations from around the 1975 period. These residuals were presented in Table 5.3. The information presented in

the tables which follow results from the conduct of the intervention analysis procedures on the six residual series from the two periods tested. From the information presented in the tables, statements can be made with respect to the association between the investment tax credit and investment spending.

Each of the models presented from which the results are derived is described using the normal Box Jenkins (BJ) (p,d,q) x (P,D,Q) classification scheme. The first three factors in this scheme (i.e., p,d, and q) indicate the order or degree of the nonseasonal autoregressive parameters, differencing parameters, and moving-average parameters, respectively. The last three factors in this scheme (i.e., P,D, and Q) indicate the same for the seasonal parameters. These parameters are used to adjust for the serial dependence, nonstationarity, and seasonality that may be in the regression residual time-series derived from the previous step. These parameters and the nature of their consideration in the time-series models were described in Chapter 4. In each of the tables, the factor names (i.e., p,d,q,P,D, and Q) are replaced by numerical values which indicate the order or degree to which the factors are assumed in the model.

In each table below, the following information is presented: the coefficient and standard error of the intervention term, which are used to provide a measure of whether an impact from the investment tax credit intervention

on the residual series being tested is present; the Student t statistic determination of the significance of the intervention term, which is the measure of whether an investment tax credit impact is present; the Box Pierce Q (BPQ) statistic, which is derived from conducting the portmanteau lack of fit test and which is used to help test the adequacy of the time-series model; the significance of the BPQ statistic, which is a measure of the adequacy of the time-series model being tested; and the number of autocorrelations out of the twelve which are computed that are within two standard deviations of zero, which is another diagnostic test which considers the adequacy of the time-series model. The specification of the Student t statistic, which is used to determine the significance of the intervention term, and the BPQ statistic, which is used to help determine the adequacy of the time-series models, are presented in Appendix C.

In the test of significance of the intervention term, the null hypotheses that is being tested is, "The intervention term is insignificant." In the third line of each table the alpha level or confidence level is given which indicates the chance of incorrectly rejecting the null hypothesis when it is actually true. That is, upon stating that the intervention term is significant or an impact is present in the model being described, the chance that the statement is incorrect is given by the alpha level in the

tables. For example, the alpha level for qualified investment in Table 5.4 is .0343. Therefore, upon concluding that the intervention term is significant (i.e., there is an association between the investment tax credit and qualified investment activity), the chance of rejecting this statement when it actually is true is 3.43 percent. A smaller alpha level is indicative of a higher level of confidence in this test than a larger alpha level. Further, upon establishing an arbitrary cut-off at the 85 percent confidence level for hypothesis testing purposes, the conclusion is reached that the null hypothesis (i.e., The intervention term is insignificant.) is rejected. If the arbitrary cut-off had been set at a higher level, say 90 percent, the conclusions would have been no different from those discussed below except with respect to the model for total investment in the ancillary test for the 1962 period described in Table 5.12 and with respect to the model for qualified investment in the ancillary test for the 1975 period described in Table 5.13. Moreover, upon considering setting the arbitrary cut-off at a lower level, the level would have to be lowered to just below 78 percent in order for any of the conclusions to change from what is given below. If the confidence level was lowered to just under 78 percent (which is unacceptably low for hypothesis testing purposes), the only conclusions which would differ would be those with respect to the model for nonqualified investment for the 1975 period described in

Table 5.7. Therefore, the confidence level was set at 85 percent. Consequently, upon noting that the intervention term is significant or noting that the hypothesis is rejected at the 85 percent level, the conclusion can be made that there is an association between the investment activity series being analyzed and the investment tax credit.

In the test of significance of the BPQ statistic, which is calculated to help determine the adequacy of the resulting time-series model, the null hypothesis that is being tested is, "There is no autocorrelation among the residuals of the time-series noise model being tested." The alpha level is given in the fifth line of the table which, likewise, indicates the chance of incorrectly rejecting the null hypothesis when it is actually true. As such, upon stating that there is autocorrelation among the residuals of the model being described, the chance that the statement is incorrect is given by the alpha level in the tables. For example, the alpha level of the BPQ statistic for the model of qualified investment in Table 5.4 is .4766. If the statement was made that there is autocorrelation or dependence among the residuals of the time-series model when there actually was no autocorrelation among the residuals, the chance of making this incorrect statement would be 47.66 percent. As the alpha level in this test gets larger, the confidence that there is no autocorrelation in the model also gets larger. Further, upon establishing an arbitrary cut-off

at the 97.5 percent confidence level for hypothesis testing purposes, the conclusion is reached that the null hypothesis (i.e., There is no autocorrelation among the residuals of the time-series model being tested.) can not be rejected. Consequently, upon noting that the hypothesis can not be rejected at the 97.5 percent level, the conclusion is made that there is no autocorrelation among the residuals and based upon this test, the time-series model is considered to represent adequately the data.

A point of clarification may be necessary at this point with respect to the alpha level or confidence level of the hypothesis tests of the intervention term and the BPQ statistic. The terms in which the hypotheses are analyzed are "opposite" from each other in the sense that for testing the significance of the intervention term, the confidence in the conclusion grows as the alpha level gets smaller; and for testing the significance of the BPQ statistic, the confidence in the conclusion grows as the alpha level gets larger. This opposite view arises because the conclusions relating to the significance of the intervention terms are stated in terms of "rejecting the null hypothesis;" whereas, the conclusions relating to significance of the BPQ statistic are stated in terms of "failing to reject the null hypothesis." Therefore, for purposes of the arbitrary cut-off of the confidence level, as the cut-off level gets smaller, the confidence that the intervention term is significant becomes less; whereas,

as the cut-off level gets larger, the confidence that there is no autocorrelation in the residuals of the time-series model becomes less.

As mentioned in Chapter 4, the autocorrelation function of each time-series model also is examined to help determine the adequacy of the model. The model is considered to be adequate, based upon this test, if the autocorrelation of the residuals for various lags is generally within two standard deviations of zero. The information provided in the sixth line of the tables which follow indicates the number of autocorrelation functions out of the 12 provided by the McKeown-Hopwood time-series package that are within two standard deviations of zero. Upon noting that at least 11 of the autocorrelations are within two standard deviations of zero, the model, based upon this diagnostic test, is considered adequate.

Consequently, upon determining that a model provides an adequate representation of a time-series, based upon reference to both the significance of the BPQ statistic and the behavior of the autocorrelation function, inferences may be made regarding the characteristics of the data (e.g., whether the investment tax credit has impacted investment).

At this point, the specific details of the time-series models of the regression residuals produced are more fully described. The order of the model presentation for each intervention period both in this discussion and in the tables

is based upon the "goodness" of the models in modelling the residual time-series. That is, the best model for each period is presented first. The determination of the models' "goodness" is based upon the relative strength or significance of the intervention terms, and the positive results of the diagnostic test (i.e., the significance of the BPQ statistic and the frequency of passage of the autocorrelation function of residuals test) indicating the adequacy of the model. It is important to note, however, that even though some of the models below provide better representations of the data than others, they all support the same conclusion: there is an association between the investment tax credit and qualified and total investment spending.

The first model described for the regression residuals of the 1962 intervention period is summarized in Table 5.4. The results from the model in the table are based upon the 50 quarterly regression residuals from the 1962 period presented in Table 5.3. The model takes the form (1 1 0) x (1 0 1) upon utilizing the BJ classification scheme (described above). The intervention term is significant at the .0343 and .0008 levels for qualified investment and total investment, respectively. That is, the chance of the intervention term appearing significant when it is actually insignificant is given by these decimals. Therefore, the hypothesis that the intervention term is insignificant is

TABLE 5.4

RESULTS OF THE INTERVENTION ANALYSIS OF THE RESIDUAL SERIES

INTERVENTION DATE: JANUARY 1962

MODEL: (1 1 0) x (1 0 1)/a

NUMBER OF LAGS: 4/b

	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.
Coefficient of the Intervention Term/c	.77	1.43	.02
Standard Error of the Intervention Term/d	.40	.41	.22
Significance of the Intervention Term/e	.0343/i	.0008/i	.4561/j
Box Pierce Q Statistic/f	8.62	7.45	8.87
Significance of the Box Pierce Q Statistic/g	.4766/k	.5906/k	.4562/k
Frequency of Passage of the Autocorrelation Function of Residuals Test/h	11/12	12/12	11/12

NOTES TO ACCOMPANY THIS TABLE ARE PRESENTED BELOW.

TABLE 5.4 (CONTINUED)

RESULTS OF THE INTERVENTION ANALYSIS OF THE RESIDUAL SERIES

INTERVENTION DATE: JANUARY 1962

MODEL: (1 1 0) x (1 0 1)/a

NUMBER OF LAGS: 4/b

NOTES TO ACCOMPANY TABLE 5.4

This model is based upon conducting the intervention analysis procedure on the 50 regression residuals from the 1962 period (presented in Table 5.3) derived from the multiple regression analysis step. The results shown in this table indicate that this particular model detects an impact of the investment tax credit upon qualified and total investment activity. Furthermore, based upon the diagnostic tests (see f,g,h, and k below), the model appears to represent adequately the regression residual series and the conclusions related to the significance or lack of significance of the intervention terms are supportable.

a The description of the model which is used to produce the data in the table is given using the normal Box-Jenkins classification scheme, (p d q) x (P D Q). This scheme captures and indicates an accounting and/or adjustment for various behavioral characteristics of the time-series data being modelled. The characteristics of concern are the number of seasonal and nonseasonal autoregressive terms included in the model, the degree of seasonal and nonseasonal differencing required to attain stationarity within the time-series, and the number of seasonal and nonseasonal moving-average terms included in the model. The consideration of these factors by the model is necessary in order that inferences may be made regarding the effect of the investment tax credit.

b The number of calendar quarters from the last quarter before the date of the intervention (i.e., January 1, 1962 for this period) that the intervention impact was lagged in the model is given. That is, it was assumed in this model that if any investment tax credit impact was present, it would not be noted until the quarter ended December 31, 1962 because of the lag between the effective date and the enactment date of the legislation.

TABLE 5.4 (CONTINUED)

RESULTS OF THE INTERVENTION ANALYSIS OF THE RESIDUAL SERIES

INTERVENTION DATE: JANUARY 1962

MODEL: (1 1 0) x (1 0 1)/a

NUMBER OF LAGS: 4/b

NOTES TO ACCOMPANY TABLE 5.4

c The coefficient of the intervention term is used to measure the strength of any investment tax credit impact within the particular time-series being tested. This term is utilized, in conjunction with its standard error (see note d below), to make a judgement with respect to the impact of the investment tax credit as noted in the time-series being tested.

d The standard error of the intervention term is a measure of the variability of the intervention term in the time-series model of the data being analyzed. This statistic is used as a part of the Student t statistic to make a judgement regarding the significance of the impact of the investment tax credit as noted in the time-series being tested.

e The intervention term is analyzed by use of the Student t test to determine if a significant investment tax credit impact is present in the time-series being modelled following the intervention date (i.e., January 1, 1962 in this period). If the hypothesis (The intervention term is statistically insignificant.) is rejected, then the results suggest that there is an association between the investment tax credit and the investment activity series being tested. See i and j below.

f The BPQ statistic is a measure of the degree of autocorrelation remaining in the residuals of the time-series model after making adjustments for autoregressive, nonstationarity, and moving-average factors in the time-series input. This statistic is based upon a consideration of the first 12 autocorrelation functions calculated for this model.

TABLE 5.4 (CONTINUED)

RESULTS OF THE INTERVENTION ANALYSIS OF THE RESIDUAL SERIES

INTERVENTION DATE: JANUARY 1962

MODEL: (1 1 0) x (1 0 1)/a

NUMBER OF LAGS: 4/b

NOTES TO ACCOMPANY TABLE 5.4

g The BPQ statistic is tested by reference to the chi-square statistical distribution to determine if a significant degree of autocorreltion or serial dependence exists in the time-series model residual series after modelling the time-series as indicated. If the hypothesis (There is no autocorrelation among the residuals of the time-series model.) can not be rejected, then the results suggest that, based upon this test, the model adequately represents the time-series. See k and l below.

h The first 12 autocorrelations of the residuals of the time-series model are examined to determine if they fall within two standard deviations of zero. If 11 or more of the autocorrelation functions are within two standard deviations of zero, the model, based upon this test, is considered to be adequate for purposes of making inferences regarding the impact of the investment tax credit.

i In testing the significance of the intervention term, the null hypothesis (The intervention term is insignificant.) is rejected at the arbitrarily established 85 percent level; therefore, an association between the investment tax credit and this series of data is believed to exist. Further, the number given is an indication of incorrectly rejecting the hypothesis when it is actually true. Moreover, a smaller number in this regard is indicative of a higher level of confidence in the above conclusion than a larger number.

TABLE 5.4 (CONTINUED)

RESULTS OF THE INTERVENTION ANALYSIS OF THE RESIDUAL SERIES

INTERVENTION DATE: JANUARY 1962

MODEL: (1 1 0) x (1 0 1)/a

NUMBER OF LAGS: 4/b

NOTES TO ACCOMPANY TABLE 5.4

j In testing the significance of the intervention term, the null hypothesis can not be rejected at the arbitrarily established 85 percent level; therefore, this test indicates that no association exists between the investment tax credit and nonqualified investment activity.

k In testing the significance of the BPQ statistic, the null hypothesis (There is no autocorrelation among the residuals of the time-series model.) can not be rejected at the arbitrarily established 97.5 percent level; therefore, this test suggests that no autocorrelation exists in the residuals of the time-series model and that the model is adequate. Further, the number given is an indication of the chance of incorrectly rejecting the hypothesis when it is actually true. Moreover, a higher number in this regard is indicative of a higher level of confidence in the above conclusion than a lower number.

rejected at the arbitrarily established 85 percent level for both qualified investment and total investment. The interpretation of these tests of significance is that since the intervention terms are considered significant, the investment tax credit is believed to have affected both qualified and total investment activity. The intervention term in the nonqualified investment model is considered to be insignificant at the .4561 level. That is, if the statement was made that the intervention term in the model for nonqualified investment activity is significant, then the chance of being incorrect is 45.61 percent. Therefore, since the hypothesis that the intervention term is insignificant can not be rejected at the 85 percent level, the conclusion is reached that there is no association between the investment tax credit and nonqualified investment.

The diagnostic tests (the test of the significance of the BPQ statistic and the test of the frequency of the autocorrelation function lying within two standard deviations of zero) indicate that there is very little, if any autocorrelation or dependence among the residuals of the time-series model. Consequently, with the time-series model being considered adequate, the statements relating to the significance of the intervention terms are supported. This is the case since one of the assumptions of the intervention analysis technique is that in order for the intervention term to have any meaning, the residuals of the time-series model

must be randomly distributed (i.e., the time-series model must adequately represent the data).

More specifically, the significance of the BPQ statistics of .4766, .5906, and .4562 is an indication that if the null hypothesis of no autocorrelation among the residuals of the time-series models is rejected, the chance that this rejection is incorrect is 47.66 percent, 59.06 percent, and 45.62 percent, respectively. Therefore, the test fails to reject the null hypothesis at the arbitrarily established 97.5 percent level for the qualified, total, and nonqualified investment models and based upon this test, the model is considered adequate. Further, the number of times that the autocorrelation of the residuals is within two standard deviations of zero is 11 of 12 for the qualified and nonqualified investment models and 12 of 12 for the total investment model. Therefore, based upon the diagnostic tests, whose results are given above, the time-series model is considered adequate. Consequently, the statements concerning the significance of the intervention terms are considered valid.

The second model described for the regression residuals of the 1962 intervention period is summarized in Table 5.5. The results from the model in the table are based upon the 50 quarterly regression residuals from the 1962 period presented in Table 5.3. The model takes the form (0 1 0) x (1 0 1) based upon the BJ classification scheme (described above).

The intervention term is significant at the .0609 and .0155 levels for qualified investment and total investment, respectively. As is the case of the model discussed above and presented in Table 5.4, the the hypothesis that the intervention term is insignificant is rejected at the 85 percent level for both qualified investment and total investment. Consequently, the interpretation made from these statistics is that the investment tax credit has affected both qualified and total investment activity. The intervention term in the nonqualified investment model is considered to be insignificant at the .7462 level. That is, if the statement was made that the intervention term in the model for nonqualified investment activity is significant, then the chance of being incorrect is 74.62 percent. Therefore, the hypothesis that the intervention term is insignificant can not be rejected at the 85 percent level and the conclusion is made that the investment tax credit has not affected the nonqualified investment activity.

The diagnostic tests indicate that there is very little, if any autocorrelation or dependence among the residuals of the time-series model. As such, with the time-series model being considered adequate, the statements relating to the significance of the intervention terms are supported.

More specifically, the significance of the BPQ statistics of .6515, .5858, and .0152 is an indication that if the null hypothesis of no autocorrelation among the

TABLE 5.5

RESULTS OF THE INTERVENTION ANALYSIS OF THE RESIDUAL SERIES

INTERVENTION DATE: JANUARY 1962

MODEL: (0 1 0) x (1 0 1)/a

NUMBER OF LAGS: 4/b

	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.
Coefficient of the Intervention Term/c	.71	1.16	-.21
Standard Error of the Intervention Term/d	.44	.50	.32
Significance of the Intervention Term/e	.0609/i	.0155/i	.7462/j
Box Pierce Q Statistic/f	7.76	8.44	22.25
Significance of the Box Pierce Q Statistic/g	.6515/k	.5858/k	.0152/l
Frequency of Passage of the Autocorrelation Function of Residuals Test/h	12/12	11/12	11/12

NOTES TO ACCOMPANY THIS TABLE ARE PRESENTED BELOW.

TABLE 5.5 (CONTINUED)

RESULTS OF THE INTERVENTION ANALYSIS OF THE RESIDUAL SERIES

INTERVENTION DATE: JANUARY 1962

MODEL: (0 1 0) x (1 0 1)/a

NUMBER OF LAGS: 4/b

NOTES TO ACCOMPANY TABLE 5.5

This model is based upon conducting the intervention analysis procedure on the 50 regression residuals from the 1962 period (presented in Table 5.3) derived from the multiple regression analysis step. The results shown in this table indicate that this particular model detects an impact of the investment tax credit upon qualified and total investment activity. Furthermore, based upon the diagnostic tests (see f,g,h,k, and l above), the model appears to represent adequately the regression residual series and the conclusions related to the significance or lack of significance of the intervention terms are supportable.

FOR EXPLANATION OF NOTES ABOVE, a THROUGH k, SEE THE NOTES WHICH ACCOMPANY TABLE 5.4.

l In testing the the significance of the BPQ statistic, the null hypothesis is rejected at the arbitrarily established 97.5 percent level; therefore, this test indicates that there may be autocorrelation among the residuals of the time-series model suggesting that this model may not adequately represent the time-series. However, this model is considered adequate because of the strong positive results from the frequency of passage of the autocorrelation function of residuals test (see h).

residuals of the time-series models is rejected, the chance that this rejection is incorrect is 65.15 percent, 58.58 percent, and 1.52 percent, respectively. Therefore, the test fails to reject the null hypothesis at the 97.5 percent level for the qualified and total investment model; however, the null is rejected at the 97.5 percent level for the nonqualified investment model. Further, the number of times that the autocorrelation of the residuals is within two standard deviations of zero is 12 of 12 for the qualified investment model and 11 of 12 for the total and nonqualified investment models. Therefore, based upon the results from both of the diagnostic tests, the time-series model is considered adequate. Consequently, the statements concerning the significance of the intervention terms are considered valid.

The third model described for the regression residuals of the 1962 intervention period is summarized in Table 5.6. The results from the model in the table are based upon the 50 quarterly regression residuals from the 1962 period presented in Table 5.3. The model takes the form (1 1 0) x (0 0 1) based upon the BJ classification scheme (described above). The intervention term is significant at the .0824 and .0826 levels for qualified investment and total investment, respectively. Therefore, since the hypothesis that the intervention term is insignificant is rejected at the 85 percent level for both the qualified investment and total

TABLE 5.6

RESULTS OF THE INTERVENTION ANALYSIS OF THE RESIDUAL SERIES

INTERVENTION DATE: JANUARY 1962

MODEL: (1 1 0) x (0 0 1)/a

NUMBER OF LAGS: 4/b

	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.
Coefficient of the Intervention Term/c	.69	.83	.03
Standard Error of the Intervention Term/d	.48	.58	.22
Significance of the Intervention Term/e	.0824/i	.0826/i	.4349/j
Box Pierce Q Statistic/f	10.13	10.90	8.31
Significance of the Box Pierce Q Statistic/g	.4382/k	.3783/k	.5987/k
Frequency of Passage of the Autocorrelation Function of Residuals Test/h	12/12	12/12	11/12

This model is based upon conducting the intervention analysis procedure on the 50 regression residuals from the 1962 period (presented in Table 5.3) derived from the multiple regression analysis step. The results shown in this table indicate that this particular model detects an impact of the investment tax credit upon qualified and total investment activity. Furthermore, based upon the diagnostic tests (see f,g,h, and k above), the model appears to represent adequately the regression residual series and the conclusions related to the significance or lack of significance of the intervention terms are supportable.

SEE ADDITIONAL EXPLANATORY NOTES WHICH ACCOMPANY TABLE 5.4 FOR EXPLANATION OF SYMBOLS a THROUGH k ABOVE.

investment models, the interpretation of these tests of significance is that investment tax credit is believed to have affected qualified and total investment activity. However, the intervention term in the nonqualified investment model is considered to be insignificant at the .4349 level. Therefore, as in the models for nonqualified investment described above, the conclusion is reached that the intervention term in the model of the control group is insignificant at the 85 percent confidence level and that there is no association between the investment tax credit and nonqualified investment.

The diagnostic tests indicate that there is very little, if any autocorrelation or dependence among the residuals of the time-series model. The level of the BPQ statistics for each of the models suggests that there is no autocorrelation in the time-series models as the null hypothesis in each case can not be rejected at the 97.5 percent level of confidence. Further, the number of times that the autocorrelation of the residuals is within two standard deviations of zero is 12 of 12 for the qualified and total investment models and 11 of 12 for the nonqualified investment model. Therefore, since the time-series model is considered adequate, the statements relating to the significance of the intervention terms are supported.

To summarize the results disclosed in Tables 5.4 through 5.6 which present the time-series models of the regression

residuals for the 1962 period, there appears to be an association between the investment tax credit and qualified and total investment activity; whereas, no such association was found to exist with the nonqualified investment activity series. Further, because a lag of four quarters was built into the models which accounts for the passage of time between the effective and enactment dates of the investment tax credit legislation and because an impact was noted by the models which possessed this factor, it is concluded that the impact noted in the qualified and total investment series was first detected in the calendar quarter following the date on which the investment tax credit legislation became law. Recall that as described in Chapter 4 and earlier in this chapter, models with other lags were tested, but they were rejected because they were not considered to have appropriately modelled the data. Therefore, the assumption built into these models because of the lag factor's presence is that no impact is expected until the fourth quarter after the last pre-intervention quarter. Additionally, there is no evidence of a shift in investment activity away from those assets that do not qualify for the credit to those assets that do qualify for the credit since the intervention terms in the nonqualified investment series' models were insignificant. These results are based upon models produced by performing the intervention analysis procedure on three time-series of regression residuals from the 1962 period.

These conclusions are strengthened by noting that all three sets of models presented in the tables discussed above produce very similar results. The detailed results from the similar testing of the 1975 period follow.

The first model described for the regression residuals of the 1975 intervention period is summarized in Table 5.7. The results from the model in the table are based upon the 37 quarterly regression residuals from the 1975 period presented in Table 5.3. The model takes the form (0 1 1) x (0 0 1) based upon the BJ classification scheme (described above). The intervention term is significant at the .0332 and .0055 levels for qualified investment and total investment, respectively. Therefore, the hypothesis that the intervention term is insignificant is rejected at the 85 percent level for both qualified investment and total investment. The interpretation of these tests of significance is that since the intervention terms are considered significant, the investment tax credit is believed to have affected qualified and total investment activity -- that is, the increase in the rate of the investment tax credit affected the level of qualified and total investment activity. The intervention term in the nonqualified investment model is considered to be insignificant at the .2200 level. That is, if the statement was made that the intervention term in the model for nonqualified investment activity is significant, then the chance of being incorrect

TABLE 5.7

RESULTS OF THE INTERVENTION ANALYSIS OF THE RESIDUAL SERIES

INTERVENTION DATE: JANUARY 1975

MODEL: (0 1 1) x (0 0 1)/a

NUMBER OF LAGS: 2/m

	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.
Coefficient of the Intervention Term/c	1.52	1.27	.71
Standard Error of the Intervention Term/d	.79	.47	.90
Significance of the Intervention Term/n	.0332/i	.0055/i	.2200/j
Box Pierce Q Statistic/f	14.42	8.58	19.38
Significance of the Box Pierce Q Statistic/g	.1680/k	.5724/k	.0375/k
Frequency of Passage of the Autocorrelation Function of Residuals Test/h	12/12	12/12	11/12

NOTES TO ACCOMPANY THIS TABLE ARE PRESENTED BELOW

TABLE 5.7 (CONTINUED)

RESULTS OF THE INTERVENTION ANALYSIS OF THE RESIDUAL SERIES

INTERVENTION DATE: JANUARY 1975

MODEL: (0 1 1) x (0 0 1)/a

NUMBER OF LAGS: 2/m

NOTES TO ACCOMPANY TABLE 5.7

This model is based upon conducting the intervention analysis procedure on the 37 regression residuals from the 1975 period (presented in Table 5.3) derived from the multiple regression analysis step. The results shown in this table indicate that this particular model detects an impact of the investment tax credit upon qualified and total investment activity. Furthermore, based upon the diagnostic tests (see f,g,h, and k above), the model appears to represent adequately the regression residual series and the conclusions related to the significance or lack of significance of the intervention terms are supportable.

SEE TABLE 5.4 FOR EXPLANATION OF THE FOLLOWING NOTES ABOVE: a, c, d, f, g, h, i, j, and k.

m The number of calendar quarters from the last quarter before the date of the intervention (i.e., January 21, 1975 for this period) that the intervention impact was lagged for the model is given. That is, it was assumed in this model that if any investment tax credit impact was present, it would not be noted until the quarter ended June 30, 1975 because of the lag between the effective date and the enactment date of the legislation.

n The intervention term is tested by using the Student t statistic to determine if a significant investment tax credit impact is present in the time-series being modelled following the intervention date (i.e., January 21, 1975 in this period). If the hypothesis (The intervention term is statistically insignificant.) is rejected, then the results suggest that there is an association between the investment tax credit and the investment activity series being tested. (See i and j above.)

is 22.00 percent. Therefore, since the hypothesis can not be rejected at the 85 percent level, the conclusion is reached that the intervention term is insignificant and that there is no association between the investment tax credit and nonqualified investment.

The diagnostic tests indicate that there is very little, if any autocorrelation or dependence among the residuals of the time-series model. In each case, the null hypothesis relating to the significance of the BPQ statistic can not be rejected at the 97.5 percent level of confidence, and the frequency of the autocorrelation function falling within two standard deviations is within acceptable bounds (i.e., 11 or more). Therefore, no autocorrelation is considered to be present among the residuals of the time-series models. As a result, with the time-series models being considered adequate, the statements relating to the significance of the intervention terms are supported.

The second model described for the regression residuals of the 1975 intervention period is summarized in Table 5.8. The results from the model in the table are based upon the 37 quarterly regression residuals from the 1975 period presented in Table 5.3. The model takes the form (0 1 0) x (0 0 1) based upon the BJ classification scheme (described above). The intervention term is significant at the .0644 and .0249 levels for qualified investment and total investment, respectively. Further, the hypothesis that the intervention

TABLE 5.8

RESULTS OF THE INTERVENTION ANALYSIS OF THE RESIDUAL SERIES

INTERVENTION DATE: JANUARY 1975

MODEL: (0 1 0) x (0 0 1)/a

NUMBER OF LAGS: 2/m

	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.
Coefficient of the Intervention Term/c	1.69	2.43	-.27
Standard Error of the Intervention Term/d	1.07	1.19	.56
Significance of the Intervention Term/n	.0644/i	.0249/i	.6813/j
Box Pierce Q Statistic/f	11.45	8.51	9.64
Significance of the Box Pierce Q Statistic/g	.4168/k	.6651/k	.5628/k
Frequency of Passage of the Autocorrelation Function of Residuals Test/h	11/12	12/12	12/12

This model is based upon conducting the intervention analysis procedure on the 37 regression residuals from the 1975 period (presented in Table 5.3) derived from the multiple regression analysis step. The results shown in this table indicate that this particular model detects an impact of the investment tax credit upon qualified and total investment activity. Furthermore, based upon the diagnostic tests (see f,g,h, and k above), the model appears to represent adequately the regression residual series and the conclusions related to the significance or lack of significance of the intervention terms are supportable.

SEE EXPLANATORY NOTES WHICH ACCOMPANY TABLES 5.4 AND 5.7.

term is insignificant is rejected at the 85 percent level for both qualified investment and total investment. Therefore, the investment tax credit is believed to have affected qualified and total investment activity upon the investment tax credit's rate increase. The intervention term in the nonqualified investment model is considered to be insignificant at the .6813 level. Therefore, since the intervention term is insignificant at the 85 percent level of confidence, there is considered to be no association between the investment tax credit and nonqualified investment in this case.

The diagnostic tests indicate that there is very little, if any autocorrelation or dependence among the residuals of the time-series models. In each case, the null hypothesis relating to the significance of the BPQ statistic can not be rejected at the 97.5 percent level of confidence, and the frequency of the autocorrelation function falling within two standard deviations is within acceptable bounds. Therefore, no autocorrelation is considered to be present among the residuals of the time-series models. As a result, with the time-series model being considered adequate, the statements relating to the significance of the intervention terms are supported.

The last model described for the regression residuals of the 1975 intervention period is summarized in Table 5.9. The results from the model in the table are based upon the 37

TABLE 5.9

RESULTS OF THE INTERVENTION ANALYSIS OF THE RESIDUAL SERIES

INTERVENTION DATE: JANUARY 1975

MODEL: (0 1 1) x (0 0 0)/a

NUMBER OF LAGS: 2/m

	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.
Coefficient of the Intervention Term/c	1.17	1.21	-.29
Standard Error of the Intervention Term/d	.81	.73	.56
Significance of the Intervention Term/n	.0829/i	.0558/i	.6968/j
Box Pierce Q Statistic/f	13.27	13.33	11.92
Significance of the Box Pierce Q Statistic/g	.2817/k	.2773/k	.3821/k
Frequency of Passage of the Autocorrelation Function of Residuals Test/h	12/12	12/12	12/12

This model is based upon conducting the intervention analysis procedure on the 37 regression residuals from the 1975 period (presented in Table 5.3) derived from the multiple regression analysis step. The results shown in this table indicate that this particular model detects an impact of the investment tax credit upon qualified and total investment activity. Furthermore, based upon the diagnostic tests (see f,g,h, and k above), the model appears to represent adequately the regression residual series and the conclusions related to the significance or lack of significance of the intervention terms are supportable.

SEE EXPLANATORY NOTES WHICH ACCOMPANY TABLES 5.4 AND 5.7.

quarterly regression residuals from the 1975 period presented in Table 5.3. The model takes the form (0 1 1) x (0 0 0) based upon the BJ classification scheme (described above). The intervention term is significant at the .0829 and .0558 levels for qualified investment and total investment, respectively. Consequently, the hypothesis that the intervention term is insignificant is rejected at the 85 percent level for both the qualified investment and total investment models. Therefore, since the intervention terms are considered significant, the investment tax credit is believed to have affected qualified and total investment activity upon the investment tax credit's rate increase. The intervention term in the nonqualified investment model is considered to be insignificant at the .6968 level. As such, the hypothesis regarding the significance of the intervention term can not be rejected at the 85 percent level and the conclusion is reached that the intervention term is insignificant and that there is no association between the investment tax credit and nonqualified investment.

The diagnostic tests indicate that there is very little, if any autocorrelation or dependence among the residuals of the time-series models. In each case, the null hypothesis relating to the significance of the BPQ statistic can not be rejected at the 97.5 percent level of confidence, and the frequency of the autocorrelation function falling within two standard deviations is within acceptable bounds. Therefore,

no autocorrelation is considered to be present among the residuals of the time-series models. As a result, with the time-series model being considered adequate, the statements relating to the significance of the intervention terms are supported.

To summarize the results disclosed in Tables 5.7 through 5.9 which present the time-series models of the three series of 37 regression residuals each for the 1975 period, there appears to be an association between the investment tax credit and qualified and total investment activity; whereas, no such association was found to exist with the nonqualified investment activity series. Further, because of the lag built into the models (i.e., a lag of two quarters of the 1975 year was assumed), the impact noted in the qualified and total investment series was first detected in the calendar quarter following the date on which the investment tax credit legislation became law. Additionally, there is no evidence of a shift in investment activity away from those assets that do not qualify for the credit to those assets that do qualify for the credit since the intervention terms in the nonqualified investment series' models were insignificant. These results are based upon models produced by performing the intervention analysis procedure on the three 37 element time-series of regression residuals from the 1975 period. These conclusions are strengthened by noting that all three sets of models presented in the tables produce very similar results.

This section of the chapter has described the results of the intervention analyses on the residual series. Three basic, well specified models for each intervention period resulted from the analyses. In each situation, the intervention term of the qualified investment and total investment residual series was significant, at least at the 85 percent level, while the intervention term of the control group or the nonqualified investment residual series was insignificant. From these test results, the conclusion is reached that the investment tax credit has impacted upon qualified and total investment activity (but not nonqualified investment activity) and that the impact was first noted in the calendar quarters following the date that the investment tax credit legislation became law. Further, there was no evidence that there was a shift in investment activity away from nonqualified investment activity to qualified investment activity.

The next section describes the ancillary or supplemental tests performed on the investment orders series for the two intervention periods. An intervention analysis was performed on these series assuming the same lag structure (i.e., the four calendar quarters of the 1962 year for the 1962 intervention period and the first two calendar quarters of the 1975 year for the 1975 intervention period) as above.

Results From Ancillary Test:

This section describes the results of the ancillary tests performed on the qualified, total, and nonqualified investment orders series for the two intervention periods. The analyses for the 1962 period are based upon the 50 elements of the three investment orders series from that period and the analyses for the 1975 period are based upon the 37 elements of the three investment orders series from that period. This series of intervention analyses was performed in order to confirm that the impact detected on the regression residuals discussed in the previous section was reflective of a positive impact upon investment activity. The three investment orders series modelled by the ancillary tests are given in Appendix B (columns 1 - 3).

The results of the intervention analyses on the six orders series are summarized in Tables 5.10 through 5.13. Tables 5.10 through 5.12 present the models which represent adequately the data for the 1962 period; whereas, Table 5.13 presents a model which represents adequately the data for the 1975 period. Each table includes the same type of information that was presented for the models of the residual series above: the coefficient and standard error of the intervention term, the significance of the intervention term, the BPQ statistic, the significance of the BPQ statistic, and a test of the autocorrelation function of the residuals. The

statistics used in determining the information presented in these tables are given in Appendix C. The number of calendar quarter lags between the investment tax credit legislation effective date and the date the provisions became law is the same for this series of ancillary tests as for the intervention analyses on the residual series. As such, there is a lag of four calendar quarters following the 1962 intervention and a lag of two calendar quarters following the 1975 intervention.

The first model described for the investment orders of the 1962 intervention period is summarized in Table 5.10. The results from the model in the table are based upon the 50 quarterly observations of the investment orders series from the 1962 period presented in Table 5.3. The model takes the form (2 2 1) x (0 0 0) based upon the BJ classification scheme (described above). The intervention term is significant at the .0588 and .0883 levels for qualified investment and total investment, respectively. Consequently, the hypothesis that the intervention term is insignificant is rejected at the 85 percent level for both the qualified investment and total investment series. Therefore, since the intervention terms are positive and considered significant, the investment tax credit is believed to have increased qualified and total investment activity. The intervention term in the nonqualified investment model is considered to be insignificant at the .5171 level; therefore, the null

TABLE 5.10

RESULTS OF THE INTERVENTION ANALYSIS OF THE

INVESTMENT ORDERS SERIES

INTERVENTION DATE: JANUARY 1962

MODEL: (2 2 1) x (0 0 0)/a

NUMBER OF LAGS: 4/b

	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.
Coefficient of the Intervention Term/c	.65	.58	-.01
Standard Error of the Intervention Term/d	.40	.42	.23
Significance of the Intervention Term/e	.0588/i	.0883/i	.5171/j
Box Pierce Q Statistic/f	6.86	3.02	9.55
Significance of the Box Pierce Q Statistic/g	.6516/k	.9673/k	.4008/k
Frequency of Passage of the Autocorrelation Function of Residuals Test/h	12/12	12/12	11/12

This model is based upon conducting the intervention analysis procedure on the 50 elements of the investment orders series from the 1962 period presented in Appendix B (columns 1-3). The results shown in this table indicate that this particular model detects an impact of the investment tax credit upon the qualified and total investment orders series and no impact upon the nonqualified investment orders series. Furthermore, based upon the diagnostic tests (See f,g,h, and k above), the model appears to represent adequately the investment orders series and the conclusions related to the significance or lack of significance of the intervention terms are supportable.

SEE ADDITIONAL EXPLANATORY NOTES WHICH ACCOMPANY TABLE 5.4.

hypothesis relating to its significance can not be rejected at the 85 percent level of confidence. Consequently, the conclusion is reached that the intervention term is insignificant and that there is no association between the investment tax credit and nonqualified investment.

The diagnostic tests indicate that there is very little, if any autocorrelation or dependence among the residuals of the time-series model. In each case, the null hypothesis relating to the significance of the BPQ statistic can not be rejected at the 97.5 percent level of confidence, and the frequency of the autocorrelation function falling within two standard deviations is within acceptable bounds (i.e., 11 or more). Therefore, no autocorrelation is considered to be present among the residuals of the time-series models. As a result, with the time-series model being considered adequate, the statements relating to the significance of the intervention terms is supported further.

The second model described for the investment orders of the 1962 intervention period is summarized in Table 5.11. The results from the model in the table are based upon the 50 quarterly observations of the investment orders series from the 1962 period presented in Table 5.3. The model takes the form (2 2 0) x (0 0 0) based upon the BJ classification scheme (described above). The intervention term is significant at the .0741 and .0973 levels for qualified investment and total investment, respectively. Consequently,

TABLE 5.11

RESULTS OF THE INTERVENTION ANALYSIS OF THE INVESTMENT ORDERS SERIES

INTERVENTION DATE: JANUARY 1962

MODEL: (2 2 0) x (0 0 0)/a

NUMBER OF LAGS: 4/b

	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.
Coefficient of the Intervention Term/c	.63	.57	-.01
Standard Error of the Intervention Term/d	.42	.42	.28
Significance of the Intervention Term/e	.0741/i	.0973/i	.5142/j
Box Pierce Q Statistic/f	7.48	3.16	10.33
Significance of the Box Pierce Q Statistic/g	.6788/k	.9778/k	.4229/k
Frequency of Passage of the Autocorrelation Function of Residuals Test/h	12/12	12/12	11/12

This model is based upon conducting the intervention analysis procedure on the 50 elements of the investment orders series from the 1962 period presented in Appendix B (columns 1-3). The results shown in this table indicate that this particular model detects an impact of the investment tax credit upon the qualified and total investment orders series and no impact upon the nonqualified investment orders series. Furthermore, based upon the diagnostic tests (See f,g,h, and k above), the model appears to represent adequately the investment orders series and the conclusions related to the significance or lack of significance of the intervention terms are supportable.

SEE EXPLANATORY NOTES WHICH ACCOMPANY TABLE 5.4.

the hypothesis that the intervention term is insignificant is rejected at the 85 percent level for both the qualified investment and total investment series. Therefore, since the intervention terms are positive and considered significant, the investment tax credit is believed to have increased qualified and total investment activity. The intervention term in the nonqualified investment model is considered to be insignificant at the .5142 level. Therefore, since the null hypothesis relating to the significance of the intervention term can not be rejected at the 85 percent level of confidence, the conclusion is reached that the intervention term is insignificant and that there is no association between the investment tax credit and nonqualified investment.

The diagnostic tests indicate that there is very little, if any autocorrelation or dependence among the residuals of the time-series models. In each case, the null hypothesis relating to the significance of the BPQ statistic can not be rejected at the 97.5 percent level of confidence, and the frequency of the autocorrelation function falling within two standard deviations is within acceptable bounds. Therefore, no autocorrelation is considered to be present among the residuals of the time-series models. As a result, with the time-series model being adequate, the statements relating to the significance of the intervention terms are supported.

The last model described for the investment orders of

the 1962 intervention period is summarized in Table 5.12. The results from the model in the table are based upon the 50 quarterly observations of the investment orders series from the 1962 period presented in Table 5.3. The model takes the form (0 2 2) x (0 0 0) based upon the BJ classification scheme (described above). The intervention term is significant at the .0826 and .1422 levels for qualified investment and total investment, respectively. Therefore, the hypothesis that the intervention term is insignificant is rejected at the 85 percent level for both qualified investment and total investment. Therefore, the investment tax credit is believed to have increased qualified and total investment activity. The intervention term in the nonqualified investment model is considered to be insignificant at the .8126 level. That is, the null hypothesis relating to the intervention term can not be rejected at the 85 percent level of confidence. Therefore, the conclusion is reached that the intervention term is insignificant and that there is no association between the investment tax credit and nonqualified investment.

The diagnostic tests indicate that there is very little, if any autocorrelation or dependence among the residuals of the time-series models. In each case, the null hypothesis relating to the significance of the BPQ statistic can not be rejected at the 97.5 percent level of confidence, and the

TABLE 5.12

RESULTS OF THE INTERVENTION ANALYSIS OF THE INVESTMENT ORDERS SERIES

INTERVENTION DATE: JANUARY 1962

MODEL: (0 2 2) x (0 0 0)/a

NUMBER OF LAGS: 4/b

	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.
Coefficient of the Intervention Term/c	.63	.51	-.09
Standard Error of the Intervention Term/d	.44	.46	.10
Significance of the Intervention Term/e	.0826/i	.1422/i	.8126/j
Box Pierce Q Statistic/f	10.61	6.46	4.56
Significance of the Box Pierce Q Statistic/g	.4011/k	.7725/k	.9167/k
Frequency of Passage of the Autocorrelation Function of Residuals Test/h	11/12	12/12	12/12

This model is based upon conducting the intervention analysis procedure on the 50 elements of the investment orders series from the 1962 period presented in Appendix B (columns 1-3). The results shown in this table indicate that this particular model detects an impact of the investment tax credit upon the qualified and total investment orders series and no impact upon the nonqualified investment orders series. Furthermore, based upon the diagnostic tests (See f,g,h, and k above), the model appears to represent adequately the investment orders series and the conclusions related to the significance or lack of significance of the intervention terms are supportable.

SEE EXPLANATORY NOTES WHICH ACCOMPANY TABLE 5.4.

frequency of the autocorrelation function falling within two standard deviations is within acceptable bounds. Therefore, no autocorrelation is considered to be present among the residuals of the time-series models. As a result, with the time-series model being considered adequate, the statements relating to the significance of the intervention terms are supported.

To summarize the results disclosed in Tables 5.10 through 5.12 which presented the time-series models of the investment orders series for the 1962 period, it appears that the original enactment of the investment tax credit has led to an increased level of qualified and total investment activity; whereas, no such increase was detected with the nonqualified investment activity series. The impact noted was first detected in the calendar quarter following the date on which the investment tax credit legislation became law. Additionally, there is no evidence of a shift in investment activity away from those assets that do not qualify for the credit to those assets that do qualify for the credit since the intervention terms in the nonqualified investment series' models were insignificant. These results are based upon models produced by performing the intervention analysis procedure on three time-series of investment orders from the 1962 period given in Appendix B. These conclusions are strengthened by noting that all three sets of models presented in the tables produce very similar results. The

detailed results from the similar testing of the 1975 period follow.

The one model described for the investment orders of the 1975 intervention period is summarized in Table 5.13. The results from the model in the table are based upon the 37 quarterly observations of the investment orders series from the 1975 period presented in Table 5.3. The model takes the form (2 2 0) x (0 2 0) based upon the BJ classification scheme (described above). The intervention term is significant at the .1233 and .0417 levels for qualified investment and total investment, respectively. Therefore, the hypothesis that the intervention term is insignificant is rejected at the 85 percent level for both qualified investment and total investment. As a result, since the intervention terms are positive and considered significant, the investment tax credit is believed to have affected qualified and total investment activity. The intervention term in the nonqualified investment model is considered to be insignificant at the .5762 level. Therefore, the null hypothesis can not be rejected at the 85 percent level of confidence and the conclusion is reached that the intervention term is insignificant and that there is no association between the investment tax credit and nonqualified investment.

The diagnostic tests indicate that there is very little, if any autocorrelation or dependence among the residuals of

TABLE 5.13

RESULTS OF THE INTERVENTION ANALYSIS OF THE INVESTMENT ORDERS SERIES

INTERVENTION DATE: JANUARY 1975

MODEL: (2 2 0) x (0 2 0)/a

NUMBER OF LAGS: 2/m

	QUALIFIED INVEST.	TOTAL INVEST.	NONQUAL. INVEST.
Coefficient of the Intervention Term/c	2.12	3.37	-.14
Standard Error of the Intervention Term/d	1.76	1.87	.72
Significance of the Intervention Term/n	.1233/i	.0417/i	.5762/j
Box Pierce Q Statistic/f	15.84	15.64	5.59
Significance of the Box Pierce Q Statistic/g	.1066/k	.1153/k	.8422/k
Frequency of Passage of the Autocorrelation Function of Residuals Test/h	11/12	11/12	12/12

This model is based upon conducting the intervention analysis procedure on the 37 elements of the investment orders series from the 1975 period presented in Appendix B (columns 1-3). The results shown in this table indicate that this particular model detects an impact of the investment tax credit upon the qualified and total investment orders series and no impact upon the nonqualified investment orders series. Furthermore, based upon the diagnostic tests (See f,g,h, and k above), the model appears to represent adequately the investment orders series and the conclusions related to the significance or lack of significance of the intervention terms are supportable.

SEE EXPLANATORY NOTES WHICH ACCOMPANY TABLES 5.4 AND 5.7.

the time-series models. In each case, the null hypothesis relating to the significance of the BPQ statistic can not be rejected at the 97.5 percent level of confidence, and the frequency of the autocorrelation function falling within two standard deviations is within acceptable bounds. Therefore, no autocorrelation is considered to be present among the residuals of the time-series models. As a result, with the time-series model being adequate, the statements relating to the significance of the intervention terms are supported.

Therefore, based upon the results from the intervention analysis conducted on the investment orders series from the 1975 period as presented in Table 5.13, it appears that the rate increase of the investment tax credit has led to an increased level of qualified and total investment activity; whereas, no such increase was detected with the nonqualified investment activity series. Because of the two quarter lag factor built into the model, the impact noted was first detected in the calendar quarter following the date on which the investment tax credit legislation became law. Additionally, there is no evidence of a shift in investment activity away from those assets that do not qualify for the credit to those assets that do qualify for the credit since the intervention term in the nonqualified investment series model was insignificant. These results are based upon a model produced by performing the intervention analysis procedure on three time-series of investment orders from the

1975 period. Further, it may be noted that one model is presented for this ancillary intervention analysis, whereas, three models were presented for each of the other intervention analyses described above. Only one model was presented here because only one time-series model was identified which was considered adequate. Although the validity in this particular model is not necessarily reduced because other models also were not identified, the overall confidence of the results coming from this portion of the study may be considered less than that from the preceding intervention analyses discussed above.

This section has presented the results of the supplemental tests in which a series of intervention analyses was performed on orders of qualified, total, and nonqualified investment. The tests were performed on the series for the 1962 intervention period as well as the 1975 intervention period. The tests indicate that the investment tax credit has had a positive impact on investment activity in the case of qualified orders and total orders. The control groups of nonqualified investment apparently were not affected by the investment tax credit. This also suggests that there was no shift in investment activity from those assets that do not qualify for the credit to those assets that do qualify for the credit. Therefore, these ancillary tests have confirmed that the association noted in the intervention analyses on the regression residuals above is reflective of an increase

in the levels of qualified and total investment activity. Further, as in the intervention analyses on the regression residuals above, no impact from the investment tax credit was noted in the nonqualified investment series in the ancillary tests.

The results from the ancillary tests at first do not appear to be as conclusive as do the results from the intervention analyses on the regression residuals because, in general, the confidence levels of the intervention terms in the ancillary tests are not as high as the significance levels of the intervention terms in the initial intervention analyses. The range of intervention terms in Tables 5.4 through 5.9 was from .0008 to .0829 (all at least at the 90 percent level). In Tables 5.10 through 5.13 the range was from .0417 to .1422 (all at least at the 85 percent level).

The weaker, although confirmatory, results were not unexpected, possibly because of the following reasons:

1. The effect of the six economic variables which are important factors in influencing investment was not removed in the ancillary test, as it was for the input data used for the intervention analysis step. Recall that the multiple regression step removed that fluctuation in investment activity that could be explained by the economic variables and a residual series resulted. The residual series,

which accounted for the fluctuation of investment activity that could not be explained by the economic factors, then served as the input for the intervention analysis step. As a result, the economic variables' presence in the ancillary tests tended to mask or dilute the impact of the investment tax credit. This observation justifies the original deletion of the six variables in the effort to capture the desired effect.

2. Although the procedures described in an early portion of this chapter which tested for interaction between the investment tax credit and the economic variables showed that no significant interaction existed, perhaps there really is some interactive impact present. Perhaps tests that are more sensitive need to be developed or utilized in testing for the presence of such effect. Nonetheless, if present, this type of interactive effect between the investment tax credit and the economic variables could mask or dilute the impact of the investment tax credit in the ancillary test results.

These ancillary tests were deemed necessary in order to confirm the direction of the impact on investment activity noted in the intervention analysis step on the regression

residual series. There was a strong impact of the investment tax credit on the residual series detected by conducting the intervention analysis step; however, the supplemental test was utilized to confirm that the results on the residual series could be translated into the statement that the investment tax credit has had a positive impact upon investment activity. These ancillary tests have shown that such a statement may be made.

Summary:

This chapter has presented the results of the procedures performed on the qualified investment orders, total investment orders, and nonqualified investment orders series in testing for an association between the investment tax credit and investment spending. The major results of the study are enumerated below:

1. Qualified and total investment orders have been impacted by the enactment of and change in the provisions of the investment tax credit. Consequently, since the assumption is made in this study that investment orders and investment expenditures are highly correlated, the statement can be made that the investment tax credit has been associated with and has impacted upon investment

spending. This conclusion is based upon noting several significant intervention terms in the intervention analyses performed on the regression residuals.

2. This observed impact may apparently be attributed to the investment tax credit rather than other factors since no intervention effect was noted in the control groups (i.e., nonqualified investment series).

3. The investment tax credit's impact upon qualified and total investment has been a positive one. That is, the level of investment activity has increased because of the investment tax credit. This is confirmed by detecting a positive impact in the qualified orders and total orders series upon the enactment of and the change in the investment tax credit provisions. Moreover, no impact was noted in the nonqualified orders series.

4. There was no evidence of a shift in investment activity away from those assets that do not qualify for the investment tax credit to those assets that do qualify for the investment tax credit. Had such a shift been present, a significant negative impact

would have been expected in the intervention analyses of the nonqualified investment residual series and of the nonqualified orders series. No such negative impact was noted.

The next chapter provides a summary and conclusions resulting from this dissertation.

CHAPTER 6

SUMMARY AND CONCLUSIONS

The main focus of this dissertation has been upon the following two basic questions:

1. Has the availability of the investment tax credit provisions given rise to an increased level of investment expenditures within the United States economy over the level of investment expenditures that would have been expected without the availability of the provisions?

2. Has an increase in the rate of the investment tax credit given rise to an increased level of investment expenditures within the United States economy over the level of investment expenditures that would have been expected had the investment tax credit rate not been increased?

The investment tax credit provisions are believed to play a very important role in our nation's fiscal policy strategy of stimulating investment. The provisions have been a part of the country's tax law for over twenty-one years (except for two short periods of suspension and repeal), and the provisions have cost the United States Treasury billions of dollars in terms of lost tax revenues. Even though the investment tax credit has been considered very important in its assigned role of stimulating investment, there has been great disagreement, primarily among tax policy experts and economists, as to the effectiveness of the credit in meeting its role. The purpose of this dissertation has been to address the questions listed above, even though they have been addressed before, by utilizing a methodological approach that had not been utilized previously with respect to this topic. As a result of this study, a contribution has been made toward reducing the uncertainty that has existed relative to the investment tax credit's effectiveness.

The historical background of the investment tax credit was presented in Chapter 2. Included in the discussion was a chronology of the credit's creation, development, and metamorphosis over time. Some of the important comments attributable to the credit's proponents and opponents were presented which were made during various discussions about the credit, its role within the economy, and its likely effect upon the economy. Also, a discussion was offered of

the changing (and most often expansive) definition of "qualified investment," which is that type of asset which gives rise to the opportunity to claim the investment tax credit.

Chapter 3 included an overview of the nature of investment theory, which included a discussion of some of the major approaches taken in attempting to explain investment activity; a discussion of the literature relevant to the investment tax credit and its role as a stimulant of investment spending; and a summary of the various economic variables that are believed to have had an important role in the various approaches discussed in explaining investment activity.

Based upon the discussion included in Chapter 3, the following two points should be clear:

1. Investment theory is in a state of flux in which no single accepted or acceptable theoretical approach to explaining investment activity has evolved. Uncertainty abounds as to specifically which set of economic variables are to be considered and what their relative relationship to one another should be, when examining investment behavior.

2. Because of the uncertain nature of investment theory, which serves as the base when empirically

examining the effect of exogenous variables on investment (e.g., the investment tax credit), inconclusive results have resulted when the effects of the investment tax credit's presence on investment have been examined. Consequently, the results of the studies reviewed must be viewed as less than totally conclusive.

Even though much uncertainty exists in the investment area, a number of economic variables, as noted in Chapter 3, which are considered influential to investment activity have continually appeared in the literature. These influential variables were distilled from the investment literature reviewed; further, two economists (Klein and Taubman) also noted that the variables were ones which, by a consensus of many economists, seem to play an integral role in influencing investment activity. These economic variables namely, output, profits, cashflow, interest rate, capital stock, and capacity utilization are utilized in this dissertation to provide the theoretical foundation upon which the two research questions are addressed.

The methodological approach used in the study is described in Chapter 4. The economic variables are utilized in a linear multiple regression analysis to remove that part of the variance within several investment series that can be explained by these structural economic variables. The regression analysis is conducted for two qualified investment

series, two total investment series, and two nonqualified investment series. The variance in the investment series that is not explained by the economic variables is then examined over time by utilizing the intervention analysis procedure. The procedure is used to determine if the residual or unexplained variance series from the qualified, total, and nonqualified regressions behave differently after the enactment of or change in the rate of the investment tax credit than before. Upon noting a difference in the residual series after the intervention from that before the intervention, the conclusion is made that the difference is attributable to the investment tax credit. Moreover, such a result would show that there is an association between the investment tax credit and investment spending and that the investment tax credit impacts upon investment spending.

A further series of ancillary intervention analyses were performed in order to confirm that the association or impact noted would necessarily mean that the impact on investment spending is a positive one.

Results of the Research:

The detailed results of the hypothesis testing of the dissertation were presented in Chapter 5. The primary results of the tests performed are summarized below:

1. Qualified and total investment orders have been impacted by the enactment of and change in the provisions of the investment tax credit. Consequently, since the assumption is made in this study that investment orders and investment expenditures are highly correlated, the statement can be made that the investment tax credit has been associated with and has impacted upon investment spending. This conclusion is based upon noting several significant intervention terms in the time-series models on which the intervention analyses were performed. Since the sign accompanying the intervention term is positive, the amount of unexplained fluctuation in the regression equations has increased and as a result the amount of the investment fluctuation explained by the economic variables has gone down. This relative decline in the economic variables' importance is attributed ostensibly to the investment tax credit's presence and its importance and role in the investment process.

2. This observed impact may apparently be attributed to the investment tax credit rather than other factors since no intervention effect was noted in the control groups (i.e., nonqualified investment series).

3. The investment tax credit's impact upon qualified and total investment has been a positive one. That is, the level of investment activity has increased because of the investment tax credit. This is confirmed by noting a positive impact in the qualified orders and total orders series upon the enactment of and the change in the investment tax credit provisions. Moreover, no impact was noted in the nonqualified orders series.

4. There was no evidence of a shift in investment activity away from those assets that do not qualify for the investment tax credit to those assets that do qualify for the investment tax credit. Had such a shift been present, a significant negative impact in the models' intervention term would have been expected in the intervention analyses of the nonqualified investment residual series and of the nonqualified orders series. No such negative impact was noted.

Contributions:

It is believed that this dissertation offers a

respectable advance in the state of knowledge. The two primary contributions of this work are discussed below.

Firstly, the conclusions which are derived from this study are useful information that could have implications on tax policy decisions. The results of the empirical work suggest that the investment tax credit has been effective in stimulating investment activity. This conclusion is useful to tax policy experts and tax policy-makers because it helps to reduce uncertainty that is present in the literature about the effectiveness of the investment tax credit. This uncertainty is evidenced by noting various, and often conflicting, conclusions in previous empirical studies upon addressing basically the same questions. Because of the nature of empirical research and the inherent design weaknesses that are involved, an issue often must be addressed several different times, using several different approaches in order to gain confidence in the ultimate conclusion. This process of utilizing a multiplicity of methods on a particular research question is known as triangulation. This dissertation represents the completion of another block in the triangulation process. This study contributes additional confidence that the investment tax credit is an effective fiscal policy tool because of the positive results noted upon the utilization of a different methodological approach.

The introduction of a new methodological approach to tax

policy studies, which includes the application of the intervention analysis technique, is the second major contribution of this study. The intervention analysis procedure utilized in this dissertation has never been utilized before, either in conjunction with other statistical methods or by itself, to examine and study a tax policy issue. This technique offers a unique perspective on the evaluation of an effect pattern of an intervention over time. This approach is a worthwhile alternative to using econometric models which typically are comprised of a number of equations designed to reflect the way that economic forces are expected to interact based upon how they have interacted in the past. It is likely that the intervention analysis technique can also be applied to other tax provisions which have been designed to promote certain types of activity in order to learn if those provisions are effective.

Limitations:

The results of this study are conditional upon the research design and empirical procedures utilized. The intervention analysis technique, which was performed on a univariate time series (i.e., various regression residual series and various orders series), represents both a strength and a weakness. As already mentioned in the previous section, the procedure possesses definite and strong merits

as a methodological tool. However, as a weakness, this tool at least in theoretical terms, is not as strong as other more advanced versions of the intervention analysis procedure. This procedure, in some cases, also can be utilized to examine multiple time-series at one time. In theory, the application of the multiple time-series intervention analysis to this research would encorporate all of the economic variables important to investment simultaneously such that a regression step would not be necessary. However, in practice there are problems in applying the multivariate intervention analysis technique in cases where more than two independent variables are present. Therefore, at such time when an application can be made, it could strengthen the conclusions of the study and would enable an additional step be taken in the triangulation process.

An additional limitation relates to the quality of the data manipulated and the choice of the surrogates made. The macro data utilized is the result of a complicated collection and estimation process conducted by the governmental agencies supplying the data. Further, various seasonality and deflating procedures are applied to the data by these agencies in restating the data for presentation. Although the procedures used by these governmental agencies have been refined over the years, probable future improvements will be seen in the collection and manipulation process. Future changes in their procedures will presumably improve the quality (i.e., fairness, validity, etc.) of the data.

Further, the specific surrogates of the economic variables utilized in this study were included because it was believed that they were the best surrogates available for the tests performed. However, perhaps there are other measures currently available, or maybe others will be developed in the future, which could be applied to such a research design such that more accurate and valid results would be obtained.

Another limitation of the study is related to the assumption made with respect to the linearity of the economic variables in the regression equations. Clearly, if the economic variables can not be fairly represented in a linear fashion, then the results of the study could be misstated.

Further, the results of this study are interpretable only in so far as the control group properly performs its role of controlling for all exogenous forces and in so far as it is not affected by the investment tax credit intervention. Moreover, the control group is effective in this research only to the degree that its behavior in the absence of the investment tax credit would parallel the behavior of the experimental group.

Lastly, ad hoc models, such as the time-series models in this study, can only be used to make implications as opposed to conclusions. However, it must be stated that in this study, the implications of this work are strong and do, indeed, support the statement that the investment tax credit is associated with the investment spending.

Suggestions for Future Research:

The above discussion alludes to several possible useful extensions or offshoots of this research. Some of the possibilities that are believed to be worthy of consideration are:

1. Other available surrogates could be utilized in future research of a similar nature and design. Such an effort could support the above statements that the investment tax credit does, indeed, have an impact upon investment and the results obtained are not just "flukes" obtained because of the particular selection of the surrogates.

2. The research could be extended to determine the impact of the investment tax credit on various industries or other categories. It would be interesting to see the various levels of impact on different segments within our economy.

3. When some of the practical difficulties mentioned above relating to the application of the multivariate intervention analysis procedure have

been resolved, the advanced technique can be utilized to explore the issue of this study further. This advanced technique could possibly better eliminate any existing interaction between the investment tax credit and the various economic variables involved.

4. The intervention analysis technique could be applied to various other tax provisions, both tax credits and tax deductions, which have been enacted with the intent of promoting or stimulating various activities within the economy. A similar research design could be utilized in an effort to determine the effectiveness of the particular provision under examination.

5. The research could be extended to examine the efficiency of the investment tax credit. Although the extension would, perhaps, be very challenging, the relative efficiency in applying the investment tax credit in various situations and in relation to other investment stimulants are very important considerations that need exploration.

6. The stability of the nonqualified investment series in its use as a control group could be examined as

an extension of this study. A micro-level study of this issue may show that nonqualified investment activity may have been stimulated or that there was a shifting of activity away from nonqualified investment activity as a result of the investment tax credit within some sectors or industries within the economy.

7. This study has shown that the investment tax credit has had an impact upon investment activity. A worthwhile extension would be to investigate the magnitude of this impact upon investment.

Recommendations:

This dissertation has been concerned with a very complicated issue. From the above, it is clear that the theoretical foundation on which this and other studies in which the investment tax credit's effectiveness is an issue is not solidly established. Further, there are perhaps exogenous factors that may influence investment activity and which would have impacted significantly upon a study of the investment tax credit's effectiveness that have not systematically been considered in previous studies. Moreover, more sensitive methods of empirical research may be developed and refined which could be employed to examine this

issue from yet another direction. Therefore, the foremost recommendation made is that research in this area should be continued so that the limitations of this and previous research efforts may be mitigated and clearer results may be achieved. The research should not only be continued, but the scope of the questions addressed should be expanded, as well. For example, the efficiency of the investment tax credit vis a vis other potential alternatives should be examined towards an effort of achieving the most efficient tax policy possible. As a part of the research concerned with the investment tax credit's efficiency, costs and benefits will have to be measured. The costs, of course, would primarily be comprised of the tax revenue loss to the United States Treasury in the short-run because of the utilization of the investment tax credit by taxpayers. The benefits should be a measure of the amount by which the tax revenues are higher in the longer-run (because of the stimulation of more investment, growth, economic activity, etc.) than they would have been without the availability of the credit. As is suggested by this research, a lag of several periods would be expected before any benefits calculated in this fashion would likely be noted. The operationalization of this recommendation, admittedly, would not be without methodological challenge.

Lastly, the implications for tax policy are obvious, assuming that the past reaction of investment activity to the

investment tax credit is a guide to the future. Under such an assumption, the availability of the investment tax credit should be continued; however, research should also be continued in an effort to achieve the most efficient investment stimulant possible.

APPENDIX A

EXCERPTS FROM THE INTERNAL REVENUE CODE SECTIONS 38 AND 48 REGARDING THE PROVISION IN THE LAW FOR THE CREDIT AND REGARDING THE NATURE OF CURRENTLY QUALIFYING PROPERTY

SEC. 38. INVESTMENT IN CERTAIN DEPRECIABLE PROPERTY.

(a) General Rule.—There shall be allowed, as a credit against the tax imposed by this chapter, the amount determined under subpart B of this part.

(b) Regulations.—The Secretary shall prescribe such regulations as may be necessary to carry out the purposes of this section and subpart B

SEC. 48. DEFINITIONS, SPECIAL RULES.

(a) Section 38 Property.—

(1) In general.—Except as provided in this subsection, the term "section 38 property" means—

(A) tangible personal property (other than an air conditioning or heating unit), or

(B) other tangible property (not including a building and its structural components) but only if such property—

(i) is used as an integral part of manufacturing, production, or extraction, or of furnishing transportation, communications, electrical energy, gas, water, or sewage disposal services, or

(ii) constitutes a research facility used in connection with any of the activities referred to in clause (i), or

(iii) constitutes a facility used in connection with any of the activities referred to in clause (i) for the bulk storage of fungible commodities (including commodities in a liquid or gaseous state), or

(C) elevators and escalators, but only if—

(i) the construction, reconstruction, or erection of the elevator or escalator is completed by the taxpayer after June 30, 1963, or

(ii) the elevator or escalator is acquired after June 30, 1963, and the original use of such elevator or escalator commences with the taxpayer and commences after such date, or

(D) single purpose agricultural or horticultural structures, or

(E) in the case of a qualified rehabilitated building, that portion of the basis which is attributable to qualified rehabilitation expenditures (within the meaning of subsection (g)), or

(F) in the case of qualified timber property (within the meaning of section 194(c)(1)), that portion of the basis of such property constituting the amortizable basis acquired during the taxable year (other than that portion of such amortizable basis attributable to property which otherwise qualifies as section 38 property) and taken into account under section 194 (after the application of section 194(b)(1), or

(G) a storage facility used in connection with the distribution of petroleum or any primary product of petroleum

Such term includes only recovery property (within the meaning of section 168 without regard to any useful life) and any other property with respect to which depreciation (or amortization in lieu of depreciation) is allowable and having a useful life (determined as of the time such property is placed in service) of 3 years or more The preceding sentence shall not apply to property described in subparagraph (F) and, for purposes of this subpart, the useful life of such property shall be treated as its normal growing period

APPENDIX B

QUARTERLY ECONOMIC DATA UTILIZED FOR THE PRELIMINARY AND MULTIPLE REGRESSION ANALYSIS TESTING 1962 PERIOD AND 1975 PERIOD

1962 PERIOD

QUARTER ENDED	1	2	3	4	5	6	7	8	9
6/30/54	9.28	9.82	.54	50.9	26.9	42.7	1.90	63.9	79.7
9/30/54	10.31	10.81	.50	51.0	27.9	44.7	1.90	64.4	79.1
12/31/54	10.83	11.61	.78	52.6	31.1	47.8	2.09	65.0	80.8
3/31/55	13.15	13.57	.42	55.5	36.5	53.4	2.39	65.7	84.5
6/30/55	13.21	14.06	.85	58.1	37.7	54.6	2.56	66.4	87.4
9/30/55	13.86	14.93	1.07	58.8	37.3	55.1	2.81	67.2	87.5
12/31/55	14.77	15.59	.82	60.2	36.8	56.1	2.83	76.9	88.6
3/31/56	14.00	15.00	1.00	60.2	34.3	53.9	2.83	68.7	87.6
6/30/56	15.15	15.66	.51	60.2	33.0	54.1	3.08	69.6	86.5
9/30/56	14.26	14.82	.56	59.3	32.6	50.7	3.33	70.5	84.2
12/31/56	15.01	15.15	.14	61.6	31.1	51.7	3.55	71.4	86.3
3/31/57	14.11	15.02	.91	62.4	32.3	45.2	3.44	72.1	86.5
6/30/57	12.42	13.28	.86	61.6	32.4	50.9	3.66	72.8	84.6
9/30/57	11.86	12.37	.51	61.6	32.0	50.5	4.01	73.5	83.9
12/31/57	10.71	11.64	.93	58.9	29.2	48.1	3.62	74.2	79.4
3/31/58	10.38	11.13	.75	55.4	25.5	43.4	2.76	74.8	74.1
6/30/58	10.54	11.32	.78	54.6	25.7	43.5	2.44	75.4	72.4
9/30/58	11.37	12.40	1.03	57.4	28.3	47.4	3.25	76.1	75.4
12/31/58	11.68	12.19	.51	60.0	31.7	52.7	3.76	76.7	78.2
3/31/59	12.93	13.58	.65	62.9	35.2	55.1	3.98	77.3	81.4
6/30/59	13.31	13.96	.65	66.0	39.2	58.6	4.32	78.0	84.6
9/30/59	13.39	14.00	.61	63.3	35.0	53.6	4.68	78.7	80.5
12/31/59	13.04	13.78	.74	63.6	36.0	53.3	4.82	79.4	80.1
3/31/60	12.58	13.19	.61	67.7	36.8	56.6	4.64	80.2	84.5
6/30/60	13.06	14.00	.94	66.0	34.2	54.0	4.30	81.1	81.3
9/30/60	12.56	13.85	1.29	64.8	34.5	52.7	3.67	82.1	78.9
12/31/60	12.35	13.56	1.21	63.0	32.7	51.6	3.74	83.0	75.8
3/31/61	12.46	13.66	1.20	61.9	32.1	51.5	3.64	83.8	73.8
6/30/61	12.41	13.33	.92	64.5	35.5	53.8	3.61	84.5	76.4
9/30/61	13.53	14.18	.65	66.8	36.4	55.6	3.90	85.1	78.4

COLUMNAR HEADINGS EXPLAINED BELOW

APPENDIX B (CONTINUED)

QUARTERLY ECONOMIC DATA UTILIZED FOR THE PRELIMINARY AND MULTIPLE REGRESSION ANALYSIS TESTING

1962 PERIOD AND 1975 PERIOD

1962 PERIOD (CONTINUED)

QUARTER ENDED	1	2	3	4	5	6	7	8	9
12/31/61	13.42	14.32	.90	69.2	38.6	58.1	3.84	85.8	80.6
3/31/62	13.99	15.09	1.10	70.2	44.2	63.0	3.83	86.5	81.2
6/30/62	13.86	14.93	1.07	70.9	43.4	62.7	3.63	87.2	81.3
9/30/62	13.68	14.69	1.01	71.8	44.2	64.4	3.73	88.0	81.6
12/31/62	14.50	15.83	1.33	72.4	47.0	65.8	3.60	88.7	81.6
3/31/63	14.91	15.43	.52	73.7	46.6	64.8	3.64	89.5	82.3
6/30/63	15.38	16.48	1.10	75.7	48.9	67.9	3.75	90.4	83.8
9/30/63	15.60	16.21	.61	76.2	49.3	69.2	3.91	91.2	83.6
12/31/63	15.93	17.83	1.90	77.5	49.6	70.5	4.00	92.1	84.2
3/31/64	16.87	17.66	.79	78.6	55.2	74.8	4.08	93.0	84.5
6/30/64	18.07	18.75	.68	80.4	55.1	74.2	4.07	94.0	85.5
9/30/64	17.58	18.56	.98	81.8	55.3	75.7	4.05	95.1	86.1
12/31/64	18.26	19.92	1.66	83.1	55.0	74.9	4.06	96.1	86.5
3/31/65	18.74	19.67	.93	86.7	63.0	82.9	4.13	97.5	88.9
6/30/65	19.22	20.24	1.02	88.7	65.0	85.3	4.15	99.2	89.4
9/30/65	19.66	20.51	.85	90.8	64.9	86.1	4.20	101.0	89.9
12/31/65	21.24	21.57	.33	92.4	66.6	88.6	4.50	102.7	90.0
3/31/66	22.26	23.36	1.10	95.3	68.3	90.4	4.92	104.5	91.1
6/30/66	23.14	23.90	.76	97.5	66.0	91.3	4.89	106.4	91.6
9/30/66	23.22	24.59	1.37	98.9	63.9	91.5	5.39	108.3	91.2

COLUMNAR HEADINGS EXPLAINED BELOW

APPENDIX B (CONTINUED)

QUARTERLY ECONOMIC DATA UTILIZED FOR THE PRELIMINARY AND MULTIPLE REGRESSION ANALYSIS TESTING

1962 PERIOD AND 1975 PERIOD

1975 PERIOD

QUARTER ENDED	1	2	3	4	5	6	7	8	9
12/31/71	23.56	27.79	4.23	110.6	50.5	93.9	5.80	139.3	79.4
3/31/72	23.96	28.24	4.28	114.2	53.8	98.3	5.71	140.4	81.3
6/30/72	25.36	30.16	4.80	117.3	53.5	101.5	5.97	141.7	82.8
9/30/72	26.43	31.12	4.69	119.8	55.5	102.1	6.08	143.0	83.7
12/31/72	27.60	32.41	4.81	124.2	57.2	108.0	6.15	144.3	86.0
3/31/73	29.43	34.51	5.08	127.2	60.9	117.0	6.58	145.8	87.2
6/30/73	31.26	36.37	5.11	129.2	55.0	119.7	6.72	147.4	87.7
9/30/73	31.82	37.62	5.80	130.7	55.0	117.7	7.33	148.9	87.9
12/31/73	34.77	40.49	5.72	131.8	55.6	120.1	6.83	150.5	87.6
3/31/74	34.80	39.03	4.23	130.1	47.4	121.7	7.02	152.1	85.5
6/30/74	33.22	37.80	4.58	131.3	41.1	120.7	8.06	153.7	85.5
9/30/74	34.10	38.67	4.57	132.1	29.7	121.8	8.46	155.2	85.1
12/31/74	28.04	33.51	5.47	124.1	32.1	110.0	7.65	156.8	79.1
3/31/75	25.20	28.55	3.35	111.2	36.8	98.0	7.27	158.1	70.3
6/30/75	24.53	31.33	6.80	112.4	43.6	100.3	7.74	159.0	70.7
9/30/75	24.83	29.80	4.97	119.4	50.6	111.1	8.20	160.0	74.6
12/31/75	24.36	27.21	2.85	122.5	54.8	115.1	7.84	160.9	76.1
3/31/76	25.13	31.36	6.23	127.1	58.1	116.6	7.46	162.0	78.4
6/30/76	26.89	31.80	4.91	129.7	54.4	115.7	7.48	163.2	79.5
9/30/76	28.51	34.53	6.02	131.5	54.3	115.3	7.31	164.4	80.0
12/31/76	28.82	34.52	5.70	132.5	53.1	115.5	6.45	165.6	80.0
3/31/77	28.82	33.75	4.93	134.7	57.8	124.3	6.78	166.9	80.7
6/30/77	30.67	37.38	6.71	138.0	66.6	129.8	6.83	168.2	82.1
9/30/77	30.89	37.32	6.43	139.8	74.2	133.2	6.97	169.6	82.4
12/31/77	32.85	37.95	5.10	141.1	65.4	131.0	7.38	170.9	82.6
3/31/78	33.32	40.47	7.15	141.3	65.6	132.9	7.82	172.2	82.0
6/30/78	35.92	41.01	5.09	145.5	71.8	140.9	8.17	173.3	83.9
9/30/78	38.06	44.73	6.67	148.6	72.8	142.1	8.43	174.5	85.2
12/31/78	39.96	46.34	6.38	151.7	73.9	147.1	8.84	175.6	86.4
3/31/79	43.95	50.21	6.26	153.8	69.0	146.6	9.17	177.0	86.9

COLUMNAR HEADINGS EXPLAINED BELOW

APPENDIX B (CONTINUED)

QUARTERLY ECONOMIC DATA UTILIZED FOR THE PRELIMINARY AND MULTIPLE REGRESSION ANALYSIS TESTING 1962 PERIOD AND 1975 PERIOD

1975 PERIOD (CONTINUED)

QUARTER ENDED	1	2	3	4	5	6	7	8	9
6/30/79	39.99	45.54	5.55	153.4	66.1	148.3	9.11	178.6	85.9
9/30/79	38.94	43.83	4.89	153.7	65.1	151.0	9.12	180.1	85.3
12/31/79	41.12	46.51	5.39	153.4	57.5	146.4	10.66	181.7	84.4
3/31/80	39.87	43.88	4.01	152.9	56.7	149.7	12.27	183.3	83.4
6/30/80	36.85	40.49	3.64	143.9	54.8	132.6	10.33	184.8	77.9
9/30/80	39.00	43.65	4.65	141.5	52.0	137.8	10.66	186.4	75.9
12/31/80	39.10	43.92	4.82	148.6	49.8	139.1	12.64	187.9	79.1

EXPLANATION OF COLUMNAR HEADINGS:

1 - Qualified Investment (in billions)
2 - Total Investment (in billions)
3 - Nonqualified Investment (in billions)
4 - Output (in billions)
5 - Profit (in billions)
6 - Cashflow (in billions)
7 - Interest Rate (in percentages)
8 - Capital Stock (in billions)
9 - Capacity Utilization (in percentages)

A description of and the source of these data are given in Chapter 4 of this study in the section entitled "Surrogation of Economic Variables."

APPENDIX C

MATHEMATICAL SPECIFICATION OF VARIOUS STATISTICAL CALCULATIONS PERFORMED

Bartlett-Box F Test:

$$\chi^2 = -\left[v - \frac{p(p+1)^2(2p-3)}{6(p-1)(p^2+p-4)}\right] \ln L$$

where v is the degrees of freedom of the sum of squares and products tested.

p is the number of variance series tested.

$$L = \frac{|s|}{(s^2)^p (1-r)^{p-1}[1+(p-1)r]}$$

$$s^2 = \frac{1}{p}\sum_{i=1}^{p} s_{ii}$$

$$s^2 r = \frac{1}{p(p-1)} \sum_{i \neq j} \sum s_{ij}$$

The statistic is χ^2 distributed with $\frac{1}{2} p(p+1) - 2$ degrees of freedom.

F Statistic:

$$F = \frac{SS_R(B_1|B_2)/r}{MS_E}$$

where $SS_R(B_1|B_2)$ is the regression sum of squares due to B_1 adjusted for the presence of B_2 already in the model.

MS_E is the mean squared error of the regression model.

The F statistic is $r, n-p$ distributed where r is the number of regression variables included in the regression sum of squares.

n is the number of observations.

p is the number of regression coefficients.

APPENDIX C (CONTINUED)

MATHEMATICAL SPECIFICATION OF VARIOUS STATISTICAL CALCULATIONS PERFORMED

Student t Statistic:

$$t = \frac{B_I}{SE_I}$$

where B_I is the coefficient associated with the intervention term.

SE_I is the standard error of the intervention coefficient.

The t statistic is $N-2$ distributed where N is the number of observations in the time-series.

BPQ Statistic:

$$Q = m \sum_{k=1}^{K} r_{\hat{a}\hat{a}}^2(k)$$

where $r_{\hat{a}\hat{a}}(k)$ is the estimated autocorrelation function of the k^{th} residual $\hat{a}_t$.

$\frac{1}{m}$ is the variance of the autocorrelation.

The statistic is approximately distributed as χ^2 with $K-p-q$ degrees of freedom where K is the number of autocorrelation functions included in the Q statistic.

p is the number of autoregressive terms in the time-series model.

q is the number of moving average terms in the time-series model.

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