Name: David A. Nicks　　　　Date of Degree: December 1986

Institution: Oklahoma State University

Location: Stillwater, Oklahoma

Title of Study: ENERGY SUPPLY AVAILABILITY: THE IMPORTANCE TO INDUSTRIES AND INVESTORS

Pages in Study: 52　　　　Candidate for Degree of Masters of Business Administration

Scope of Study: This study analyzed the impact of energy supply interruptions on firms within the manufacturing sector. The manufacturing sector was classified into three levels of energy intensity, high, moderate, and low. The measure of impact on these firms was the market measure of risk or a firm's market beta. The longitudinal portion of this analysis covers the time period 1972 to 1982, with supply instability occurring during the 1973 Arab Oil Embargo and the 1979 Iranian Crisis. The purpose of this study was twofold. First, to analyze the general level of risk transmitted to the market place across the three energy intense classifications, and second, to analyze the changes in these firms' market beta during periods of supply stability and unrest. It was hypothesized that risk levels in general would be higher for the relatively more energy intense firms and that these risk levels would increase proportionally to energy intensity during periods of supply instability.

Findings and Conclusions: The results of this study indicated general levels of risk, as measured by beta, were lower for the relatively more energy intense firms. Possible reasons for this deviation from expectations included technological superior or more efficient operations in energy intense firms, energy source substitution, production integration structures, final product price elasticity, and the characteristics of the product markets themselves. The results of the longitudinal portion of this study showed very little support for the hypotheses during the Arab Oil Embargo of 1973. The results showed limited support for the data concerning the 1979 Iranian Crisis. Reasons for this limited support included the ability of energy intense firms to pass forward rising energy costs, the nature of the final product (i.e. final demand or derived demand), the time periods immediately preceding energy supply interruptions, and the reasons presented above.

ADVISER'S APPROVAL ______________________

ENERGY SUPPLY AVAILABILITY: THE

IMPORTANCE TO INDUSTRIES

AND INVESTORS

Thesis Approved:

____
Thesis Advisor

W. Gary Simpson
____

____

ENERGY SUPPLY AVAILABILITY: THE IMPORTANCE TO INDUSTRIES AND INVESTORS

By

DAVID ALLEN NICKS

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1982

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTERS OF BUSINESS ADMINISTRATION
December, 1986

PREFACE

This study analyzes the effects of energy supply instability on firms within the manufacturing sector. More specifically, the firms within the manufacturing sector were classified into three energy intensive groups, and a measure of market risk for these firms was analyzed over a time period consisting of both energy supply stability and unrest.

It was hypothesized that the more energy intensive firms would be subject to higher risk levels in general, and these risk levels would increase during times of energy supply instability. The results showed limited support for the above hypotheses, and possible explanations were explored.

I would like to extend my appreciation to all the people who assisted me with this work during my time at Oklahoma State University. In particular, special gratitude goes to Dr. James F. Jackson for his support and guidance.

Special thanks also to my family members for their support and encouragement.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

Energy is a resource that has become a matter of great concern to the United States and a major contingency to the continued growth of our economy. Throughout the decade of the seventies energy consumption increased dramatically, as America's production became increasingly dependent on some form of energy. Total energy consumed by the United States represented approximately 30 percent of world use, during most of this time period.[1] This consumption figure translated into 65 percent for productive purposes and 35 percent for consumption purposes.[2]

Along with increases in energy consumption came increases in oil importation. Before the oil embargo of 1973, the United States imported 26 percent of its oil needs. The dependence grew to 42 percent in 1977 and is expected to be over 50 percent by the close of 1986, unless changes in current policies are adopted. America's growing energy needs and rising foreign import dependence contributed to problems of energy costs and supply availability through the past decade. World oil prices quadrupled in the early seventies, tripled in the late seventies, giving rise to a price increase of over 17 times altogether. As prices rose, demand fell, conservation efforts increased, research and development efforts grew and energy efficient systems were stressed. According to a study published by the Department of Energy:

> Curtailment of energy consumption, declining labor productivity, lower living standards and slowed economic growth appear to be the predominant market response to higher energy prices.[3]

As if massive price increases weren't enough, supply interruptions played havoc with the production of energy requiring goods. These interruptions occurred twice in the last decade. As expressed by David Deese and Joseph Nye in their book entitled Energy and Security:

> Both times the price of imported oil shot up precipitously, and rapid inflation and a serious recession soon followed. Both times the country endured gasoline lines, trucker revolts and the fear of heating oil shortages. Both times domestic allocation programs made matters worse. Both times stocks on hand at the end of the disruption were greater than at the beginning. Both times the improved machinery to deal with the interruption proved to be woefully inadequate.[4]

As evident from past occurrences, it is impossible for our nation to abruptly reduce its energy consumption without adverse consequences. Given that the United States is a major consumer of energy and that energy supplies are susceptible to uncontrollable forces, the use of energy as a production input gives rise to both uncertainty and vulnerability.

In 1981, nearly 40 percent of the oil consumed by the free world's economy was vulnerable to terrorism, accidents, warfare and extortion.[5] This being the case, much research has been conducted on energy use, conservation, alternative energy forms and energy's effect on major economic variables. These studies center mainly on the macro effects and conditions caused by energy supply uncertainty. The text of this particular study involves an analysis closer to a micro-orientation. The study involves energy consuming firms, their equity base, the investors who contribute to the equity base, and how all the above are affected by the uncertainty and vulnerability of energy supplies.

Reason for the Study

According to Howard and Elizabeth Odum, energy is a measure of everything, and everything has a component of energy.[6] Energy is involved in everything, whether this energy is a primary output or a resource input. The consumption of energy grew appreciably in the seventies, and by 1976, the cost of this energy represented eight percent of GNP (Gross National Product), a 50 percent increase over 1972. Energy consumption has been linked to such economic variables as GNP, growth and employment. With energy as a key resource and its consumption growing, energy price increases cause rapid changes in company and industry financial statements.

Along with the growth in energy consumption comes energy intensity and dependence. Energy dependence constitutes a need for an uninterrupted energy supply. As mentioned previously, supply security may not always be possible. The uncertainty of energy supply conditions constitutes a risk for dependent companies. Interruptions of supply cause problems in production, sales and especially costs. Structural constraints and substitution problems prevent any short term solution. Also, the uncertainty of the duration of the shortage poses problems in the substitution of resources. Labor could be substituted for capital more easily in the short run, however complete substitution to maintain capacity is not probable. Supply vulnerability translates into uncertain variations in key company operating and financial variables.

Richard Stinson, in his discussion of the energy supply problem states:

> What it really does is make highly suspect very many sophisticated earnings estimates. It introduces

> uncertainty because you don't know the duration of the shortage. There are too many variables.[7]

According to economic theory, a reduction in supply translates into rising prices. This in turn translates to cost increases for energy consuming firms. Therefore, these firms' cost structure is subject to uncertain fluctuations which are uncontrollable and irreversible by the firm in the short run.

Uncertain costs create uncertainty throughout the financial system. Expected earnings, projected sales and even capital improvements are subject to a wider range of estimation. This wider range causes risk in planning for the future. A cost structure dependent on energy availability causes earnings to also be dependent on the supply of energy. Fluctuation in these variables is of major importance to the firms and also to an important source of funds, the investors.

Uncertainty of company profits and performance causes the uncertainty of investor returns. Deviations in growth and profits cause uncertainty in both capital appreciation and returns from dividend payments. According to financial theory, this added uncertainty must be accompanied by higher expected returns to entice investment. It is in this fashion that the supply vulnerability of the firms transforms into increased investor risk. With the future financial performance of these firms in question, problems in maintaining adequate stock values could occur. If energy supply problems translate into larger swings in company stock prices relative to the market, this company must increase its compensation to investors. Stock prices which increase in variability relative to past occurrences increase cost and capital flow problems. The variations in company stock prices are an estimate or a perception by the investor as to future happenings. The perception of risk by investors is an important determinant in their financial decisions. It is this perception of risk and its fluctuations that is of prime concern to this study.

Statement of the Problem

The purpose of this study is to examine the empirical relationship between the susceptibility of our energy supply and investors' perceived risk, taking into account different degrees of energy intensity. According to financial theory, the return required on a given investment bears a direct relationship to the perceived risk level. The problem lies in the uncertainty of energy supply and how this uncertainty translates into risk for both the firm and the investor. The relationship between absolute risk levels and levels of energy intensity will be discussed in a cross-sectional analysis of 20 major industry groups identified by SIC (Standard Industrial Classification) code.

Anticipation of findings suggests a direct relationship between energy intensity and perceived risk. Also expected, is an increase in the level of risk during previous supply interruptions. These thoughts will be elaborated and defended in subsequent chapters. To facilitate such an analysis of risk reaction, an appropriate risk measure must be chosen.

Research Variables

The risk of not obtaining expected returns consists of both market and company induced factors. Both measures are affected by the uncertainty of supply conditions. The factors specific to the firm itself include standard measures of financial performance. Measures of company returns such as ROI (return on investment), ROE (return on equity) are popular performance guides. Variations in these variables create the risk of not meeting future expectations.

A collection of key financial variables could also be used to monitor fluctuations and update future return expectations. Earnings measures such as EBIT (earnings before interest and taxes) and EPS (earnings per share) give an indication of the amount available to stockholders. Variation in these earnings variables indicates a dispersion and hence a risk of future stockholder earnings. Therefore, the deviations of all these financial variables contribute to an increase in the range of future expected returns.

The earnings measure of risk would suffice, assuming that investors hold a portfolio of only one stock. Since most do not hold only one stock, the risk inherent in these fluctuating variables can be minimized or completely reduced by investor actions. This being the case, risk as measured by these variables could be meaningless to a majority of investors. This financial concept will be expanded and justified in the next chapter.

A measure more supported by empirical and theoretical study is the market beta. This involves the analysis of company stock prices and how they fluctuate with a market proxy of all stocks. The market beta is the measure of perceived risk which will be used in this study.

The second research variable concerns the measure of energy consumption or dependence. It is desirable to derive an energy intensity figure versus pure energy consumption. To do so, energy consumption must be related to a production or value of shipments figure. Energy consumption per unit of output is the measure used in this study and exact calculations and explanations are given in Chapter III.

The above discussions have given a general description and explanation of the intent and reasoning for this study. Following will be a discussion of the scope or limitations of the study, as well as a summary of the proceedings.

Scope of Analysis

This study involves both longitudinal and cross sectional analyses generated by using primary data. The data is regressed and tabulated and the final results are presented for observational analyses. The final output variables, energy intensity and a risk indicator are not correlated but their movements are analyzed both by tabular and graphical representation.

No correlation analysis is performed on energy shocks or price increases, instead this analysis consists of analyzing observationally the risk perception before, during and after the supply shock periods. The study is limited to the manufacturing sector. This should not hinder the results, however, as this sector accounts for almost 40 percent of domestic energy consumption.[8]

Summary of Study

Chapter I has dealt with introducing the concepts of energy consumption and dependence, energy importance, and the risk of supply interruptions. Major research variables were chosen, and the scope of this study was discussed.

Chapter II discusses energy and how it relates to major economic variables. Findings of previous studies will be presented. The risk concept as mentioned above is analyzed, following financial theory as well as empirical evidence. Discussion of the time period and major supply shocks will conclude Chapter II.

Chapter III presents the methodology involved in gathering and processing the data. Derivation of both energy and risk indicators will be discussed.

Chapter IV analyzes the results generated from the data. Hypotheses of expected results are presented and defended. The actual results are analyzed and any deviations from expectations are discussed. The final portion of Chapter IV presents possible limitations and their effects on the outcome of this analysis.

Endnotes

[1]"Scorecard on Energy," Dunn's Review, June 1977, pp. 54-57.

[2]Andre Van Dam, "Economic Aspects of Energy Conservation," USA Today, January 1982, pp. 27-29.

[3]James Cook, "The Great Conservation Fallacy," Forbes, May 10, 1982, p. 156.

[4]David A. Deese and Joseph S. Nye, Energy and Security (Cambridge: Ballinger Publishing Co., 1981), p. 303.

[5]Ibid., p. 3.

[6]Howard T. Odum and Elizabeth C. Odum, Energy Basis for Man and Nature (New York: McGraw Hill, 1976), p. 1.

[7]Richard T. Stinson, "Energy Crisis: Who Is Helped Who Is Hurt," Financial World, November 28, 1973, p. 27.

[8]John G. Myers and Leonard Nakamura, Saving Energy in Manufacturing (Cambridge: Ballinger Publishing Co., 1978), p. 4.

CHAPTER II

LITERARY REVIEW

Energy

Webster defines energy as the capacity of being active or doing work. Production in the manufacturing sector constitutes a significant proportion of total domestic activity or work. Similarily, energy consumption in manufacturing is a significant component of total domestic energy use. The demand for energy can be derived in the production process or in the form of final demand. Direct consumption of energy as a production output is a form of final demand. The consumption of products whose production is energy induced represents a derived demand or indirect energy consumption. Energy consumption in manufacturing is predominantly of an indirect nature, with possible exceptions in the petroleum and coal products industry. According to Myers and Nakamura in their study on manufacturing energy use,

> At any time, the total amount of energy used in manufacturing depends on the level and composition of demand for manufactured products, the price of energy, the quantities of capital equipment available for use in production, and the level of technology.[1]

The energy sources pertinent to this study consist of the five major energy sectors. These include coal, natural gas, electricity, crude and refined petroleum. Electricity and natural gas account for 75 percent of the energy consumed by manufacturers.[2]

The use of some type and quantity of energy is required in almost all production processes. Widespread use has significant impact on the substitution possibilities needed to reduce the effects of undesirable price changes. According to economic theory, as the price of input "A" increases, the consumption or demand for input "B" should increase, assuming they are substitutes.

Substituting labor for capital is one form of energy conservation. The magnitude of this substitution is limited however by the required need of some amount of energy. This amount of energy has been referred to by some to contain properties similar to those of fixed costs.[3] Also, efficiency and capacity considerations further limit labor-capital substitution especially in the short run.

Another form of substitution occurs between different sources of energy. Fuel oil for natural gas or natural gas for electricity are two examples. Problems occur here due to different facility requirements for each source. Retooling and sufficient planning time limit substitutions. The government also restricts substitution possibilities by maintaining high pollution and emission standards. An effective means for analyzing energy substitutions is to estimate their price elasticities.

Elasticities

Robert Halvorsen, in his study on the empirical price sensitivities of the major energy sources, analyzed both absolute and cross price elasticities. With the exception of electricity all the absolute price elasticities calculated exceeded unity. These values are as follows: electricity -.92, fuel oil -2.82, natural gas -1.47 and -1.52 for coal.[4] The negative sign indicates a normal economic good; quantity demanded responds inversely to price changes. The aggregate demand for the energy sources appears to be somewhat price sensitive. Conservation efforts therefore are directly related to energy prices.

The substitution of one source of energy for another was studied by Halvorsen in his calculation of cross price elasticities. His results indicated wide variations across industries. The results did portray the energy sources as substitutes as opposed to compliments. Fuel oil shows the greatest cross price elasticity with respect to electricity and natural gas. All other values are less than unity, with the majority of the price elasticities remaining under .5.

Given the price responsiveness of energy sources, Hamilton Treadway exposes the transmission of energy price increases to the economy.[5] He concludes that the first effect of price increases is inflationary, affecting both direct and indirect energy consuming sources. The second effect translates into a reduction in aggregate output and employment. Specific studies involving this second effect are discussed in the following section.

Energy Growth and GNP

Several studies have been conducted relating energy consumption to major economic variables. One study in particular was conducted by Hamilton Treadway in 1977.[6] His study included analyzing year to year changes in energy growth and correlating them to similar changes in GNP. The data was collected during 30 year period from 1947-1977. Results indicated a one to one relationship between the growth in GNP and energy. Or in other words, a 10 percent annual growth in GNP requires a 10 percent growth in energy consumption. Several studies conducted since 1971 indicate the same direct relationship, however the magnitude of such a relationship has fallen significantly. A study conducted by Andre van Dam in 1982 confirms the reduction in the magnitude of the relationship between energy consumption and GNP.[7] He assesses, that in 1940 it took 120,000 BTU's to produce one real dollar of GNP, whereas today it requires only 50,000 BTU's. He states that the reduction in the energy/GNP ratio can be explained by a higher proportion of capital and energy intensive goods and services or in other words, production economies of scale. His conclusions indicate an energy/GNP growth relationship of approximately .667. In a study by James Cook on energy conservation, his discussions with petroleum industry leaders led to an approximate of a .4 to .5 relationship.[8] Even though the decline in the energy/GNP ratio reduces the impact of energy supply problems, a 50 percent contribution margin to the nation's growth in production is a very significant factor.

Energy Growth and Employment

The relationship between labor and energy has been given some attention to the discussion of substitution possibilities. Hamilton Treadway, in his study of energy growth, confirms that in general, energy and labor are substitutes.[9] The empirical relationship between the growth of energy and employment rates yields importance to the substitution concept.

The energy-labor relationship has been addressed by Treadway. Using the same correlational analysis as he did with GNP, he assesses the growth rate in energy necessary to maintain full employment. An unemployment rate of three percent historically requires an energy growth rate of seven to nine percent a year. Maintaining a four percent level of unemployment requires only a five to six percent annual growth in energy consumption.

Treadway also estimates that five to six percent growth in energy consumption can be maintained through a six to seven percent annual increase in GNP. These statistics of energy consumption give emergence to the connection of employment and GNP and how energy consumption could be considered as a transmission mechanism for this relationship.

Production Effects

Treadway goes further in his analysis, by estimating the impact of energy cost changes to operating production capacities. He estimates that the 1973 embargo may have reduced our economic capacity by as much as four to five percent. For a given amount of technology and fixed resources, a rise in the price of energy, a variable resource, will reduce capacity, translating into a rise in the firm's long-run average cost. This price/capacity relationship is magnified by the intensity of energy consumption in the manufacturing process. Since rising prices are a spillover cost of reduced availability of supplies, capacity as well as cost constraints accompany energy interruptions.

Cyclical Activity

From the studies relating energy to the major economic variables, one can infer a pro-cyclical movement of energy consumption and the economy. This inference is justified by many empirical studies.[10,11] A study conducted by a conference of energy authors confers precious decisions of energy consumption.[12] They regard energy as containing a component similar to a fixed cost, which results in high use per unit of output when production is slow and opposite in growth years. This indicates an inefficiency due to the fixation of a portion of the firm's resources and cost structure. Therefore, even though the cyclical actions of energy consumption and economic activity are direct, they are not proportional, giving rise to an inverse relationship between economic activity and energy output ratios.

Conservation

In reaction to past rising prices and limiting supplies, the nation has experienced reductions in industrial and consumer demand. The reduction in industrial consumption takes one of two forms. The first being termed housekeeping changes. This could be the capturing of process heat or the converting of wastes to energy sources. The second form of industrial conservation involves production changes. This is more long term in nature and provides for the changing of facilities to accommodate alternative energy sources. Both of these changes include efficiency increases, further reducing energy consumption.

The reduction in consumer demand takes many forms. Habit changing reactions such as carpooling, buying smaller houses and cars, lowering thermostats and less traveling have caused significant reductions in demand. The government itself has had a hand in affecting consumption rates. However, through their price controls, safety standards and emission controls, their overall affect has likely been negative. With conservation efforts heightened worldwide, world oil consumption fell 10 percent from 1979-1981, domestic industrial sectors' consumption per unit of output fell 17 percent between 1973 and 1980. Over the same period, household consumption fell 12 percent.[13] Many economists argue however that these reductions were due to curtailments, normal price/demand reactions or the recent structural shifts away from energy intensive goods. Whether these efforts are considered conservative in nature is not as important as the effects of these reductions. Referring back to the discussion on the association between energy consumption and leading economic indicators, it is even questionable if conservation efforts are in the nation's best efforts. Reductions in energy consumption should bring rises in unemployment and reductions in GNP and productive capacity. One possible argument lies in the fact that these relationships are declining in magnitude. This decline may be a continuing adjustment due to rising efficiencies and structural changes. If this is the case, conservation efforts in the future will have less harmful impacts on economic conditions.

Alternative Energy Sources

The growing uncertainty of energy supplies and the rising prices of the seventies have prompted many studies involving alternative energy sources. Research and development efforts have been increased across all industries in an effort to find a cheaper, renewable and plentiful energy source. The alternative sources receiving the most attention and experimentation include solar and nuclear fuels. Other studies involve using the earth's geothermal heat as an energy source. The power of the wind is an old source of energy, and scientists are trying to expand and develop its use through windmills. The forces of the sea may prove to yield future power through tidal flows and wave power. The burning of organic material, or biomass, has received attention yet remains a very low priority. A final alternative source of power is the oil trapped in shale or tar sands. The problem lies in the cost of extraction, with research being conducted to minimize this cost. The growing research into new sources of energy implies a desire to be self-supporting in the future, not dependent on foreign sources. It is this present energy dependence which causes uncertainty and risk. This risk and how it is measured is the subject of the next section.

Risk

As discussed in the introducing pages of this study, the uncertainty of energy supplies and the inability of firms to adapt to shortages in the short run pose a risk to the company. The risk contains both a systematic or undiversifiable risk and an unsystematic or diversifiable risk. The former is related to market risk or broad stock market movements while the latter is caused by variations in earnings, sales, costs, etc. These forms of risk are translated to the stockholder and depending on his portfolio have different levels of importance.

Diversifiable Risk

Risk in a portfolio is considered diversifiable if, by adding stocks with the proper earnings correlation, the range of expected returns is reduced. Diversifiable risk is due to fluctuations of financial variables inherent in the firm of the underlying stock. Variations in dividends, earnings and earnings per share for example, cause uncertainty as to the return received by investing in the firm. The uncertainty or fluctuation in these financial variables is specific to the firm and can be considered essentially random. However in an efficient portfolio of stocks, the unsystematic risk can be eliminated. An important concept in eliminating diversifiable risk is the correlation coefficient. The correlation coefficient is a measure of the covariation of the returns of two stocks. Two stocks, perfectly negatively correlated, will cause upward swings in one stock to be offset by downward swings in the other. This is the concept known as diversifying, or eliminating fluctuations of one stock by adding a stock whose fluctuations are the opposite. Complete opposite correlation is a sufficient but not necessary condition. The addition of several stocks with less than perfect negative correlations would also diversify the portfolio. The variations in these stocks which are not accountable to overall market movements will be eliminated. Hence, a measure of diversifiable risk is not important to investors who hold an efficient portfolio of stocks. The risk remaining is the risk inherent to the market, or the movements of the stock with the market as a whole. The risk of general market swings is known as systematic or undiversifiable risk.

Systematic Risk

The risk inherent in the market as a whole, or the risk which cannot be diversified by adding counter-correlated stocks to a portfolio, is systematic or undiversifiable in nature. Systematic risk affects all firms simultaneously. It is the relevant risk in an efficient portfolio of stocks. Systematic risk is related to broad swings in the stock market and is measured by the extent to which a given stock tends to move up and down with the market. The level of systematic risk is affected by macro forces such as inflation, high interest rates and recession. Since systematic risk results from changes in the stock market, it is often called market risk.

A Measure for Market Risk

A measure developed in financial theory and tested by many researchers involves the market beta concept. Beta is an index of risk relating company stock movements to overall stock market fluctuation.

Returns on individual securities are driven by macroeconomic events. These events will affect investor perceptions to the extent that the following three factors are affected: 1) The responsiveness of the assets' return to economic events, 2) The relation between the firm's basic characteristics and the characteristics of firms in the market, and 3) The general uncertainty attached by investors to macroeconomic events. Factors one and two can be represented by the covariance of the assets' returns to that of the market. Factor three is described as the variance of the market. This gives rise to the formula: beta = covariance (RjRm)/variance (Rm), (Rj; return on asset j, Rm; return on the market). Any changes in the above structural relationships will cause changes in the beta coefficient. Beta, therefore, is the ratio of the marginal risk of the security to the risk of the market, or a measure of the relative volatility of the stocks' returns to that of the market. The premium expected return on a risky asset is proportional to the premium return on the market, with the value of beta being the measure of proportionality. Therefore, beta is the index for determination of premium returns. For example, a beta greater than one indicates a relatively more volatile stock and requires a premium return greater than the market premium.

To estimate an index of riskiness between the market and an individual firm, an easier method than calculating variances and covariances can be used. This method involves simple linear regression.

Beta Estimation

Using regression for beta calculations requires stock returns data from both the firm in question and the market as a whole. With the market returns as the independent variable and the firm returns as the dependent variable, fitting a least square regression line to these data points will result in both alpha and beta estimations. The method of alpha and beta estimations will be discussed in detail in the following chapter.

Summary of Risk Measurement

The previous discussion has given insight into the concept of risk and its measurement. In summary, of interest is that portion of risk undiversifiable and inherent in the market. The best measure of this is found by the convariability of firm stocks with the portfolio of all risky assets. Changes in economic conditions affecting the market will affect the firm itself, the extent of which is dependent upon the firm's beta. It is these such economic conditions of the past that are essential in examining the systematic risk and energy relationships. To assist in more closely approximating the relationship between energy supply and risk, supply interruption periods will be compared with periods of energy supply stability to analyze changes in overall risk levels.

Supply Shocks

In October of 1973, the Arab Nations, member of the Organization of Petroleum Exporting Countries, declared an embargo on exports to the United States. Shipments of 800,000 barrels of oil a day were halted entirely. Petroleum and related energy prices quickly escalated. This period quickly became known as the "energy crisis."

In early November of 1979, 62 Americans were seized by the Iranian military. In response to this attack, on November 12, 1979, President Jimmy Carter ordered an immediate suspension of all imports from Iranian sources. American reaction spurred conservation efforts never before seen. This period constitutes the second energy crisis involved in the time frame of this study.

A conference board of energy authors surveyed executives from large energy intensive firms to get their response to the outcomes of such crisis periods.[14] The responses indicated that the degree of awareness has heightened significantly. Assignments of high level management to research and development and study teams accelerated and more funds were allocated for new capital equipment and research, both basic and applied. Also, more precise attention was given to ways of accounting for energy usage, specifically switching to the use of accounting of BTU's.

The period of analysis includes the years 1972-1982. This period is broken down into three sub-period classifications. The years 1972 and 1973 were transitional, accompanied by escalating prices and dependence. The years to follow, 1974, 1975 and 1976 are deemed as crisis years. These years were plagued by rapid energy price escalations and reductions in supply. The economy rebounded in the years 1977, 1978 and 1979 and hence will be considered a normal period. Since the Iran importation embargo occurred late in 1979, the crisis or supply restricted period will be 1980. Finally, the periods 1981 and 1982 will be considered normal, as far as energy supply statistics are concerned. Therefore, the supply involves four crisis years for analysis and seven periods of relative supply stability. Comparatively, the normal years will serve as standards so as to monitor the effect of the supply shortages on risk perceptions.

Summary

The above text has been offered as a background to the pertinent subjects involved in this study. From these pages, one can see the importance of energy, its supply and consumption. Impacts on growth, Gross National Product and employment are significant factors affecting the competitiveness and longevity of firms and industries. The availability of energy directly affects consumption and in turn the economic variables discussed in this chapter.

To assess the importance of the impacts of energy consumption a measure of financial variation was introduced and discussed. The level of movement in this measure of financial risk during periods of supply availability and interruption is the context of this study. The methodology for this type of analysis is the subject of the following chapter.

Endnotes

[1]John G. Myers and Leonard Nakamura, Saving Energy in Manufacturing (Cambridge: Ballinger Publishing Co., 1978), p. 2.

[2]Ibid., p. 15.

[3]Myers and Nakamura, Manufacturing, p. 18.

[4]Robert Halvorsen, "Energy Substitution in U. S. Manufacturing," The Review of Economics and Statistics, November 1977, p. 381.

[5]Hamilton Treadway, "The Economies of Energy Growth," Public Utilities Fortnightly, September 15, 1977, p. 16.

[6]Ibid., p. 12.

[7]Andre Van Dam, "Economic Aspects of Energy Conservation," USA Today, January 1982, p. 29.

[8]James Cook, "The Great Conservation Fallacy," Forbes, May 10, 1982, p. 156.

[9]Treadway, "Economics," p. 381.

[10]Myers and Nakamura, Manufacturing.

[11]John G. Myers et al., eds., Energy Consumption in Manufacturing (Cambridge: Ballinger Publishing Co., 1974).

[12]Ibid., p. 11.

[13]Myers et al., Manufacturing, pp. 16-17.

[14]Myers et al., Manufacturing, pp. 8-16.

CHAPTER III

RESEARCH METHODOLOGY

Introduction

The purpose of the following discussion is to familiarize the reader with the research methods employed in this study. The study contains two major sub-sections. As discussed earlier, a longitudinal analysis is performed to assess the reaction of beta to energy supply shocks. The second analysis involves a cross-sectional look at the manufacturing sector to assess the impact of energy intensity on perceived risk levels. By limiting the analysis to the manufacturing industry, little significance is lost, because the manufacturing industry represents approximately 40 percent of domestic energy consumption. The pieces of analysis will be broken down into major subsections, the first dealing with energy consumption and intensity factors.

Energy Consumption

In order to measure energy consumption on a basis significant to actual intensity, energy consumption was measured against the industry's value of shipments. The data was collected from The Census of Manufacturers, 1977 edition.[1] The year 1977 was chosen to represent a midpoint in the longitudinal study and to keep away from crisis periods.

The measure of energy consumption involves purchased fuels and electricity consumed. This figure is sometimes labeled as gross energy consumption. According to a study conducted by a conference of energy authors, they assess that "Gross energy consumed is the relevant measure from the point of view of the economy, for it reveals the demand of the industry on the energy resource base."[2] The unit of measurement involves BTU's consumed.

The industries in the manufacturing sector and their energy consumption figures can be seen in Table I below.

TABLE I

ENERGY CONSUMPTION BY MANUFACTURING SECTOR

SIC CODE	INDUSTRY GROUPS	MILLION BTU'S CONSUMED
	All Industries	12,929.0
20	Food and kindred industries	952.4
21	Tobacco products	20.8
22	Textile mill products	339.2
23	Apparel and other textile products	65.6
24	Lumber and wood products	227.7
25	Furniture and fixtures	52.7
26	Paper and allied products	1,308.4
27	Printing and publishing	92.3
28	Chemicals and allied products	2,978.5
29	Petroleum and coal products	1,303.4
30	Rubber and miscellaneous plastic products	272.3
31	Leather and leather products	23.1
32	Stone, clay, and glass products	1,251.8
33	Primary metal industries	2,539.4
34	Fabricated metal products	395.3
35	Machinery, except electrical	339.6
36	Electric and electronic equipment	249.3
37	Transportation equipment	389.9
38	Instruments and related products	78.4
39	Miscellaneous manufacturing industries	49.1

SOURCE: United States Bureau of Census, Census of Manufacturers, Washington, D. C.: United States Government Printing Office, 1977, p. 34.

The method for converting energy consumption to energy intensity involves the industry's value of shipments. The value of shipments gives a measure of production, which, when weighed against gross energy consumption, allows comparison between industries' energy efficiency or intensiveness. Table II shows the value of shipments figure and the calculated intensiveness indices.

TABLE II

ENERGY USE PER VALUE OF SHIPMENTS

INDUSTRY	MILLION BTU'S CONSUMED	SHIPMENT ($ MILLION)	ENERGY/OUTPUT INDEX
Food & Kindred	952.4	192,912	.0049
Tobacco	20.8	9,051	.0023
Textile	339.2	40,551	.0084
Apparel	65.6	40,245	.0016
Lumber	227.7	39,919	.0057
Furniture & Fixtures	52.7	16,978	.0031
Paper	1308.4	52,089	.0251
Printing	92.3	49,716	.0019
Chemicals	2978.5	118,154	.0252
Petroleum	1303.4	97,453	.0134
Rubber	272.3	39,553	.0069
Leather	23.1	7,607	.0030
Stone	1251.8	35,477	.0353
Primary Metal	2539.4	103,179	.0246
Fabricated Metals	395.3	90,024	.0044
Machinery	339.6	122,188	.0028
Electronics	249.3	88,433	.0028
Transportation Equipment	389.9	166,954	.0023
Instruments	78.4	28,898	.0027
Miscellaneous	49.1	19,151	.0026

SOURCE: United States Bureau of Census, Census of Manufacturers, Washington, D. C.: United States Government Printing Office, 1977, pp. 34-37.

The energy/output ratios will enable one to observe categories by which can be labeled high, medium, and low energy intensities. This ranking is observational in nature and involves establishing categories based on the clustering of values. The breakdown of energy intensive categories can be seen in Table III.

The energy intensive categories will serve as a guide to the analysis of the energy-risk relationship. It is the individual energy intensive categories that will be observed against their corresponding betas. The betas will also be analyzed over time in each category.

The foregoing discussion establishes energy intensive categories. To continue the analysis, the levels of risk, or beta, that apply to each category must be estimated.

TABLE III

ENERGY INTENSITY BY SIC CODE

SIC Code	Industry
HEAVY ENERGY INTENSITY	
22	Textile
26	Paper
28	Chemicals
29	Petroleum
32	Stone
33	Primary metal
MODERATE ENERGY INTENSITY	
20	Food
24	Lumber
25	Furniture
30	Rubber
31	Leather
32	Fabricated metals
LIGHT ENERGY INTENSITY	
21	Tobacco
23	Apparel
27	Printing
35	Machinery
36	Electronics
37	Transportation
38	Instruments
39	Miscellaneous

Risk

The analysis of risk calls for a substantial amount of data gathering. Following a brief introduction to the source of these data bases, the research method itself will be examined.

Data Base

The Center for Research in Security Prices (CRSP), located out of the Graduate School of Business at the University of Chicago, maintains a data base involving firm and market stock returns.[3] This data base is referred to as the CRSP tapes. These tapes maintain an up to date listing of both daily and monthly stock returns for each firm listed on the New York Stock Exchange (NYSE).

The tapes consist of master files, index files and return files. The master files maintain a list of all companies by SIC code, CUSIP, (identification number) and firm name. The return and index files list the returns for the individual firm and the market as a whole respectively. Once accessed, the data is stored in a file accessible only by the user. The gathering of the data involves four separate programs, which will each be discussed in turn.

Company Returns Acquisition

In order to allow storage for the data desired, a user data file must be established. This file initialization allows the storage of the programs used in gathering the data and allows access by file name. Each written program is given the user data file number so as to ensure proper storage.

The first data base acquisition involves the master file, or the listings of all company returns. The output from the program lists the companies by name, SIC code and CUSIP number. The first two digits of the SIC code relate to the industry within the manufacturing sector. By limiting firm selection to the SIC code parameters of the manufacturing sector, only firms within the manufacturing sector will be represented in the sample. This base of manufacturing companies serves as the population for a sample of three hundred firms. One hundred firms within each energy intensive category will be randomly chosen from the individual data base population.

The energy intensive ratios calculated earlier established parameters from which the firms will be chosen for each energy use classification. In order to assure adequate observations, one hundred firms were randomly chosen in each of the three energy intensive categories. The CUSIP number of each firm allows access to that company's returns.

The returns from chosen companies are accessed from the CRSP tapes. The CRSP tapes provide access to both monthly and daily stock returns as well as returns involving all distributions or only cash distributions.

The returns generated in this study involve capital gains yield plus the yield from all distributions to stockholders. The returns are calculated on a monthly basis from 1972 through 1982.

In order to facilitate easier data processing, a single return for all one hundred firms within each category was calculated by month. A simple averaging of each of the one hundred returns was conducted, limiting the output to a single return factor for each energy category. The program itself is run three times, one for each set of energy intensive firms. This involves changing only the CUSIP number inputs and leaving the computer program intact. Each successive run is given a new name and stored in the data file.

The returns established in the above section form the dependent variable used in estimating the beta parameters. The independent variable estimation is the subject of the following section.

Market Index Returns Acquisition

In order to monitor the individual returns covariation with market returns, a market proxy must be established. The CRSP tapes provide a market proxy comprised of all the firms listed on the NYSE. The chosen index is equally weighed and generates returns based on capital gains and dividend yields. In order to facilitate the congruence of the company return file and index return file, an averaging loop is involved in the index program as well. The output of this program lists the average monthly returns of all firms on the NYSE from the period 1972-1982. This forms the second part of our dependent-independent variable relationship. At this point, the data file contains information pertaining to the company returns of the three energy intensive categories and the returns on the market proxy. Regression of the firms' returns to the returns of the market will produce the desired risk estimate, beta.

Beta Estimation

To facilitate regression analysis, a statistical package entitled Statistical Analysis System (SAS), is used.[4] SAS is a computer system for data analysis that involves many applications. The particular function called upon in this study involves the use of the general linear model of regression. This follows the least squares principle and estimates the factor relating the dependent and independent variables.

The SAS program can access the stored data files by data set name. The stored data files from the previous discussion are the sole input to the regression program.

In order to facilitate the analysis of the longitudinal portion of this study, yearly data is necessary. To accomplish this, several data sets were established. By accessing only 12 observations from the company return file, yearly data sets can be generated. Doing the same for the market index files generates a total of 22 data sets, two sets for each of the eleven years.

By initializing the company data sets as the dependent variable and the market data sets as the independent variable, SAS will regress the two sets to generate a beta factor. By regressing one data set at a time, yearly figures are generated. Along with the beta coefficients, the SAS program generates significance numbers and r2 values. The values generated are presented in Chapter IV and are used for the final observational analyses.

Summary

The method of research pertaining to this study involves two main processes, data gathering and data processing. The data gathering consisted of establishing energy intensive categories. In each of these categories, the returns of one hundred randomly generated companies were established. Returns pertaining to a market proxy were gathered as well. The returns from the companies and the market served as inputs to the regression analysis. The final output from this methodology produced risk estimates from each energy intensive category from the years 1972-1982. This output will facilitate both the longitudinal and cross-sectional study, which is the text of Chapter IV.

Endnotes

1. U. S. Bureau of Census, _Census of Manufacturing_, Washington, D. C.: U. S. Government Printing Office, 1977, pp. 32-38.

2. John G. Myers et al., eds., _Energy Consumption in Manufacturing_, Cambridge: Ballinger Publishing Company, 1974, p. 8.

3. _Center for Research in Security Prices_, Graduate School of Business, University of Chicago, 1983, 2:40.

4. June T. Helwig, "SAS Introductory Guide," _SAS Institute_, 1978.

CHAPTER IV

RESULTS AND CONCLUSIONS

The final chapter presents two main hypotheses of results. Expected output from both the cross-sectional and longitudinal data will be discussed. The actual results will be presented in both graphical and tabular form and any deviations from expectations will be examined.

Expected Results

The first hypothesis centers on the cross-sectional data as it pertains to the different energy classifications. It is expected that as energy intensity increases the risk as it pertains to the overall swings with the market will also increase. The high energy intense sector should show a higher beta on average than both the moderate and low intensity sectors.

The second hypothesis is broken down into two sub-hypotheses and concerns the longitudinal data. It is expected that the betas in the different energy classifications should all increase during the crisis periods examined. In addition to this, it is expected that the proportionality of the beta increases will vary directly with energy intensity.

Several arguments can be made to support the above hypotheses. Firms with higher energy dependence will be relatively more capital intensive as compared to less energy intensive firms. This higher capital intensity will lead to relatively higher financial and operating leverage. With a high level of financial leverage a firm will face a higher proportion of fixed costs relative to lower leveraged firms. As input prices increase the margin on a unit of output can remain constant only if these cost increases can be completely pushed forward to the final consumer. To the extent all costs can't be pushed forward, those firms whose fixed costs represent a greater portion of total costs, will see a more dramatic decline in revenues. Given this, it can be argued that overall downswings in the economy could be magnified by the extent to which a firm is highly leveraged. On the other side, with highly leveraged firms, economics of scale exist and the long run average cost curve should show a relatively steeper negative slope, indicating upswings in overall economic activity could be magnified as well.

To the extent the output of these firms is not perfectly price inelastic, price increases will cause reductions in demand. Reduced output levels will equate to reductions in product margins. These margin reductions should be magnified by the extent to which fixed costs represent a greater proportion of a firm's financial structure.

Firms who employ less energy intensive production facilities will enjoy a somewhat more flexible financial structure. Lower financial and operating leverage should reduce the relative impact of rising energy costs. At the same time, economies of scale do not exist and the firm adheres to a relatively flatter long run average cost curve.

In summary, it is expected that the large energy cost increases during the supply shock periods will be translated to the market place in the form of higher betas. This increase in variation of stock returns should increase with increasing dependence on energy as an input.

Several studies have been conducted yielding supportive evidence for the above hypotheses. A study conducted by S. L. Myers in 1975 suggested an empirical relationship between systematic risk and financial variables such as leverage, earnings and growth.[1] He found effects on leverage similar to the aforementioned arguments. Several studies have since been conducted confirming both a theoretical and empirical relationship between leverage and systematic risk.[2,3] A study conducted by Frank Fabozzi and Jack Francis found that a firm's leverage was the single most positively influencing factor in determining swings in beta among several variables analyzed such as financial indicators, size, competitiveness and technology.[4]

Investor perceptions are a significant key in determining any financial return of an asset. To the extent investor perceptions conform to the theoretical propositions and empirical evidence presented, one should expect light energy intensity firms to show a relatively lower more stable beta than both moderate and heavy energy consumers.

Actual Results

The results of the statistical regression can be seen in Table IV. This table is used to address the first hypothesis. By observing Table IV, it is obvious that the data does not support our expectations and earlier suppositions. The light energy intensive sector's beta averaged 1.14 over the eleven year period from 1972 to 1982. Comparitively, the moderate use sector averaged .99 and the heavy intensity sector averaged .95. It is evident from the results that the heavy energy dependent firms are able to minimize shocks and market swings and transmit a smaller portion of these overall swings to the investor.

TABLE IV

ENERGY INTENSITY AND BETA

	YEAR	BETA	R^2	STANDARD ERROR OF ESTIMATE
LIGHT				
	1972	1.23	.91	.12
	1973	1.16	.97	.07
	1974	.99	.97	.05
	1975	1.23	.97	.06
	1976	1.33	.90	.14
	1977	.97	.94	.08
	1978	1.25	.98	.05
	1979	1.14	.93	.10
	1980	1.09	.90	.12
	1981	1.08	.85	.14
	1982	1.10	.94	.09
MODERATE				
	1972	.98	.78	.17
	1973	1.15	.98	.05
	1974	1.00	.99	.04
	1975	1.00	.92	.10
	1976	.89	.91	.09
	1977	.87	.90	.09
	1978	1.00	.96	.06
	1979	.82	.93	.07
	1980	1.00	.92	.09
	1981	1.01	.90	.11
	1982	1.13	.97	.07
HEAVY				
	1972	1.04	.92	.10
	1973	.99	.95	.07
	1974	.80	.96	.05
	1975	.94	.93	.08
	1976	.87	.98	.04
	1977	.83	.92	.08
	1978	1.05	.96	.07
	1979	.94	.91	.09
	1980	1.01	.96	.06
	1981	.99	.88	.12
	1982	1.01	.99	.04

To explain these results several scenarios can be presented. Perhaps the energy intensive firms are seen by investors as technologically superior. Through technological expertise and perhaps extreme conservation efforts these firms are absorbing these changes more effectively and transmit relatively less of these fluctuations to the market place. Firms characterized by energy dependence are obviously highly dependent on energy prices and hence will equip themselves to minimize price fluctuations. An example would be the use of alternative energy sources, the most common of which is fuel oil and natural gas substitution. To the extent a firm can substitute energy sources in the short-run, given the available technology, they are able to minimize the effects of rising input prices.

Other explanations involve the primary product produced by these industries. If the products are subject to intense competition, regulation, technological observations and so forth, this perception will carry to the industry as well. An examination of the firms in the individual categories indicates that the firms themselves within each grouping can alter the results to the extent they are similar in size, output, structure, etc. The heavy use industries are characterized by large chemical, petroleum, textiles, metals and paper industries. On average, these industries are strongly vertically integrated and in some instances are totally self-sufficient. From this, price or cost increases in one sector of the firm may be contributory to earnings, while sectors further in the production line may absorb these price increases, with the end result being very little fluctuation in total company earnings. This type of integration is becoming more prevalent in industries such as petroleum and chemicals and helps to insulate earnings from uncontrollable variables. Also, the industries in the heavily intensive sector are complimentary in nature. Interdependence of inputs and feedstocks between these industries may have affected the results.

The light energy intense industries, tobacco, apparel, printing, machinery, electronics and instruments are highly divergent from one another. The products in this category are somewhat specialized, and to a large extent, these products should be relatively more price elastic. Also, several key inputs to the apparel, printing, machinery, and electronics industries come from the chemical, steel and textiles industries. To the extent the energy cost increases were pushed forward to the primary consumer, as discussed earlier, the lighter intense industries could be the major recipient of these cost increases and could therefore incur larger variances of returns. The price elasticity of the end product would determine the extent of which the light use industries could further pass an increase in costs to the final consumer.

In summary, the cross-sectional data yielded results indicating that energy intensive firms were able to minimize the effects of substantial energy price increases more effectively than less intensive firms, and in turn, transmit less of these fluctuations to the market. Light energy users were seen as being the least effective in minimizing the effects of energy price swings. The nature of the individual light energy intense firms and the possibility of these industries absorbing a majority of transferred energy costs seems to be the best explanation for the deviation from expectations.

The final portion of this study deals with the analysis of beta over time. The two areas to be addressed include the absolute movements during the time period and the relative magnitude of these movements across the energy classifications. The graph in the Appendix has been provided to aid in the observational analysis.

The data concerning the first supply shock period, 1974-1976, shows little conformance to our expectations. The light energy use sector shows the most dramatic increase, with beta increasing 33 percent over this three-year period. The moderate energy sector shows a slight decline in beta while the heavy energy use sector beta rises in 1975, only to fall slightly in 1976. These results indicate the light energy sector was unable to absorb this market instability without transmitting a major portion of risk to the investor. The heavy energy use sector showed a slight susceptibility to market influences but maintained a beta less than average for that sector throughout this time period. Several factors contributing to these results are important.

The first supply shock, 1974-1976, was preceded by years of intense inflation and rising energy prices. During the years 1972 and 1973, the industries were subject to price increases and perhaps expected continual increases in the future. In other words, this period was transitional in nature and spurred conservation efforts and process efficiency increases to minimize the impact of continued rising prices. This transitional period helped to minimize the effects of further energy price escalations.

The drastic reduction in oil imports in late 1973 and the subsequent years of limited imports had some positive effects on industries as well. While the general level of demand dropped during this period, overall demand still exceeded available supply, hence rising prices. This deficiency was reduced in subsequent years by increases in domestic production. The increases in domestic production produced favorable effects to the economy and to the perceptions of investors. Since the petroleum industry represents a significant portion of the energy intensive sector, increases in domestic production should have a favorable effect on this sector's financial stability.

Price elasticity and the ability to pass along costs, as discussed earlier, helps to explain the results. To the extent the output from the heavy use industries, petroleum, chemicals, etc., are relatively more price inelastic, the consumers will absorb a higher relative proportion of the energy costs. A relatively price inelastic good helps the industry to maintain product margins and more importantly maintain dividends and returns to investors.

The nature of products and the businesses involved in the light energy use sector affect the ability of these industries to absorb price increases and correspondingly transmit less financial variations to the marketplace. In general, the industries in the light use category, as described earlier, sold their goods to the final consumer. Prices for these goods, given moderate competition, are much more price inelastic than the goods from the heavily intensive sector. Therefore, the maintenance of product margins for the light use industries is more difficult. To the extent the light energy intensive industries sell their goods directly to the final marketplace, these goods are subject to relatively more macro economic forces than goods sold as feedstocks or process inputs. The general economic times of the 1970's, wage controls, price controls and high inflation further limited the ability of the light energy use sector to insulate changing resource costs from the end consumer.

The ability of the heavy energy use sector to pass forward the rising energy costs to the purchasers of the products minimized the adverse financial impact on them. To the extent the end products of the heavy intensive sectors are feedstocks to the light use sectors, and the products from the light use sectors are relatively price inelastic, the ability of the heavy intensive sector to pass forward rising energy costs provides relatively more stable earnings for the heavy intensive sector at the expense of the light use sector.

In summary, the transitional years of 1972 and 1973, characterized by inflation and rising energy costs, played an important role in transmitting information to the industrial sectors. The ability to adjust consumption and plant process facilities in the short run (1972-1975) reduced the overall impact. Increases in domestic production dramatically affected the heavily intensive sector as did their ability to pass forward rising energy costs. These factors and others mentioned above are possible arguments in the defense of the actual results presented. The final analysis period, 1980, denotes a somewhat different story.

The supply shock period of 1980 was transmitted to the public and the industries much more abruptly than the previous interruption. The years immediately preceding this period were not transitional in nature and were characterized by relatively lower inflation and slower rising energy costs. This is depicted by comparing the betas from all groups in the early 1970's to the closing periods of the study. Industries had very little reaction time and prices rose dramatically during a relatively short time frame.

As can be seen in Table IV and the Appendix, the second period of analysis more closely conforms to the expected results than the first period, but still does not support all of our expectations. The heavily intensive sector rose seven percent from 1979 to 1980, but the moderate intensive section showed the largest increase, 22 percent, during this time period. The light energy use sector showed a decline during this period and shows a slight increase throughout the remaining years. The moderate use industry shows an increase of 13 percent throughout the remainder of the study. In analyzing the relative movements between the moderate and heavy use sectors it is obvious there are significant factors other than energy costs that are affecting investors' perceptions and industry betas.

The moderate use sector perhaps does not possess the process technologies and the substitution methods relative to the heavy use sector. Fixed process techniques and substitution capabilities partially explain the dramatic relative rise in the moderate sector. The heavy use sector perhaps was caught somewhat off guard. The immediate price rise and supply reduction again spurred domestic production and conservation efforts. Without previous warnings, as was the case in the earlier period, the actions and reactions by the heavily intensive industries took more time to work. In other words, industries are likely to be unable to maintain or alter their betas in the short run. The rise in 1980 shows the initial shock, subsequent efforts maintained this level throughout the remainder of the analysis. It seems also that the heavy use industries were unable or less efficiently able to pass forward rising costs, as evident by the rise in heavy use sectors' betas and decline in light use sectors' betas.

The period 1981 and 1982 was a boom period for the domestic petroleum industry. Profits were high and stock values grew considerably. Government regulations hampered industry efforts and imported production slowly began to rise. These conditions were a significant factor in maintaining the heavy use industry's betas as compared to the significant rise in the moderate use industry's betas.

From the investor's viewpoint, the shock was more dramatic and abrupt, and the interruption was due to a single supply country. This portrayed relatively more vulnerability than the previous period and hence more of the risk was transmitted to the marketplace.

Summary

This study was conducted to demonstrate a direct empirical relationship between energy intensity and a measure of an industry's undiversifiable risk. In addition to this, suppositions were made as to the relative reactions of an industry's beta during periods of energy supply uncertainty. The magnitude of beta movements across the energy classifications was expected to move directly in proportion to energy intensity.

The actual results differed somewhat from the hypotheses presented. The overall betas were higher for the lighter energy intense sections as compared to the heavy use sectors. The movement of the betas did not appear to bear a direct relationship to the industry's energy intensity.

The major arguments presented in support of the results included technological efficiencies, passing forward costs, conservation and energy source substitution. The general level of economy stability and the conditions preceding each supply interruption period had a significant impact on the results.

In closing, it is evident from the results that several other factors beyond the scope of this paper have a significant impact on investors' perception of risk. From this study, however, it can be seen that the rising costs of energy are of prime concern to the industries who are less likely to be able to pass these costs forward.

Further investigation is needed to show empirical support for this and other factors significantly affecting a firm's systematic risk. The final section of this chapter deals with possible limitations and the effect they might impose on this study.

Limitations

All empirical studies have assumptions or procedures which may limit their applicability. Already mentioned is the limit of the study to the manufacturing sector. This, however, is not a major problem since the manufacturing sector consumes a significant amount of the nation's energy supply.

The problems of observational analyses versus the statistical approach was brought out in the close of chapter one. Not regressing the calculated betas against the energy/output ratios is the single most limiting problem of this study. However, it was felt that the classifications of intensity were obvious enough so as not to hinder their associations with the supply shocks. The statistical approach would have only helped the cross-sectional portion and was therefore seen as limiting in itself.

The data gathering procedure is, too, not without limitations. To begin with, although evidence supports the use of randomly generated portfolios, perhaps some attention should have been given to the major firms within each industry. This method may, however, have given returns more closely approaching individual company statistics versus the sector as a whole.

By using monthly data, the index and returns were limited to the companies listed on the NYSE. This is not a major consideration for the energy classes with the exception of possibly limiting the data base to choose from. More serious problems arise in the designation of a market proxy. The index used may therefore not be an efficient enough proxy, or in other words, may not be sufficiently representative of the market for all risky assets. Although evidence supports the use of equal weighed portfolios, one could argue that in limiting the market to the NYSE, a value weighed index would have been a better proxy. However, only empirical studies yielding conclusive results could solve this problem. The returns file for the industries represents three portfolios of one hundred stocks, each with the same weight given to determine beta. Again, arguments could be presented for the use of a value weighted portfolio, giving preference to industry leaders. This would structure the beta to be more characteristic of the industry leaders and less a measure of cross-sectional industry risk and was therefore discarded. The use of the cross-sectional returns in these industries may also minimize interindustry differences, thereby reducing the correlation between the risk indices and energy intensity.

Another problem involves the industry returns. As mentioned, the one hundred company returns were averaged to obtain one observation per period. This simple averaging could also reduce period by period fluctuations minimizing reactions to the supply shocks. This, however, would place much more emphasis on the observational results in determining correlations with the supply shocks.

The final factor affecting the applicability of the industry portfolios is the use of all distributions in calculating returns. This introduces the problem of the returns being affected by things other than price appreciation. However, it was felt that the complete return provided a much better measure of actual investor returns. Also, the inclusion of cash dividends allows the data to reflect short term company distribution decisions which would be influenced by cash flow problems.

The final section of the research involved the regression program. The limitations of the regression approach center on measurement periods and the market proxy. No overlapping data was used and monthly data incorporated. No significant empirical results have favored one time period over the next. The final limitation is the use of the twelve observations to derive beta. This problem yields no concern as significant r^2 values were found.

In closing, this study is not without the usual limitations of any cross-sectional and/or longitudinal study. The reasoning presented in the previous section, as well as portions of the previous chapters, and the support of several empirical studies, more than justifies the significance of the outcome of this analysis.

Endnotes

[1]S. L. Myers, "A Re-Examination of Market and Industry Factors in Stock Price Behavior," Journal of Finance 28 (June 1973).

[2]Robert Bowman, "The Theoretical Relationship Between Systematic Risk and Financial Variables," Journal of Finance 34 (June 1979):617-628.

[3]W. Beaver, P. Kettler, and M. Scholes, "The Association Between Market Determined and Accounting Determined Risk Measures," Accounting Review 45 (October 1970).

[4]Frank J. Fabozzi and Jack Clark Francis, "Industry Effects and Determinants of Beta, Quarterly Review of Economics and Business 19 (No. 3):62-74.

SELECTED BIBLIOGRAPHY

An Energy Input-Output Matrix for the United States, 1963: Users Guide. Urbana, Illinois: University of Illinois, March, 1973.

Annual Survey of Manufacturers. Washington, D. C.: U. S. Government Printing Office, 1976.

Beaver, W., Kettler, P., and Scholes, M. "The Association Between Market Determined and Accounting Determined Risk Measures." _Accounting Review_ 45 (October 1970):78-90.

Bowman, Robert. "The Theoretical Relationship Between Systematic Risk and Financial Variables." _Journal of Finance_ 34 (June 1979): 617-630.

Brigham, Eugene F. _Financial Management Theory and Practice_. Hinsdale, Illinois: Dryden Press, 1979.

Buell, John. "On the Energy Crisis." _The Progressive_, January, 1976, pp. 24-25.

Bureau of the Budget. _Standard Industrial Classification Manual, 1967_. Office of Statistical Standards. Washington, D. C.: U. S. Government Printing Office, 1967.

Center for Research in Security Prices. Graduate School of Business. University of Chicago, 1983.

Cook, James. "The Great Conservation Fallacy." _Forbes_, May 10, 1982, pp. 156-157.

Crawley, Gerald M. _Energy_. New York: MacMillan Publishing Co., 1975.

Deese, David A., and Nye, S. Joseph. _Energy and Security_. Cambridge: Ballinger Publishing Co., 1981.

Eden, Richard, et al, eds. _Energy Economics_. Cambridge: Cambridge University Press, 1981.

"Energy Conservation." _Business Week_, April 6, 1981, pp. 58-64.

"Energy Consumption." _Monthly Energy Review_ (March 1975):2-13.

"Energy Crisis: Easing But Not Over." _U. S. News and World Report_, November 8, 1982, p. 17.

"Energy Impact: Less Than Feared." Business Week, December 22, 1973, pp. 113-115.

Fabozzi, Frank J., and Francis, Jack Clark. "Industry Effects and Determinants of Beta." Quarterly Review of Economics and Business 19 (No. 3):61-74.

Federal Energy Administration. National Energy Outlook: 1976. Washington, D. C.: U. S. Government Printing Office, 1976.

Halvorsen, Robert. "Energy Substitution in U. S. Manufacturing." The Review of Economics and Statistics (November 1977):381-388.

Harrington, Diana R. Modern Portfolio Theory and the Capital Asset Pricing Model. Englewood Cliffs, New Jersey: Prentice Hall, 1976.

Helwig, Jane T. "SAS Introductory Guide." SAS Institute, 1978.

Hinton, Deane R. Energy: Continuing Crisis. Bulletin 81, Department of State Bulletin, February, 1981.

Mancke, Richard B. Providing for Energy: Report of the Twentieth Century Fund Task Force on the United States Energy Policy. New York: McGraw Hill, 1977.

Modighani, Franco, and Pogue, Gerald R. "An Introduction to Risk and Return: Concepts and Evidence Part II." Financial Analysts Journal (May-June 1974):69-86.

Myers, John G., and Nakamura, Leonard. Saving Energy in Manufacturing. Cambridge: Ballinger Publishing Co., 1974.

Myers, John G., et al., eds. Energy Consumption in Manufacturing. Cambridge: Ballinger Publishing Co., 1974.

Myers, S. L. "A Re-Examination of Market and Industry Factors in Stock Price Behavior." Journal of Finance 28 (June 1975):580-596.

Odum, Howard T., and Odum, Elizabeth C. Energy Basis for Man and Nature. New York: McGraw Hill, 1976.

Richardson, Harry W. Economic Aspects of the Energy Crisis. Lexington Books, 1975.

"The Scorecard on Energy." Dunn's Review, June 1977, pp. 54-57.

Stoubaugh, Robert R., and Yergin, Daniel. Energy Future. New York: Random House, 1979.

Stanford Research Institute. Patterns of Energy Consumption in the United States. Prepared for the Office of Science and Technology, Executive Office of the President. Washington, D. C.: U. S. Government Printing Office, January, 1972.

Treadway, Hamilton. "The Economics of Energy Growth." _Public Utilities Fortnightly_, September 15, 1977, pp. 9-18.

U. S. Bureau of Census. _Census of Manufacturers_. Washington, D. C.: U. S. Government Printing Office, 1977.

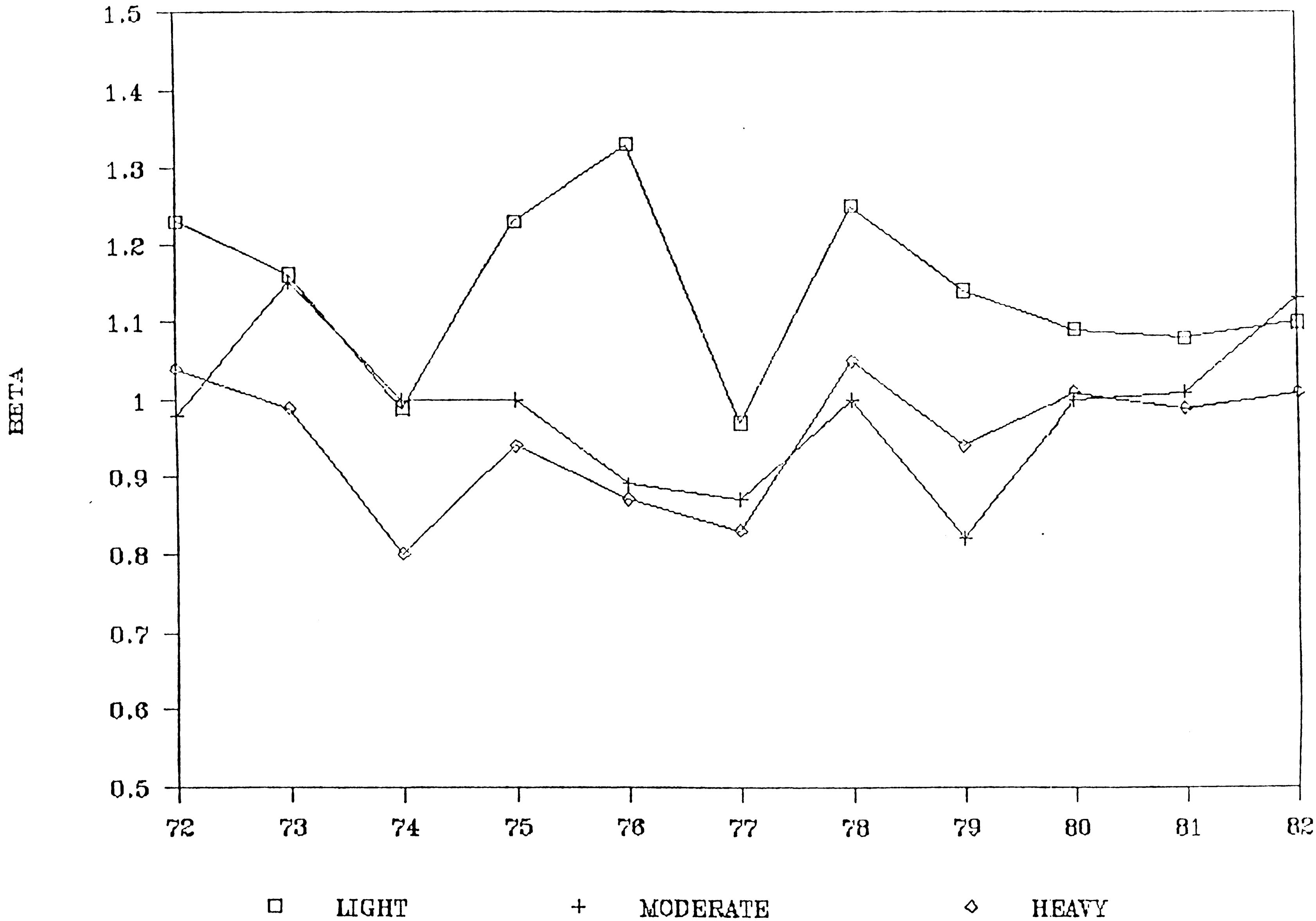
U. S. Department of Commerce. "The Input-Output Structure of the U. S. Economy 1967." _Survey of Current Business_, February 1974.

Van Dam, Andre. "Economic Aspects of Energy Conservation." _USA Today_, January 1982, pp. 27-29.

"What the Oil Cutbacks Will Cost." _Business Week_, October 27, 1973, pp. 30-31.

APPENDIX

ENERGY AND RISK



VITA

David Allen Nicks

Candidate for a Masters Degree of

Business Administration

Thesis: ENERGY SUPPLY AVAILABILITY: THE IMPORTANCE TO INDUSTRIES AND INVESTORS

Major Field: Business Administration

Biographical:

Personal Data: Born in Ponca City, Oklahoma, September 19, 1960, Son of Jerry A. and Joy A. Nicks. Married to Melissa Ann Burns on December 29, 1981; daughter Christin Ann Nicks, born March 15, 1985.

Education: Graduated from Putnam City High School, Oklahoma City, Oklahoma, May, 1978; received Bachelor of Science Degrees in Finance and Economics from Oklahoma State University in May 1982; completed requirements for a Masters in Business Administration Degree at Oklahoma State University in December 1986.

Professional Experience: Associate Analyst, Conoco Inc. January 1984 to August 1984, Administrative Assistant, Conoco Inc., August 1984 to December 1985, Administrative Coordinator, Conoco Inc., December 1985 to present.