PRICE RELATIONSHIPS BETWEEN RESOURCE BASED STOCK PRICES AND COMMODITY PRICES

By Alan J. Stevenson

A Thesis Submitted to the Faculty of Graduate Studies in Partial Fulfilment of the Requirements for the Degree of

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Department of Agribusiness and Agricultural Economics
University of Manitoba
Winnipeg, Manitoba, Canada

THE UNIVERSITY OF MANITOBA

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ABSTRACT

The purpose of this study is to empirically examine the price transmission and lead-lag relationships between stock prices of resource based firms and related commodity or stock index prices. The resulting information of this study may be of interest to investors, including investment fund managers interested in developing decision methods for resource based stocks. Data is included for twenty-five firms from resource and cyclical industries.

Price transmission relationship results show that individual stock prices are more closely related to the S&P 500 index futures price than to the related commodity futures price. This indicates that the price transmission relationship is stronger between the S&P 500 index futures price and a firm's stock price, while weaker for commodity futures price and a firm's stock price. However, the results did not show high coefficient or R^2 values, therefore the commodity futures or stock index futures markets are unlikely to be close markets for hedging resource based stock prices.

Lead-lag relationships results suggest that there are significant lead-lag relationships between related commodity futures prices and stock prices, and between S&P 500 index futures prices and stock prices. Lead-lag results also suggest that the related commodity price leads the stock price more often than the S&P 500 index futures price leads the stock price. Lead-lag results also show that there are considerably more relationships between the S&P 500 index futures price and stock price than between the related commodity price and stock price.

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CHAPTER 1

INTRODUCTION

OBJECTIVE

Investors often hold resource based firms' stocks in their portfolio and theory would suggest that there might be relationships between resource based firms' stock prices and the underlying commodity prices or stock index prices. This relationship would occur as a result of interaction between the 2 markets. For example, if a resource price such as lumber were to rise, then in theory a forestry firm such as Georgia-Pacific Corp. would see an increase in profits. Due to the increase in profits, demand for Georgia-Pacific Corp. stock would increase, in turn increasing the firm's stock price. The stock price would rise until it equalizes the additional profits earned due to the increase in lumber prices. Likewise, a relationship between a stock index price and a firm's stock price may cause similar price movements.

Investors might be interested in these types of relationships as they may gain information that could improve decision making for resource based investments. The objective of this study is to empirically analyze the price transmission and lead-lag relationships between resource based firms' stock prices and the underlying commodity futures and stock index futures price. The implication of this study is that significant price transmission or lead-lag relationships between these markets could be studied by investors to improve their investment decisions for resource based investments.

DATA

Stock prices for twenty-five resource based firms are chosen for this study. Five resource sectors are used as follows: agriculture, utilities (interest rates), lumber, metals including copper and gold, and crude oil including integrated, oil producers and oilfield services. The S&P 500 index futures price is used for the stock index comparison. Closing prices are used for the stock, commodity futures and stock index futures prices. Daily data is used for the fifteen year period from January 1, 1984 to December 31, 1998.

More recent data is not used due to the large number of mergers and acquisitions in the following years, which would reduce the number of firms that could be used. Examples of these mergers include: GTE Corp. merger with Bell Atlantic in 2000, Exxon and Mobile merger in 1999, Arco and BP merger in 2000, Chevron and Texaco merger in 2001 and Ranger Oil acquisition by Canadian Natural Resources in 2000.

PRICE TRANSMISSION RELATIONSHIPS

By studying the price transmission relationships between the markets, an investor might be able to predict the amount of a price movement in the commodity futures price that might be expected in the stock price of a resource based firm. Chapter 2 studies the price transmission relationships between resource based firms' stock prices and their underlying commodity futures or stock index futures prices. Cointegration is first examined using the Engle-Granger procedure. It is a common belief that pairs of economic variables should not diverge from each other by a great amount. If the spread between 2 variables are mean reverting, the values move together over the long term and the values are 'cointegrated'.

The price transmission relationship between resource based stock prices and commodity futures prices is examined. The results are analyzed to determine if there are significant price transmission relationships. The implication of significant price transmission relationships between resource based stock prices and the underlying commodity futures or stock index futures prices is that investors could use this information for making investment decisions.

LEAD-LAG RELATIONSHIPS

Chapter 3 examines the lead-lag relationships between both the commodity futures price and stock index futures price and the stock price of resource based firms. If these relationships are found to be significant, an investor might be able to predict which markets lead the other and the length of time that it takes for information to be transferred between the markets. An investor might make investment decisions in order to capitalize on those price movements. For example, if the lumber futures price were to lead the Georgia-Pacific Corp. stock price by 3 days, upon seeing an increase in the lumber futures price, an investor may purchase Georgia-Pacific Corp. stock and then expect an increase in that stock price approximately 3 days later. The implication of this study is that investors might be able to predict the time and direction of price movements in the dependent market by the price movements in the independent market. The investor could then make investment decisions to capitalize on these predictions.

SUMMARY

Chapter 4 summarizes and discuses the results of this study. The significance of price transmission and lead-lag relationships between resource based firms' stock prices and the underlying commodity futures prices or stock index futures prices are presented and their implications for practical use by investors.

CHAPTER 2

PRICE TRANSMISSION RELATIONSHIPS BETWEEN RESOURCE BASED STOCK PRICES, COMMODITY FUTURES PRICES, AND STOCK INDEX FUTURES PRICES

INTRODUCTION

The objective of this chapter is to empirically examine the price transmission relationship between the underlying commodity price and the stock price of various cyclical and resource based firms that produce a given commodity or use that commodity as an input. The S&P 500 index futures price is used as well to examine its relationship with individual stock prices.

An implication of this study is that investors, including investment fund managers, may be able to gain information from the commodity future markets and S&P 500 index futures markets and their relationships with stock prices. The investor or fund manager could then use this information, for example, to buy lower valued stocks and sell higher valued commodities, such as buying Exxon stock and selling short crude oil on the futures market.

This study is organized as follows. First the theoretical framework of price transmission between commodity or stock index futures prices and stock prices is developed and discussed. Next, choice of data, data sources and construction of the models used are explained. Results are explained for price transmission between commodity futures price and stock price and then between the S&P index futures price and stock price, followed by a summary.

THEORY

Price may be transmitted between the commodity futures market and stock market through time, space, or form. All 3 dimensions may be of interest, depending on the commodity or the firm involved. Time is a factor where commodities are storable and held for considerable periods of time. Space becomes a factor when the resource must be transported from the production area to an end use destination. Form becomes a factor if the commodity is processed into a higher valued product where it takes on a new or enhanced form. Theory further suggests that there should be price transmission between the related commodity price and the stock price of a firm producing that commodity. For example, an increase in the value of the related commodity such as oil should increase the earnings and increase stock price of an oil producing firm due to the resulting increase in investor demand for the firm's stock. Likewise an increase in the price of a commodity input would decrease the earnings and stock price of a manufacturing firm that uses the input, reducing the demand for stock and the stock price for that firm.

Past Studies and Price Transmission

While literature is somewhat limited, research has shown a link between stock and commodity prices. Previous studies have found that a gold mining firm's stock price is related to the price of gold (Blose and Shieh, 1995; Faff and Chan, 1998; Gramza, 2000; Tufano, 1998), while oil prices do influence oil company stock prices (Sadorsky, 2001; Strong, 1991). Likewise, a firm that is using the commodity as an input should see its stock price fall due to the increased costs that lower profits (Bary, 1996; Doherty, 1999; Haines, 1997; Tufano, 1998).

Previous studies also show that a resource or cyclical firm's stock price could be closely related to a stock index (Faff and Chan, 1998; Sadorsky, 2001). That is, if the stock index price were to rise then the firm's stock price would often be expected to rise as well. Examples of factors that would influence both the individual stock prices and the stock index future prices include interest rates, GNP (Gross National Product) and inflation rate. These factors cause the stock index and individual stock prices to be related. As an example, if interest rates were to drop, a firm's stock price and the stock index price would increase for the following reasons; (1) GNP would increase as consumers would be willing to borrow and spend more, increasing demand for products, thereby increasing profits of firms which would increase demand for stocks; (2) the lower interest rate would reduce financing costs of the firm and increase investment opportunities, as well as cause increased consumer borrowing and spending, again increasing the profits and the demand for stocks. On the other hand, an increase in the inflation rate is generally viewed as unfavorable for stock prices, given the uncertainties associated with inflation, resulting in lower stock prices.

Price Transmission and Beta

A regression coefficient of 1 for the relationship between the stock price and the corresponding commodity price represents 1 to 1 price transmission. Likewise a regression coefficient of 1 for the relationship between the stock price and stock index price represents a 1 to 1 price transmission relationship. The coefficient size for beta for the stock index price could be influenced by factors such as the firm's leverage and risk profile, size and diversification of the firm. In general, the more risky a firm's cash flow, the more risky its stock price and the higher the beta it will exhibit.

R^2 can be used to show the degree to which stock price variations can be attributed to variations in the commodity futures price or the stock index price. R^2 values of 1 show a perfect statistical fit of the model and the strongest relationship between the commodity price or the stock index price and the stock price.

DATA AND PROCEDURE

Data

Daily data is used for the fifteen year period from January 1, 1984 to December 31, 1998, and is included for twenty-five resource based stocks, commodity futures, including agricultural, interest rates, lumber, metals and petroleum as well as the S&P 500 index futures. Due to the cyclical nature of resource commodity and stock prices, data from a time period long enough to cover at least 1 cycle is required. This data is prior to some of the mergers and acquisitions that occurred within resource industry following 1998 and so provides a larger number of firms to analyze. Daily data is used in order to analyze the short term behavior in relationships between the markets.

Nearby futures prices are used rather than cash commodity prices because a more reliable set of futures prices is available. As well, a number of analysts are believed to pay more attention to futures prices rather than cash prices as futures prices are expected to contain cash price expectations and can be used to hedge or cross hedge. Futures markets can also be used for cross hedging by taking short positions, for example. Commodity futures prices are from the USA and London, while S&P 500 index futures price data is used from USA. Stock values are included for the NYSE (New York Stock Exchange), with the data adjusted for stock splits. Daily closing prices are used for all commodity and stock index futures and stocks. Commodity futures prices are from Technical Tools database and stock prices are from the CRSP (Center for Research in Security Prices) database.

Cointegration

Often it is believed that certain pairs of economic variables, wages and prices for example, should not diverge from each other by too great an extent, at least in the long run (Granger, 1986). There are a large number of papers devoted to the analysis of cointegration (Johansen, 1991, Johansen and Juselius, 1990, Kugler and Lenz, 1993), and empirical studies in macroeconomics often involve nonstationary and trending variables. When the error term of stationary data is random around a mean, the data is referred to as being integrated, but when there is a trend in the error term around the mean the data is referred to as being nonstationary. When studying 2 variables, if the spread between those variables are mean reverting, values are tied together in the long term by a common stochastic trend, and the values are 'cointegrated' (Alexander, 2001). For example, if stock $price_t$ minus commodity $price_t$ gives a stationary error term then the stock and commodity prices are referred to as being 'cointegrated'. For example, to remove the above trend in the error term, the stock price and futures price could be first differenced.

To test for cointegration, the Engle-Granger test is used (Engle and Granger, 1987). There are 4 reasons that the Engle-Granger test is often the preferred and most popular method for financial time series (Alexander, 2001):

1) This method is fairly straightforward to implement and to interpret.
2) From a risk management point of view the Engle-Granger criterion of minimum variance for deriving hedge ratios is usually more important than the Johansen criterion of maximum stationarity.
3) There is sometimes a natural choice of dependent variable in the cointegrating regressions.
4) The Engle-Granger small sample bias may not be a problem since sample sizes are often sufficiently large in financial analysis and the cointegration vector is super consistent.

Two steps are used for the Engle-Granger procedure. First, estimate an OLS (Ordinary Least Squares) regression on the data and second, apply a stationarity test such as the ADF (Augmented Dickey Fuller) test to the residuals from this regression (Alexander, 2001).

ESTIMATION PROCEDURES

Commodity Futures Price and Stock Price Relationship

The first part of this study analyses the daily relationships between commodity future price and stock price. For example, if the oil futures price rises by

1 percent, the corresponding percentage change in an integrated oil company stock value will be given by the coefficient b, estimated using a returns (percentage change in price) model as follows:

$$s_t = \alpha_s + b_s c_t + \varepsilon_t \quad (2.1)$$

where s_t is the firm's stock price, α_s is the intercept, and b_s is the percentage rise in the firm's stock price from a 1 percent increase in the related commodity futures price, c_t is the related commodity futures price and ε_t is the error term.

In formulating a model to study the price transmission relationships between the underlying commodity and the stock price, the model may have problems with nonconstant variance (heteroskedasticity) and autocorrelation due to the nature of financial prices and using a 1 variable time series model. To correct for possible heteroscedasticity, the natural logs of stock price are used as follows:

$$s_t = log\ s_t \quad (2.2)$$

$$c_t = log\ c_t \quad (2.3)$$

Further to correct for possible autocorrelation, a first difference or returns model is used. From formulas *(2.2) and (2.3)* gives:

$$S_t = s_t - s_{t-1} \quad (2.4)$$

$$C_t = c_t - c_{t-1} \quad (2.5)$$

Substituting *(2.4)* and *(2.5)* into *(2.1)* creates the following returns equation that is estimated:

$$S_t = \alpha_s + b_s C_t + \varepsilon_t \quad (2.6)$$

where S_t is the first difference of the log of firm's stock price, α_s is the intercept, and b_s is the percentage rise in the firm's stock price from a 1 percent increase in the related commodity futures price and C_t is the first difference of the log of the related commodity futures price. The b may also be viewed as the hedge ratio, which is the amount of commodity futures needed to hedge 1 unit of corresponding stocks (Stein, 1961).

S&P 500 Futures Price and Stock Price Relationships

Likewise the relationships between S&P 500 index futures price and stock prices are analyzed using the following returns model:

$$S_t = \alpha_s + \beta_s I_t + \varepsilon_t \qquad (2.7)$$

where S_t is the first difference of the log of the firm's stock price, α_s is the intercept, and β_s is the percentage rise in the firm's stock price from a 1 percent increase in the S&P 500 index futures price and I_t is the first difference of the log of the S&P 500 index futures price.

RESULTS

Cointegration Results

The results for the Engle and Granger test for stock price and the underlying commodity futures price are shown in Table 2.1. When the stock prices are regressed against the commodity futures prices, the hypothesis of no cointegration is rejected for only 5 of the 25 firms. These results indicate that there is not a strong long term relation between commodity futures prices and individual stock prices in most cases.

Test results for stock price and the S&P 500 index futures price are shown in Table 2.2. When the stock prices are the dependent variable, the hypothesis of no cointegration is rejected for only 2 of the 25 firms. These results indicate that for most firms there is not a strong long term relationship between the index price and individual stock prices.

Stock Price and Commodity Price Relationship Results

Stock price and commodity futures price statistical relationships using daily returns data are displayed in Table 2.3 (relationships using monthly data are displayed in Appendix C for comparison). A significant coefficient indicates that the coefficient is not equal to 0, and therefore the price movements of the commodity futures market and the stock market are related. The closer the value of the coefficient is to 1, the greater the degree that the 2 markets move together. The degree of price transmission between the commodity futures market and the stock market is analyzed by examining the coefficient. A significant coefficient would confirm that there is a strong relationship between the 2 markets. The degree that the markets move together varies through the sectors. Factors such as industry type, location, size of firm, diversification and degree of processing may affect a firm's stock price relative to a futures price.

Overall, in the agricultural sector, one coefficient is significant at the 5 percent level with a coefficient of 0.06. The utility sector is somewhat more affected by interest rate futures, as debt is an input, and utilities utilize heavy borrowing and high debt to equity ratios. (The price transmission coefficient is positive because T-Bill interest rate futures prices are 100 – discount rate). The coefficients all are significant at the 5 percent level and range from 0.56 to 0.64. Lumber firm coefficients range from 0.09 to 0.11, with all 3 significant at the 5 percent level. Metals sector firms stock prices appear to be related to commodity futures to a large extent. The coefficients range from 0.37 to 1.76 and all are significant. Smaller firms show the highest coefficients. Of particular interest are the gold mining companies where coefficients range from 1.19 to 1.76. This is similar to Tufano's (1998) results where the coefficients range from 1 to 2. In the petroleum sector, companies are categorized into 1 of the following groups: 1) integrated, 2) producers and 3) services. Coefficients for integrated oil companies range from 0.05 to 0.13. Oil producers' coefficients range from 0.11 to 0.16. Oilfield service stock prices are affected the most with coefficients ranging from 0.10 to 0.24. All petroleum sector company coefficients are significant at the 5 percent level.

The degree to which firms' stock price variations can be attributed to the commodity price variation differs across the sectors, though the R^2 would be expected to be quite low, given the use of daily data. In the agricultural sector the R^2 is low, at 0.00 for both firms, indicating that agricultural futures prices have little relation to a firm's stock price for daily price movements. For interest rate sensitive stocks, the R^2 varies from 0.07 to 0.10 indicating that interest rates do have some explanatory power on the stock price of the rather highly leveraged utility companies. In the resource sector, lumber products R^2 are 0.01 for all 3 firms, which is slightly higher than the agricultural sector but still showing that the commodity futures price has minimal effect on the stock price. The R^2 for the metals sector varies from 0.09 to 0.36. This indicates the highest impact of the commodity prices on the stock prices of all the sectors. However, the R^2 is lower for larger companies, as well as companies that are diversified in the metals they produce. In the petroleum sector, the integrated oil companies R^2's range from 0.01 to 0.05, indicating the highest impact of crude oil futures price on the oil companies' stock prices. The R^2's are 0.02 for both oil producers. Oil field services R^2's are 0.01 for the 4 companies, which show the lowest affect of the crude oil futures price on the stock price.

Stock Price and S&P 500 Index Futures Price Relationship Results

Stock price and S&P 500 index futures price statistical relationships using daily returns data are displayed in Table 2.4 (for comparison relationships using monthly data are displayed in Appendix D). The betas are statistically significant at the 5 percent level across all firms and sectors with the exception of 2 small gold mining companies. The significant betas confirm that there is a relationship between the S&P 500 index futures prices and share prices.

The betas in the agricultural sector are close to 1.00, with values of 0.72 and 0.78, indicating these companies' stock prices move in a similar pattern to the S&P 500 index futures. In the interest rate (utility) sector, the betas range from 0.47 to 0.74 (the beta sign is positive because T-Bill interest rate futures prices are 100 – discount rate). This indicates a somewhat high degree of movement of the 2 markets together, although it is less than the agricultural sector. In the resource sector, lumber betas range from 0.78 to 0.90, indicating a high degree of movement together. The betas vary greatly for the metals sector, ranging from –0.05 to 0.75. In the petroleum sector the betas for the integrated companies varies from 0.45 to 0.73. The oil producer companies' betas are recorded at 0.44 for both firms. In the petroleum sector, these showed the lowest degree of movement in the markets together. The oil field services companies' betas range from 0.62 to 0.90. In the petroleum sector, the service companies' stock prices show the closest relationship with the S&P 500 index futures prices.

The degree to which stock price variations of the stocks traded on the NYSE can be attributed to the S&P 500 index futures is in general higher than for the underlying commodity futures prices. The R^2's for the agricultural sector are 0.20 and 0.25. In the interest rate sector, R^2's range from 0.24 to 0.33. In the lumber sector the R^2's are in the 0.24 to 0.31 range. The R^2's for the metals sector range from 0.00 to 0.18. The higher R^2's occur for larger mining companies that are more diversified in their mining operations. In the petroleum sector, the R^2's for the integrated companies range from 0.14 to 0.37. For oil producers the R^2's are 0.04 and 0.06. The oilfield service companies' R^2's range from 0.02 to 0.22.

SUMMARY

The objective of this chapter is to empirically examine the price transmission relationships between the related commodity futures prices and the stock price of various cyclical and resource based firms that produce a given commodity. The S&P 500 futures index price is also used to examine its relationship with individual stock prices. Daily data is used for the fifteen year period from January 1, 1984 to December 31, 1998, and are included for twenty-five resource based stocks, commodity futures, including agricultural, interest rates, lumber, metals and petroleum as well as the S&P 500 index futures. The markets were tested for cointegration and the results show that there is not a strong long term relationship between the commodity futures prices and stock prices, as well as between the stock index prices and stock prices for resource based companies.

Stock prices are regressed against the related commodity futures price as well as the S&P 500 index futures price using a first difference log or returns model. The significant coefficients show that there is price transmission between the related commodity futures price and a firm's stock price. However, results show that the level of price transmission is greater between the S&P 500 index futures price and a firm's stock price, as the betas, with 5 exceptions in the utilities and metals sectors are substantially closer to 1 when compared to the coefficients between the commodity futures prices and stock prices.

In general the R^2's, a 1 degree of price variation in a firm's stock price that can be attributed to the variation in the commodity futures price is also lower than what can be attributed to the variation in the S&P 500 index futures price. This is shown by the substantially higher R^2's in results for the S&P 500 index futures price and stock price regressions, over the commodity futures price and stock price regressions. The exceptions are 2 gold mining firms that are not well diversified. In general, both the S&P 500 index futures and various commodity futures markets did not consistently show high coefficient values and R^2 values when regressed with stock price. Therefore, these markets would unlikely be close markets for hedging the stock prices.

Table 2.1: Commodity/Stock Augmented Dickey Fuller (ADF) Cointegration Tests (1984-1998)

Sector:	Dependent Variable: Stock Price	Independent Variable: Commodity Futures Price	ADF
Agriculture	Deere & Co.	Soybeans	-1.82
	Monsanto	Soybeans	-0.10
Interest Rate	Bell Atlantic	U.S. T-Bonds	-1.26
	Con. Edison Inc.	U.S. T-Bonds	-0.97
	GTE Corp.	U.S. T-Bonds	-2.16
Resources			
Lumber	Champion International	Lumber	-3.12*
	Georgia-Pacific Corp.	Lumber	-4.14*
	Weyerhaeuser	Lumber	-3.90*
Metals	Phelps Dodge	Copper	-0.97
	Coeur d'Alene Mines Corp.	Gold	-3.81*
	Homestake Mining Co.	Gold	-3.01
	Newmount Mining Corp.	Gold	-3.52*
Petroleum			
Oil Integrated	Arco	Crude Oil	-1.76
	Chevron	Crude Oil	-0.68
	Exxon	Crude Oil	-0.64
	Mobile Corp.	Crude Oil	-0.34
	Occidental	Crude Oil	-2.34
	Royal Dutch Petroleum Ltd.	Crude Oil	-1.52
	Texaco	Crude Oil	-0.76
Oil Producers	Apache Corp.	Crude Oil	-1.51
	Ranger Oil	Crude Oil	-2.35
Oil Services	Global Marine Inc.	Crude Oil	-1.56
	Halliburton Co.	Crude Oil	-1.61
	Schlumberger Ltd.	Crude Oil	-1.69
	Smith International	Crude Oil	-1.72

* indicates statistical significance at 10 percent level and rejection of null hypothesis of no cointegration.

Table 2.2: S&P 500 Index/Stock Augmented Dickey Fuller (ADF) Cointegration Tests (1984-1998)

Sector:	Dependent Variable: Stock Price	Independent Variable: S&P 500 Index Futures Price	ADF
Agriculture	Deere & Co.	S&P 500 Index	-2.20
	Monsanto	S&P 500 Index	-2.16
Interest Rate	Bell Atlantic	S&P 500 Index	-3.02
	Con. Edison Inc.	S&P 500 Index	-2.29
	GTE Corp.	S&P 500 Index	-2.54
Resources			
Lumber	Champion International	S&P 500 Index	-2.53
	Georgia-Pacific Corp.	S&P 500 Index	-1.65
	Weyerhaeuser	S&P 500 Index	-2.33
Metals	Phelps Dodge	S&P 500 Index	-0.22
	Coeur d'Alene Mines Corp.	S&P 500 Index	-3.35*
	Homestake Mining Co.	S&P 500 Index	-2.70
	Newmount Mining Corp.	S&P 500 Index	-2.70
Petroleum			
Oil Integrated	Arco	S&P 500 Index	-1.17
	Chevron	S&P 500 Index	-2.55
	Exxon	S&P 500 Index	-3.11*
	Mobile Corp.	S&P 500 Index	-1.67
	Occidental	S&P 500 Index	-2.59
	Royal Dutch Petroleum Ltd.	S&P 500 Index	-0.86
	Texaco	S&P 500 Index	-2.35
Oil Producers	Apache Corp.	S&P 500 Index	-0.86
	Ranger Oil	S&P 500 Index	-2.61
Oil Services	Global Marine Inc.	S&P 500 Index	-1.40
	Halliburton Co.	S&P 500 Index	-2.22
	Schlumberger Ltd.	S&P 500 Index	-1.07
	Smith International	S&P 500 Index	-2.18

* indicates statistical significance at 10 percent level and rejection of null hypothesis of no cointegration.

Table 2.3: Daily Price Transmission Coefficient from Commodity Futures Price to Stock Price: Returns Model (1984-1998)

Sector	Dependent Stock Price	Independent Commodity Futures Price	Price Transmission Coefficient	Alpha	R^2	DW Statistic
Agriculture	Deere & Co.	Soybeans	0.06*	0.03	0.00	1.81
			(2.38)	(0.82)		
	Monsanto	Soybeans	0.03	0.06	0.00	1.93
			(1.25)	(1.94)		
Interest Rates	Bell Atlantic	U.S. T-Bonds[a]	0.64*	0.04	0.09	2.04
			(19.50)	(1.68)		
	Con. Edison Inc.	U.S. T-Bonds	0.56*	0.03	0.10	2.03
			(20.75)	(1.643)		
	GTE Corp.	U.S. T-Bonds	0.61*	0.03	0.07	2.19
			(16.79)	(1.25)		
Resources Lumber	Champion International	Lumber	0.09*	0.01	0.01	1.90
			(5.30)	(0.28)		
	Georgia-Pacific Corp.	Lumber	0.11*	0.02	0.01	1.76
			(6.28)	(0.68)		
	Weyerhaeuser	Lumber	0.09*	0.02	0.01	2.03
			(4.99)	(0.65)		
Metals	Phelps Dodge	Copper	0.37*	0.04	0.09	1.78
			(18.80)	(1.13)		
	Coeur d'Alene Mines Corp.	Gold	1.55*	-0.03	0.23	2.09
			(33.71)	(-0.64)		
	Homestake Mining Co.	Gold	1.76*	0.00	0.36	2.15
			(46.47)	(0.02)		
Metals	Newmount Mining Corp.	Gold	1.19*	0.00	0.17	1.92
			(28.02)	(0.00)		

Table 2.3 (continued): Daily Price Transmission Coefficient from Commodity Futures Price to Stock Price: Returns Model (1984-1998)

Sector	Dependent Stock Price	Independent Commodity Futures Price	Price Transmission Coefficient	Alpha	R^2	DW Statistic
Petroleum Oil Integrated	Arco	Crude Oil	0.13* (13.87)	0.03 (1.50)	0.05	1.97
	Chevron	Crude Oil	0.10* (9.89)	0.04 (1.81)	0.03	2.05
	Exxon	Crude Oil	0.05* (5.47)	0.06* (2.42)	0.01	2.18
	Mobil Corp.	Crude Oil	0.08* (7.58)	0.05* (2.00)	0.01	2.09
	Occidental	Crude Oil	0.06* (5.09)	-0.01 (-0.28)	0.01	2.05
	Royal Dutch Petroleum Co.	Crude Oil	0.05* (5.65)	0.06* (2.62)	0.01	2.13
	Texaco	Crude Oil	0.08* (7.93)	0.03 (1.23)	0.02	2.07
Oil Producers	Apache Corp.	Crude Oil	0.11* (7.67)	0.02 (0.66)	0.02	2.06
	Ranger Oil	Crude Oil	0.16* (9.31)	-0.02 (-0.50)	0.02	2.16
Oil Services	Global Marine Inc.	Crude Oil	0.24* (5.85)	0.01 (0.10)	0.01	2.33
	Halliburton Co.	Crude Oil	0.10* (6.87)	0.01 (0.37)	0.01	1.95
Oil Services	Schlumberger Ltd.	Crude Oil	0.11* (7.22)	0.00 (0.03)	0.01	2.08

Table 2.3 (continued): Daily Price Transmission Coefficient from Commodity Futures Price to Stock Price: Returns Model (1984-1998)

Sector	Dependent Stock Price	Independent Commodity Futures Price	Price Transmission Coefficient	Alpha	R^2	DW Statistic
Oil Services	Smith International	Crude Oil	0.15* (6.69)	0.01 (0.16)	0.01	1.92

* Beta is statistically significant at the 5 percent level.
T-Ratio in parenthesis
[a] A positive sign indicates that interest rates and utility stock prices are negatively related. T-Bill futures prices are represented as (1 – T-Bill Rate), so a positive regression coefficient represents a negative relationship between stock prices and interest rates when using T-Bill futures.

Table 2.4: Daily Beta Price Transmission from S&P 500 Futures to Stock Price: Returns Model (1984-1998)

Sector	Dependent Stock Price	Independent S&P 500 Index Futures Price	Beta	Alpha	R^2	DW Statistic
Agriculture	Deere & Co.	S & P 500	0.72*	-0.01	0.20	1.89
			(30.69)	(-0.47)		
	Monsanto	S & P 500	0.78*	0.02	0.25	2.04
			(35.42)	(0.65)		
Interest Rates	Bell Atlantic	S & P 500	0.63*	0.01	0.28	1.99
			(38.12)	(0.65)		
	Con. Edison Inc.	S & P 500	0.47*	0.01	0.24	1.95
			(34.37)	(0.79)		
	GTE Corp.	S & P 500	0.74*	0.00	0.33	2.20
			(43.37)	(0.01)		
Resources						
Lumber	Champion International	S & P 500	0.78*	-0.03	0.26	1.94
			(36.54)	(-1.26)		
Lumber	Georgia-Pacific Corp.	S & P 500	0.81*	-0.02	0.24	1.85
			(35.01)	(-0.73)		
	Weyerhaeuser	S & P 500	0.90*	-0.03	0.31	2.13
			(41.22)	(-1.01)		
Metals	Phelps Dodge	S & P 500	0.75*	0.00	0.18	1.78
			(28.75)	(-0.10)		
	Coeur d'Alene Mines Corp.	S & P 500	-0.05	-0.03	0.00	2.05
			(-1.32)	(-0.74)		
	Homestake Mining Co.	S & P 500	0.06	-0.02	0.00	2.12
			(1.78)	(-0.37)		
	Newmount Mining Corp.	S & P 500	0.36*	-0.03	0.03	1.94
			(10.45)	(-0.68)		

Table 2.4 (continued): Daily Beta Price Transmission from S&P 500 Futures to Stock Price: Returns Model (1984-1998)

Sector	Dependent Stock Price	Independent S&P 500 Index Futures Price	Beta	Alpha	R^2	DW Statistic
Petroleum Oil Integrated	Arco	S & P 500	0.45*	0.01	0.15	1.91
			(26.06)	(0.28)		
	Chevron	S & P 500	0.64*	0.01	0.25	1.99
			(35.33)	(0.37)		
	Exxon	S & P 500	0.73*	0.02	0.37	2.09
			(47.20)	(0.86)		
	Mobil Corp.	S & P 500	0.72*	0.01	0.31	2.00
			(40.76)	(0.47)		
	Occidental	S & P 500	0.66*	-0.04	0.19	2.09
			(29.56)	(-1.69)		
	Royal Dutch Petroleum Co.	S & P 500	0.68*	0.02	0.36	2.03
			(45.70)	(1.14)		
	Texaco	S & P 500	0.48*	0.00	0.14	2.06
			(24.38)	(0.14)		
Oil Producers	Apache Corp.	S & P 500	0.44*	-0.00	0.06	2.06
			(15.18)	(-0.09)		
	Ranger Oil	S & P 500	0.44*	-0.05	0.04	2.16
			(12.83)	(-1.17)		
Oil Services	Global Marine Inc.	S & P 500	0.69*	-0.03	0.02	2.34
			(8.19)	(-0.33)		
	Halliburton Co.	S & P 500	0.90*	-0.04	0.22	1.93
			(32.44)	(-1.13)		
	Schlumberger Ltd.	S & P 500	0.86*	-0.05	0.20	2.06
			(30.93)	(-1.45)		
Oil Services	Smith International	S & P 500	0.62*	-0.03	0.05	1.94
			(13.37)	(-0.52)		

Table 2.4 (continued): Daily Beta Price Transmission from S&P 500 Futures to Stock Price: Returns Model (1984-1998)

* Beta is statistically significant at the 5 percent level.
T-Ratio in parenthesis.

CHAPTER 3

LEAD-LAG RELATIONSHIPS BETWEEN RESOURCE BASED STOCK PRICES, COMMODITY FUTURES PRICES, AND STOCK INDEX FUTURES PRICES

INTRODUCTION

Investment fund managers may hold resource stocks and follow the resource firm's underlying commodity price as a source of leading information for analyzing future stock price movements. For example, investment managers might expect to find a time based relationship between crude oil futures price and oil producing company's stock price such as Exxon. As well, they may expect to find a time based relationship between S&P 500 index futures price and Exxon stock price. The objective of this chapter is to analyze the lead-lag relationship between (1) commodity futures prices and stock prices and (2) stock index prices and stock prices.

An implication of this study is that investment managers might gain useful information from the lead-lag relationships between stock prices and related commodity or stock index prices. The investment manager might then use these relationships to predict price movements of stock prices of firms in which they own or plan to own stocks, and make investment decisions. As an example, if the crude oil futures price leads the stock price of Exxon by 3 days, when the crude oil futures price increases, then an investor could buy Exxon stock and might expect the price of the stock to increase a few days later on average. On the downside, a drop in Exxon stock price could be predicted from an earlier drop in crude oil futures price. Similar predictions might be made between the Exxon stock price and the S&P 500 index futures price if the lead-lag relationship is significant.

The outline of this study is as follows. First the theories of lead-lag relationships between stock prices and commodity or stock index prices are developed and discussed. Next, the data choice, data sources and model construction are explained. Results are then explained for the lead-lag relationships between the related commodity futures price and stock price and then between S&P 500 index futures price and stock price. This is followed with a summary and discussion.

THEORY

Lead-lag relationships in markets refer to the tendency of prices to be determined in one market, with information then passed on during a lag period to a corresponding market. Considerable information exists on lead-lag analysis from a number of studies (Coleman, 1996, Copeland, 1998, Fung, 1999, Joukivolle, 1995, and Koutmos, 1996). Leuthold points out that often traders are interested in identifying which market registers the new information the most quickly (Leuthold et al., 1992). Lead-lag relationships are determined based on the origin of important news when comparing 2 markets (Franses et al., 1997). Lead-lag analysis also attempts to determine the dominant market. Dominant markets are those markets that are closest to important economic activities and have the ability to assimilate information quickly, and then pass the information on to other related markets, and they are considered pre-eminent in the price discovery process (Leuthold et al., 1992).

The nature of the new information may affect the different markets in different ways. The leading behavior of the futures market often strengthens significantly around the time of macroeconomic news releases (Frino et al., 2000). As well, evidence shows that feedback from the equities market to the futures market strengthens around stock-specific information releases and that the lead of the futures market weakens during this time (Frino et al., 2000).

Limited research has been done on the lead-lag relationships between a firm's stock value and the value of the related commodity's futures price. However, research shows that the futures market does have a causality relationship with the spot market or vice versa. A number of researchers have found that prices are discovered first in the commodity futures market and that information is then passed on to the cash market for that commodity. Evidence shows that the livestock futures market plays an important role in the spot price discovery process for livestock (Leuthold et al., 1992). The evidence suggests that the cash markets in wheat, corn, and orange juice may act as satellites of the futures markets for those commodities, with about seventy-five percent of new information incorporated first in futures prices and then flowing to cash prices (Garbade and Silber, 1983). Lead-lag relationships have also been found between the currency options market and spot markets (Pan et al., 1996).

Some research has been undertaken on the price discovery relationship between stock index futures values and stock index spot values. There is strong evidence that the futures market leads the cash index (Chan, 1992). Results show that on high volatility days, the futures market is the dominant market for price discovery when comparing the S&P 500 index futures and spot index (Albert et al., 1993). The futures price was found to strongly lead the index with some weaker evidence of feedback from the index to the futures (Antoniou and Garrett, 1993). As well, others have found feedback between the S&P 500 index futures and the S&P 500 spot index (Kawaller et al., 1993). Lags may occur due to factors such as imperfect information, information arriving in large doses and market imperfections. Several possible outcomes exist regarding the lead-lag relationships between corresponding commodity futures prices and stock prices.

DATA AND PROCEDURE

Data

Daily data is used for the fifteen year period from January 1, 1984 to December 31, 1998. Stock prices from the CRSP database are included for twenty-five resource firms based in the USA and traded on the NYSE. The data for stock prices are adjusted for splits. Commodity futures prices from the Technical Tools database are included from the USA and London exchanges. Commodity futures prices from 7 commodities are included from the agricultural, interest rate, lumber, metals and petroleum sectors. For the stock index the S&P 500 index futures price is used.

Estimation Procedures

The estimation procedure used is similar to that of Boyd and Brorsen (1986) and Kim *et al.* (1999). Percentage price changes (i.e. returns, first differences of logs) of the data are taken to remove any linear time trends. Next, a series of bivariate autoregressive (AR) models are constructed. These are used in the causality tests that follow. The number of lags included is selected using Akaike's Information Criterion (AIC) (Akaike, 1976). The AIC tends to overestimate the true number of lags, thus lessening the probability of selecting too small an order in a small sample (Shibata, 1976).

The bivariate model can be written as

$$P_t = \sum_{i=1}^{p} AP_{t-i} + e_t,$$

where

$$P_t = \begin{bmatrix} P_{1t} \\ P_{2t} \end{bmatrix}, \quad A = \begin{bmatrix} a_{11}(i) & a_{12}(i) \\ a_{21}(i) & a_{22}(i) \end{bmatrix}, \quad and\ e_t = \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \tag{3.1}$$

and P_{1t} and P_{2t} are the futures price and the stock price, for example the e_t's are residuals, and the a's are coefficients to be estimated. Consistent and asymptotically efficient estimates of the parameters and standard errors are obtained by least squares techniques.

The concept of Granger (1969) causality is used to determine the direction of dynamic price adjustments. Pierce and Haugh (1977) define causality in terms of predictability. A variable X does not cause variable Y if Y cannot be predicted better by using past values of X than if past values of X are not used. If X causes Y and Y does not cause X, then X is said to unidirectionally cause Y. Bivariate causality occurs when X causes Y and Y causes X. This is called a feedback relationship. Unidirectional causality has implications for price discovery. For example, if gold futures prices cause Newmont Mining Corp. stock prices, then it would imply that prices are first discovered in the gold futures market.

The test for causality running from X to Y is performed by testing the significance of the coefficients as a group rather than individually. This test is conducted with the Wald F statistic (Wald, 1943). This test procedure is a variant of Granger's test which Monte Carlo studies have shown to be more powerful than the causality tests of either Sims (1972, 1977) or Haugh (Geweke et al., 1983; Nelson and Schwert, 1982).

Instantaneous causality tests have been used frequently in past research (e.g. Uri and Rifkin, 1985), even though some have questioned their validity (Layton, 1984; Price, 1979). The test is usually accomplished by adding the current period's price to the model. This study is primarily concerned with instantaneous relationships when no lagged relationship is present. For a zero lag model, the test of instantaneous causality can be accomplished by testing the significance of the contemporaneous correlation coefficient. Unfortunately, the direction of causality cannot be determined for an instantaneous relationship.

Two equations are used for the following bivariate model that has a 2 period lag in this example:

$$Stock\ Price = f\,(Stock\ Price_{t-1},\ Stock\ Price_{t-2},\ Futures\ Price_{t-1},\ Futures\ Price_{t-2}) \quad (3.2)$$

$$Futures\ Price = f\,(Stock\ Price_{t-1},\ Stock\ Price_{t-2},\ Futures\ Price_{t-1},\ Futures\ Price_{t-2}) \quad (3.3)$$

If adding the past commodity futures prices adds significant explanatory power to stock price in equation (3.2) as measured by the use of the F-test, then the commodity futures market 'causes' or leads the corresponding stock price. Likewise, if the past stock prices add significant explanatory power to commodity futures prices in equation (3.3) as measured by the use of the F-test, then the stock price "causes" or leads the corresponding commodity futures price.

RESULTS

Stock Price and Commodity Price Relationship Results

The Wald F-statistic, equation F-statistic and equation R^2 values for the causality relationships between resources based firms' stock prices and commodity futures prices are shown in Table 3.1. The results suggest that there are significant lead-lag relationships between the commodity futures prices and individual stock prices. Twenty-six of the fifty equations have significant equation F-statistics at the 5 percent level, indicating significant explanatory power. Lags ranged from one to ten days and the petroleum sector generally had the longest lags.

The results suggest that in the agricultural, utility, gold mining and petroleum sectors, the commodity futures price leads or causes some firm's stock price. This would indicate investors might predict the direction and the time of a movement of a firm's stock price by monitoring the movement of the commodity futures price for the commodity associated with those firms. This information could then be used to make investment decisions, in order to capitalize on that stock price movement. Some firms in the utility, metals and petroleum sectors show feedback between the markets, indicating that information flows between the markets relatively simultaneously.

Twelve out of twenty-five firms show that the related commodity futures price leads the stock price as indicated by the significant Wald F-statistics. This indicates unidirectional flow of information from the commodity futures market to the corresponding stock markets and are consistent with expectations. Seven of the twenty-five firms show feedback between the stock market and the related commodity futures market. This indicates that information flows both ways between the markets. Six of the twenty-five firms do not show a significant lead in either market. No firms show that the stock price leads the related commodity futures price, which is consistent with expectations.

Table 3.1 shows that in the agricultural sector, 1 of the 2 companies' stock price lags its corresponding underlying commodity futures price by 2 days. There is no significant feedback between the markets, nor does the stock price lead the related commodity futures market. In the utility sector, the U.S. 3-month T-Bills futures lead the stock price for 1 of 3 firms, while there is significant feedback between the markets for the 2 other firms. There are no significant lead-lag relationships between lumber futures and the stock price in the forest products sector. None of the firms show that lumber futures price leads the stock price significantly. In the mining sector, the copper production firm shows significant feedback between the markets. Of the 3 gold mining firms, 2 show significant feedback between the markets, while gold futures leads the stock price for the other firm. In the petroleum sector the results are interesting. Six of seven integrated petroleum firms' stock prices are led by the crude oil futures price. There is no significant lead-lag relationship between the remaining firm's stock price and crude oil futures price. One firm shows significant feedback between the markets for petroleum producers, while the other firm shows that the crude oil futures price leads its stock price. The crude oil futures price leads the stock price for 2 of 4 firms in oilfield services. One firm in oilfield services shows that there is significant feedback between the markets. The remaining firm's stock price does not have a significant lead-lag relationship with the crude oil futures price.

The results in the petroleum sector indicate a high percentage of lead-lag relationships between the crude oil futures price and a firm's stock price. Some investors may find it useful to study these lead-lag relationships in order to capitalize on the stock price movements, which appear to be predicted by the futures price movements.

Stock Price and S&P 500 Index Futures Price Relationship Results

For the firms where the S&P 500 index futures price leads the stock price, the time and direction of a movement in the stock price might be predicted by monitoring the S&P 500 index futures market. Likewise, when the firm's stock price leads the S&P 500 index futures price, this timing and direction of the stock price might be useful in predicting a S&P500 index futures price movement. Investment decisions could be made to capitalize on these predicted price movements.

The Wald F-statistics, equation F-statistics and R^2 values for the causality relationships between resource based stock prices and S&P 500 index futures prices are shown in Table 3.2. Twenty-nine of the fifty equations have significant equation F-statistics at the 5 percent level, indicating significant explanatory power in the equation. Lags range from 5 to 10 days. The lumber sector in general has the shortest lags, but the lags are fairly evenly distributed in the other sectors.

Nine out of twenty-five firms show that the S&P 500 index futures price leads the stock price, indicating that the S&P 500 index futures market is a lead source of information for the stocks. It would generally be expected to be the case that the S&P 500 index futures market leads individual stock prices, rather than vice versa. Nine firms show feedback between the stock market and the S&P 500 index futures market. This indicates each market passes information back to the other in relatively simultaneous fashion. Five of the twenty-five firms did not show a significant lead in either market. Only 2 of the twenty-five firms show that the stock price leads the S&P 500 index futures price. These firms include GTE Corp. in the utility sector and Haliburton Co. in the oil field services sector.

Table 3.2 shows that in the agricultural sector, both firms show a significant feedback. In the utility sector, the stock price leads the S&P 500 index futures price for 1 of 3 firms. The S&P 500 index futures price leads the stock price for 1 firm, while there is significant feedback between the markets for the other firm. In the forest products sector, 1 firm shows significant feedback between the markets. One lumber firm's results indicated that S&P 500 index futures price leads stock price. There is no significant lead-lag relationship between the markets for the other forest products sector firm.

In the mining sector, the copper production firm shows that the S&P 500 index futures price leads the stock price. Of the 3 firms in gold mining, 2 show significant feedback between the markets, while S&P 500 index futures lead the stock price for 1 firm. Again in the petroleum sector the results are interesting. Four of seven integrated petroleum firms' stock prices are led by the S&P 500 index futures price, while there is a significant feedback relationship between the markets for 1 firm. The other 2 firms do not show a significant lead-lag relationship. One firm shows a significant feedback between the markets for petroleum producers, while the other firm shows the S&P 500 index futures price leads the stock price. There is significant feedback between the markets for 1 of 4 firms in oilfield services. One firm in oilfield services shows that the stock price leads the S&P 500 index futures price. The other 2 firms show no significant lead-lag relationship between the markets. Again, some investors may find it useful to study the lead-lag relationships between the S&P 500 index futures price and a firm's stock price in order to predict price movements that might influence investment decisions.

SUMMARY

The results indicate that the underlying commodity futures price leads a firm's stock price more often than the S&P 500 index futures price leads a firm's stock price. However, there are more feedback relationships; that is, simultaneous information flows between the S&P 500 index futures price and stock prices than between the underlying commodity futures price and stock price. Stock price leads the S&P 500 index futures price for only 2 firms but, as expected, the stock price does not lead the commodity futures price. The lead-lag results indicate that commodity futures prices may be able to predict the firm's stock price movement in more cases than the S&P 500 index futures price.

There appears to be some useful information available to investors and investment fund managers as evidenced by the lead-lag relationships found in this study. In terms of sectors, the petroleum sector is the most prominent in terms of number of lead-lag relationships between stock price and commodity futures price, with only 2 of thirteen firms not having a significant lead-lag relationship between oil price and stock price. For 9 of the crude oil sector firms, the crude oil futures price leads the stock price while 2 firms have feedback relationships between the markets. The utility and metal sectors have the highest number of feedback relationships, with 2 of the 3 firms in utilities and 3 of 4 firms in the metal sector.

Petroleum sector results indicate a high percentage of lead-lag relationships between the crude oil futures price and a firm's stock price. Investors might find that studying these lead-lag relationships would be useful in order to capitalize on the stock price movements, which appear to be predicted by the futures price movements.

Agriculture, utilities and metals sectors are the most prominent in terms of number of lead-lag relationships between S&P 500 index futures price and stock price, with all firms in these 3 sectors having significant relationships. Feedback relationships are found in both firms in the agricultural sector, 1 of 3 firms in the utilities sector and 2 of 4 firms in the metals sector. One firm in the utilities sector shows that the S&P 500 index futures price leads the stock price, while the stock price leads the S&P 500 index futures price for the other firm. The remaining 2 firms in the metals sector show that the S&P 500 index futures price leads the stock price. In the petroleum sector the S&P 500 index futures price leads the stock price for 5 of the thirteen firms. There are feedback relationships between 3 of the remaining firms in the petroleum sector.

By studying these relationships further, investment managers may be able to improve their stock price transaction decisions, especially for oil stocks. Oil futures prices appear to quite consistently lead stock prices, and so they may serve as a useful predictor of stock price. Likewise, the S&P 500 index futures prices often lead stock prices in the petroleum sector and may be used as a predictor. However, it is found that the commodity futures price predicts the stock price slightly more often than the S&P 500 index futures price does.

Each firm has an individual lead-lag relationship with either the related commodity futures or S&P 500 index futures markets. Investors may find some useful information in lead-lag relationships as they develop new methods for investment decisions.

Table 3.1: Daily Lead-Lag Price Relationships for the Related Commodity Futures Price and Corresponding Stock Price.

Sector	Stock Price/Commodity Futures Price	Lag	Stock Price/Commodity Futures Price	Equation F-statistic	Wald F-statistic	R^2
Agriculture	Deere & Co	→ 3	Soybeans	1.05	3.15	0.00
	Soybeans	→ 3	Deere & Co	0.39	1.18	0.01
	Monsanto	→ 2	Soybeans	1.04	2.07	0.00
	Soybeans	→ 2[a]	Monsanto	5.43*	10.85*	0.01
Utility	Bell Atlantic	→ 7[b]	U.S. 3 Month T-Bills	2.80*	19.57*	0.01
	U.S. 3 Month T-Bills	→ 7	Bell Atlantic	2.75*	19.27*	0.01
	Con Edison	→ 4	U.S. 3 Month T-Bills	3.83*	15.30*	0.00
	U.S. 3 Month T-Bills	→ 4	Con Edison	5.00*	20.00*	0.01
	GTE Corp	→ 5	U.S. 3 Month T-Bills	1.30	6.45	0.00
	U.S. 3 Month T-Bills	→ 5	GTE Corp	4.02*	20.12*	0.02
Lumber	Champion Int.	→ 1	Lumber	3.12	3.12	0.00
	Lumber	→ 1	Champion Int.	0.26	0.26	0.00
	Georgia-Pacific Corp	→ 4	Lumber	1.18	4.73	0.01
	Lumber	→ 4	Georgia-Pacific Corp	0.75	3.02	0.01
	Weyerhauser	→ 2	Lumber	0.25	0.49	0.01
	Lumber	→ 2	Weyerhauser	1.11	2.23	0.00
Copper	Phelps Dodge	→ 3	Copper	10.58*	31.74*	0.01
	Copper	→ 3	Phelps Dodge	6.54*	19.61*	0.03
Gold	Coeur d'Alene Mines	→ 6	Gold	1.47	8.80	0.01
	Gold	→ 6	Coeur d'Alene Mines	2.62*	15.70*	0.01
Gold	Homestake Mining Co.	→ 4	Gold	5.80*	23.21*	0.01
	Gold	→ 4	Homestake Mining Co.	2.53*	10.12*	0.01
	Newmont Mining Corp	→ 6	Gold	2.28*	13.70*	0.01
	Gold	→ 6	Newmont Mining Corp	2.30*	13.78*	0.01

Table 3.1 (continued): Daily Lead-Lag Price Relationships for the Related Commodity Futures Price and Corresponding Stock Price.

Sector	Stock Price/Commodity Futures Price	Lag	Stock Price/Commodity Futures Price	Equation F-statistic	Wald F-statistic	R^2
Petroleum						
Oil Integrated	Arco	→ 8	Crude Oil	1.06	8.45	0.02
	Crude Oil	→ 8	Arco	6.79*	54.21*	0.02
	Chevron	→ 8	Crude Oil	0.64	5.13	0.02
	Crude Oil	→ 8	Chevron	3.86*	30.87*	0.01
	Exxon	→ 8	Crude Oil	0.42	3.35	0.02
	Crude Oil	→ 8	Exxon	2.60*	20.79*	0.05
	Mobil Corp	→ 8	Crude Oil	0.64	5.12	0.01
	Crude Oil	→ 8	Mobil Corp	1.50	11.99	0.01
	Occidental	→ 5	Crude Oil	0.65	3.27	0.01
	Crude Oil	→ 5	Occidental	5.65*	28.24*	0.02
	Royal Dutch Petroleum	→ 9	Crude Oil	1.20	10.76	0.02
	Crude Oil	→ 9	Royal Dutch Petroleum	4.71*	42.37*	0.02
	Texaco	→ 8	Crude Oil	1.51	12.07	0.02
	Crude Oil	→ 8	Texaco	4.26*	34.06*	0.02
Oil Producers	Apache Corp	→ 9	Crude Oil	1.22	10.94	0.02
	Crude Oil	→ 9	Apache Corp	9.17*	82.58*	0.03
	Ranger Oil	→ 8	Crude Oil	2.17*	17.33*	0.02
	Crude Oil	→ 8	Ranger Oil	8.07*	64.52*	0.03
Oil Services	Global Marine Inc	→ 8	Crude Oil	0.90	7.16	0.02
	Crude Oil	→ 8	Global Marine Inc	1.25	9.98	0.01
	Halliburton Co	→ 8	Crude Oil	0.78	6.24	0.02
	Crude Oil	→ 8	Halliburton Co	5.19*	41.48*	0.02
	Schlumberger Ltd.	→ 8	Crude Oil	0.56	4.48	0.02
	Crude Oil	→ 8	Schlumberger Ltd.	4.64*	37.16*	0.02

Table 3.1 (continued): Daily Lead-Lag Price Relationships for the Related Commodity Futures Price and Corresponding Stock Price.

Sector	Stock Price/Commodity Futures Price	Lag	Stock Price/Commodity Futures Price	Equation F-statistic	Wald F-statistic	R^2
Oil Services	Smith International	→ 10	Crude Oil	1.88*	18.78*	0.02
	Crude Oil	→ 10	Smith International	4.54*	45.42*	0.03

* Denotes significance at the 5 percent level.

[a] For example, Soybean futures price leads or 'causes' Monsanto stock price by 2 days, as evidenced by the significant causality F-statistic.

[b] Shows evidence of feedback relationships, given the 2 significant causality F-statistics.

Table 3.2: Daily Lead-Lag Price Relationships for the S&P 500 Index Futures Price and Corresponding Stock Price.

Sector	Stock Price/S&P 500 Index Futures Price	Lag	Stock Price/S&P 500 Index Futures Price	Equation F-statistic	Wald F-statistic	R^2
Agriculture	Deere & Co	→ 9 [a]	S&P 500	2.77*	24.92*	0.02
	S&P 500	→ 9	Deere & Co	3.95*	35.57*	0.02
	Monsanto	→ 8	S&P 500	3.53*	28.23*	0.02
	S&P 500	→ 8	Monsanto	5.26*	42.11*	0.02
Utility	Bell Atlantic	→ 8	S&P 500	5.41*	43.29*	0.02
	S&P 500	→ 8	Bell Atlantic	3.47*	27.77*	0.02
	Con Edison	→ 5	S&P 500	0.20	0.99	0.01
	S&P 500	→ 5 [b]	Con Edison	2.77*	13.85*	0.00
	GTE Corp	→ 5	S&P 500	6.61*	33.07*	0.02
	S&P 500	→ 5	GTE Corp	1.80	9.00	0.01
Lumber	Champion Int.	→ 5	S&P 500	2.47*	12.34*	0.01
	S&P 500	→ 5	Champion Int.	3.97*	19.84*	0.01
	Georgia-Pacific Corp	→ 5	S&P 500	1.00	4.98	0.01
	S&P 500	→ 5	Georgia-Pacific Corp	5.91*	29.55*	0.02
	Weyerhauser	→ 6	S&P 500	1.09	6.53	0.01
	S&P 500	→ 6	Weyerhauser	1.31	7.86	0.01
Copper	Phelps Dodge	→ 8	S&P 500	0.60	4.80	0.01
	S&P 500	→ 8	Phelps Dodge	6.58*	52.64*	0.03
Gold	Coeur d'Alene Mines	→ 9	S&P 500	1.55	13.99	0.01
	S&P 500	→ 9	Coeur d'Alene Mines	6.04*	54.36*	0.02
Gold	Homestake Mining Co.	→ 6	S&P 500	4.34*	26.06*	0.01
	S&P 500	→ 6	Homestake Mining Co.	3.04*	18.22*	0.01
	Newmont Mining Corp	→ 8	S&P 500	4.43*	35.40*	0.02
	S&P 500	→ 8	Newmont Mining Corp	4.97*	39.76*	0.02

Table 3.2 (continued): Daily Lead-Lag Price Relationships for the S&P 500 Index Futures Price and Corresponding Stock Price.

Sector	Stock Price/S&P 500 Index Futures Price	Lag	Stock Price/S&P 500 Index Futures Price	Equation F-statistic	Wald F-statistic	R^2
Petroleum						
Oil Integrated	Arco	→ 8	S&P 500	1.01	8.06	0.01
	S&P 500	→ 8	Arco	0.77	6.17	0.01
	Chevron	→ 5	S&P 500	1.89	9.47	0.01
	S&P 500	→ 5	Chevron	3.31*	16.53*	0.01
	Exxon	→ 8	S&P 500	2.63*	21.01*	0.02
	S&P 500	→ 8	Exxon	2.82*	22.53*	0.02
	Mobil Corp	→ 8	S&P 500	1.38	11.07	0.01
	S&P 500	→ 8	Mobil Corp	1.75	13.98	0.01
	Occidental	→ 9	S&P 500	1.56	14.01	0.01
	S&P 500	→ 9	Occidental	3.07*	27.65*	0.01
	Royal Dutch Petroleum	→ 6	S&P 500	0.50	2.99	0.01
	S&P 500	→ 6	Royal Dutch Petroleum	2.92*	17.50*	0.01
	Texaco	→ 9	S&P 500	1.09	9.80	0.01
	S&P 500	→ 9	Texaco	2.02*	18.18*	0.01
Oil Producers	Apache Corp	→ 5	S&P 500	0.55	2.74	0.01
	S&P 500	→ 5	Apache Corp	3.57*	17.85*	0.01
	Ranger Oil	→ 5	S&P 500	3.82*	19.10*	0.01
	S&P 500	→ 5	Ranger Oil	9.21*	46.03*	0.03
Oil Services	Global Marine Inc	→ 5	S&P 500	0.17	0.84	0.01
	S&P 500	→ 5	Global Marine Inc	1.25	6.24	0.01
	Halliburton Co	→ 5	S&P 500	3.58*	17.88*	0.01
	S&P 500	→ 5	Halliburton Co	1.03	5.17	0.00
	Schlumberger Ltd.	→ 6	S&P 500	1.09	5.40	0.01
	S&P 500	→ 6	Schlumberger Ltd.	0.65	3.90	0.01
	Smith International	→ 10	S&P 500	2.60*	25.95*	0.02
	S&P 500	→ 10	Smith International	4.69*	46.95*	0.03

Table 3.2 (continued): Daily Lead-Lag Price Relationships for the S&P 500 Index Futures Price and Corresponding Stock Price.

* Denotes significance at the 5 percent level.

[a] Shows evidence of feedback relationships, given the 2 significant causality F-statistics.

[b] For example, S&P 500 Index futures price leads or 'causes' Con Edison stock price by 2 days, as evidenced by the significant causality F-statistic.

CHAPTER 4

SUMMARY

Investors including mutual fund managers often hold resource based firms' stocks as part of their portfolio. Relationships often exist between stock prices of resource based companies and either the firm's underlying commodity price or stock index price or both. Investors may be interested in these relationships as they might gain information that could be used for making investment decisions for resource based companies. Therefore, the objective of this study is to empirically analyze the price transmission and lead-lag relationships between resource based firms' stock prices and their underlying commodity futures and the stock index futures price.

The stock prices of twenty-five resource based firms are chosen for this study. Five resource sectors are used as follows: agricultural, utilities (interest rates), lumber, metals including copper and gold, and crude oil including integrated, oil producers and oilfield services. The S&P 500 futures index is used for the stock index comparison. Closing prices are used for the stock price of the firm, the futures price of the commodities and the S&P 500 stock index futures. Daily data is used for the fifteen year period from January 1, 1984 to December 31, 1998, as a number of mergers occurred following 1998.

Price Transmission Relationship Results

Chapter 2 examines the price transmission relationships between stock price and underlying commodity and stock index futures price. A number of findings are presented. Cointegration is examined using the Engle-Granger procedure. It is believed that certain pairs of economic variables, such as commodity futures prices and stock prices should not diverge from each other by too great an extent. If the error term of stationary data is random around a mean, the data is then referred to as being integrated. However if there is a trend in the error term around the mean, the data is referred to as being nonstationary. In studying two variables, if the price spreads between those variables are mean reverting, the values are tied together over the long term by a common stochastic trend and the values are 'cointegrated'. Results show that when the stock price is regressed against the commodity futures price, the hypothesis of no cointegration is rejected for only 5 of 25 firms. Results show that when stock prices are the dependent variable and the stock index futures price is the independent variable, the hypothesis of no cointegration is rejected for 2 of the 25 firms. Overall, the no cointegration hypothesis is not generally rejected, indicating there is only a limited long term relationship between commodity futures prices and stock individual prices and individual stock prices and stock index futures prices.

The price transmission relationship between the stock price and commodity futures price is examined. Twenty-four of twenty-five firms showed statistically significant price transmission relationships between the commodity futures price and the stock price. The metals sector stock prices are related to the commodity futures prices to the largest extent. Given that the study uses daily data, the degree of stock price variation or R^2 that could be attributed to a commodity futures price variation was quite low, as expected. Again the metals sector shows that the variation in the firms' stock prices that could be attributed to the variation in the commodity futures prices was the greatest of all the sectors. Overall, relationships between a firm's stock price and the underlying commodity futures price are relatively limited, indicating that the underlying commodity futures market would not be a very efficient hedge for a related stock price, as evidenced by the lower R^2 values.

When the price transmission relationships between the stock index futures price and a firm's stock price are examined, it is found that twenty-three of twenty-five firms showed a statistically significant relationship. Firms' stock prices in the petroleum sector were found related to the stock index futures to the greatest extent, compared to other sectors.

In general, the degree of price transmission is greater between the S&P 500 index futures price and stock price than from the underlying commodity futures price to stock price. However, hedging a firm's stock price with the stock index futures market would not be very efficient, given the relatively low R^2 values for the equation with the firm's stock price and S&P 500 index futures price.

Lead-Lag Relationship Results

Chapter 3 examines the lead-lag relationships between (1) commodity futures prices and stock prices and (2) stock index futures prices and stock prices. First, the results show that there are often statistically significant lead-lag relationships between the commodity futures prices and individual stock prices. Twelve of the twenty-five firms show that the underlying commodity futures price leads the stock price. These firms were in the agriculture, utility, gold mining and petroleum sectors. Seven firms show feedback between the markets. None of the twenty-five firms show that the stock price leads the commodity futures price. Results in the petroleum sector indicate a high percentage of lead-lag relationships between the crude oil futures price and a firm's stock price. Investors might find the study of these lead-lag relationships useful in order to capitalize on the stock price movements. For example, crude oil prices might be used to assist in predicting the oil stock price movements. Overall, the results indicate that price movements in the underlying commodity futures market might be useful for predicting a price movement in the stock market for the firms in which the commodity futures price leads the stock price. Investors could use this information to make decisions in order to capitalize on predicted price movements in markets.

Second, the results for the lead-lag tests for relationships between stock prices and stock index prices show that the S&P 500 index price led the stock price for 9 of the 25 firms. For 2 of the 25 firms the stock price leads the S&P 500 index price, while 9 of 25 firms showed feedback or simultaneous information flows between the two markets. In summary, there may be some useful information for investors' decisions from the lead-lag relationships examined in this study.

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APPENDICIES

Appendix A

Figure A.1: Consolidated Edison Inc. Share and U.S. 3-Month T-Bill Futures Prices ($U.S.), 1984-1998

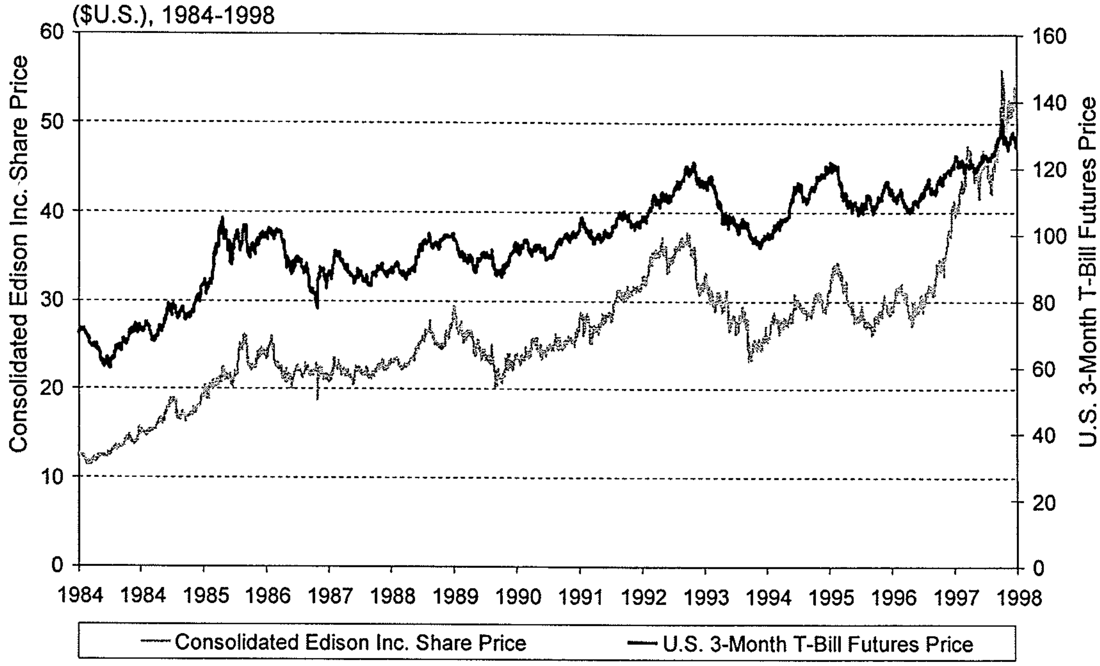


Figure A.2: GTE Corp. Share and U.S. 3-Month T-Bill Futures Prices ($U.S.), 1984-1998

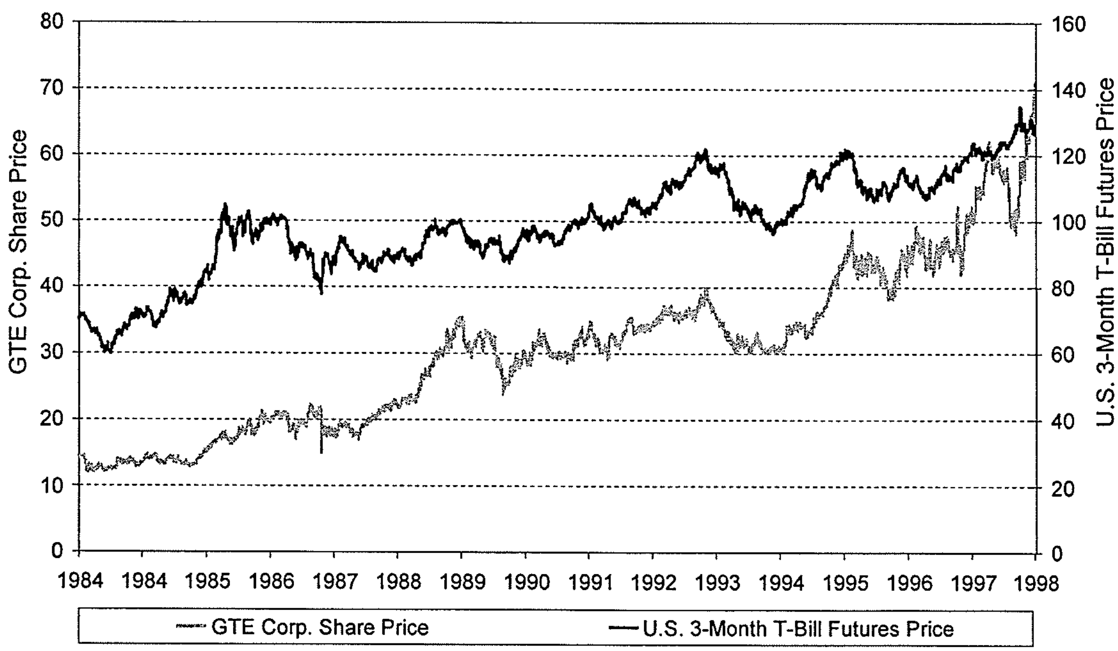


Figure A.3: Phelps Dodge Share and Copper Futures Prices ($U.S.), 1984-1998

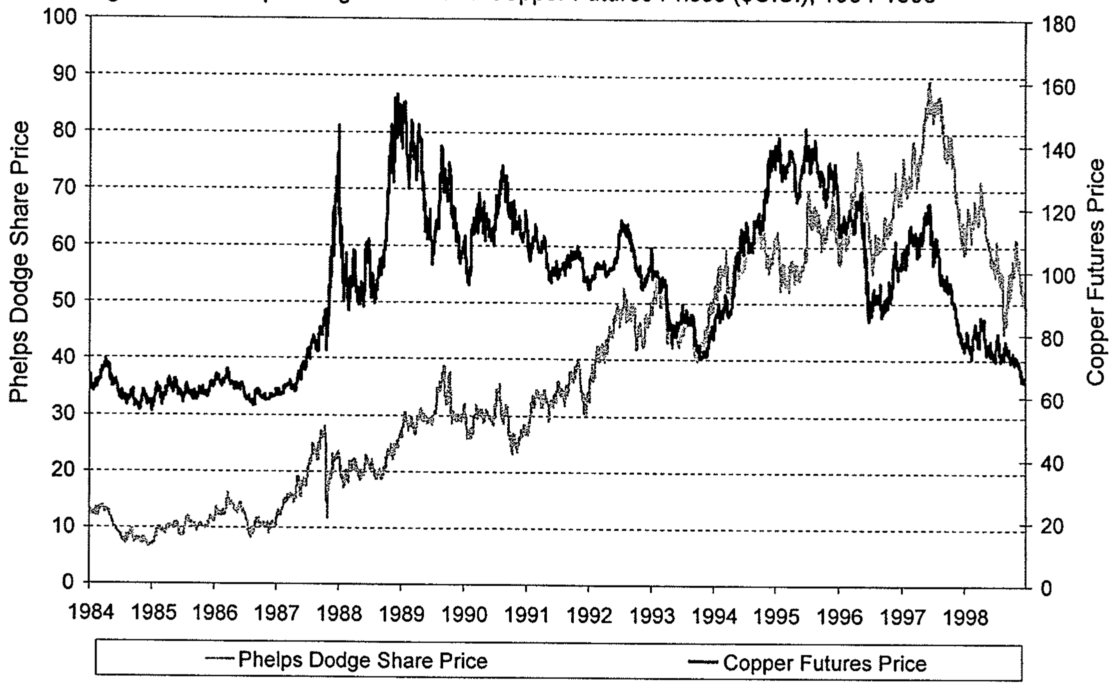


Figure A.4: Coeur d'Alene Mines Corp. Share and Gold Futures Prices ($U.S.), 1984-1998

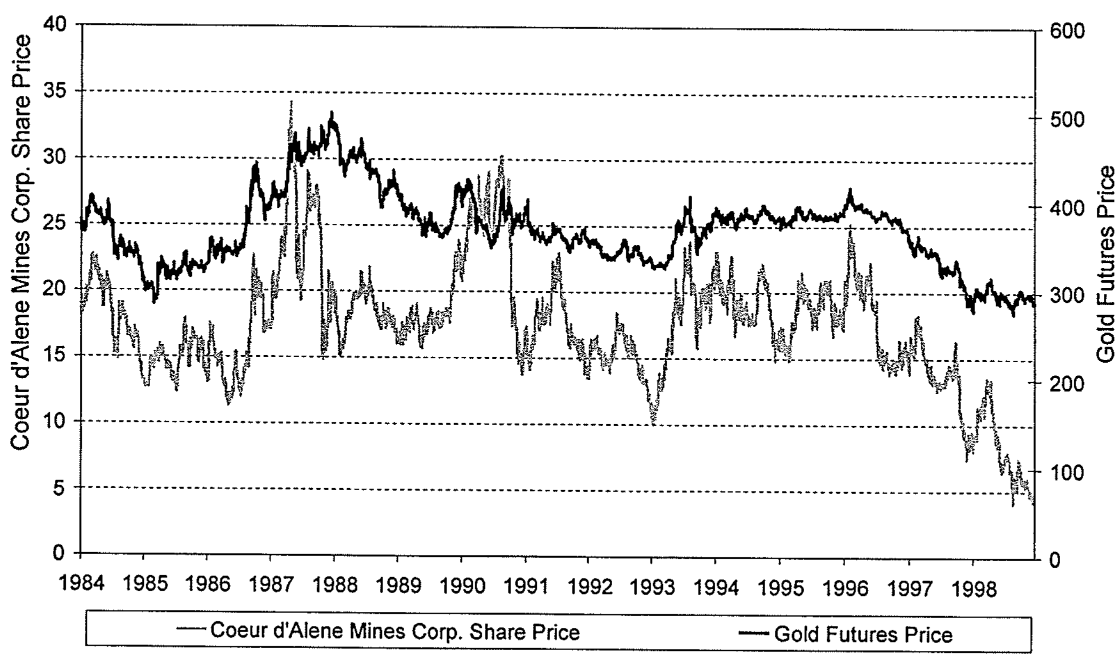


Figure A.5: Homestake Mining Co. Share and Gold Futures Prices ($U.S.), 1984-1998

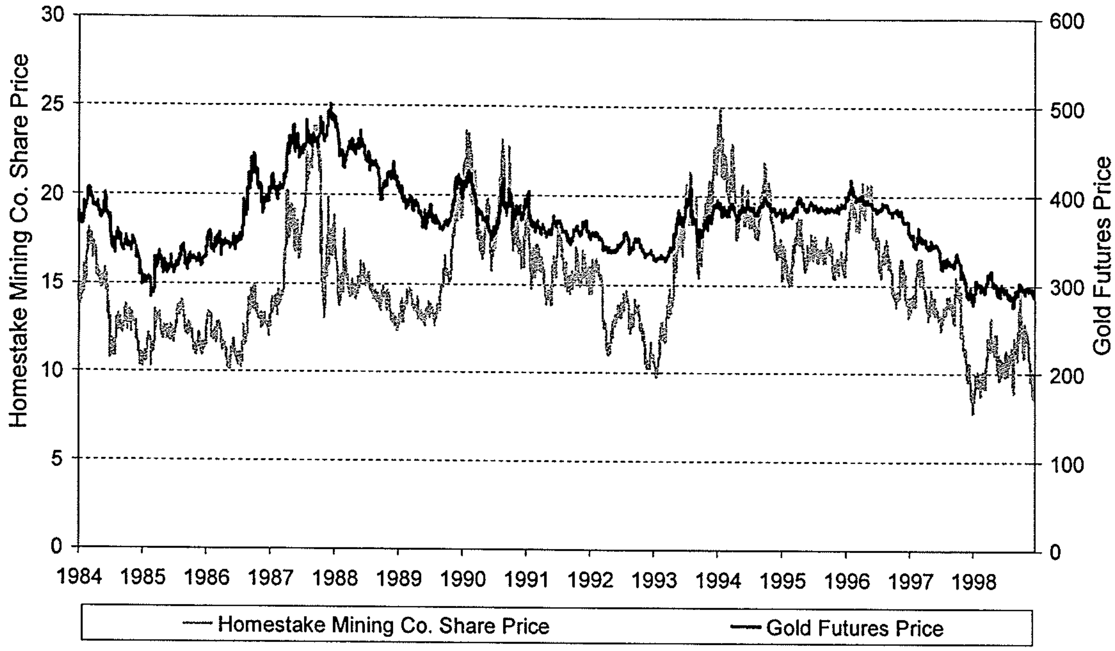


Figure A.6: Newmount Mining Co. Share and Gold Futures Prices ($U.S.), 1984-1998

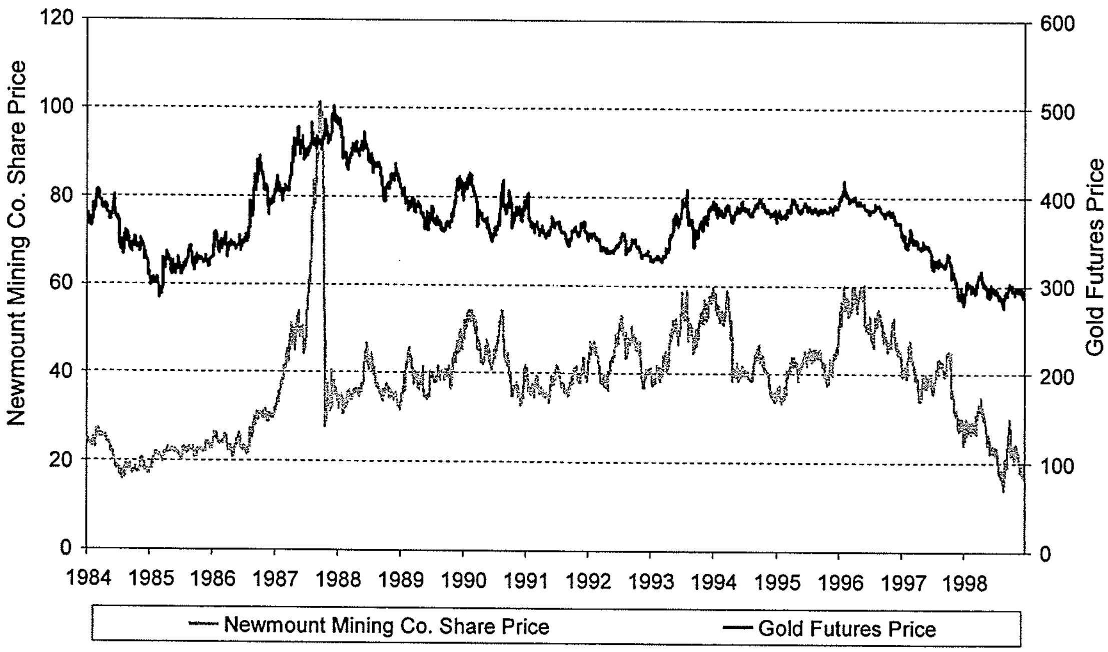


Figure A.7: Arco Share and Crude Oil Futures Prices ($U.S.), 1984-1998

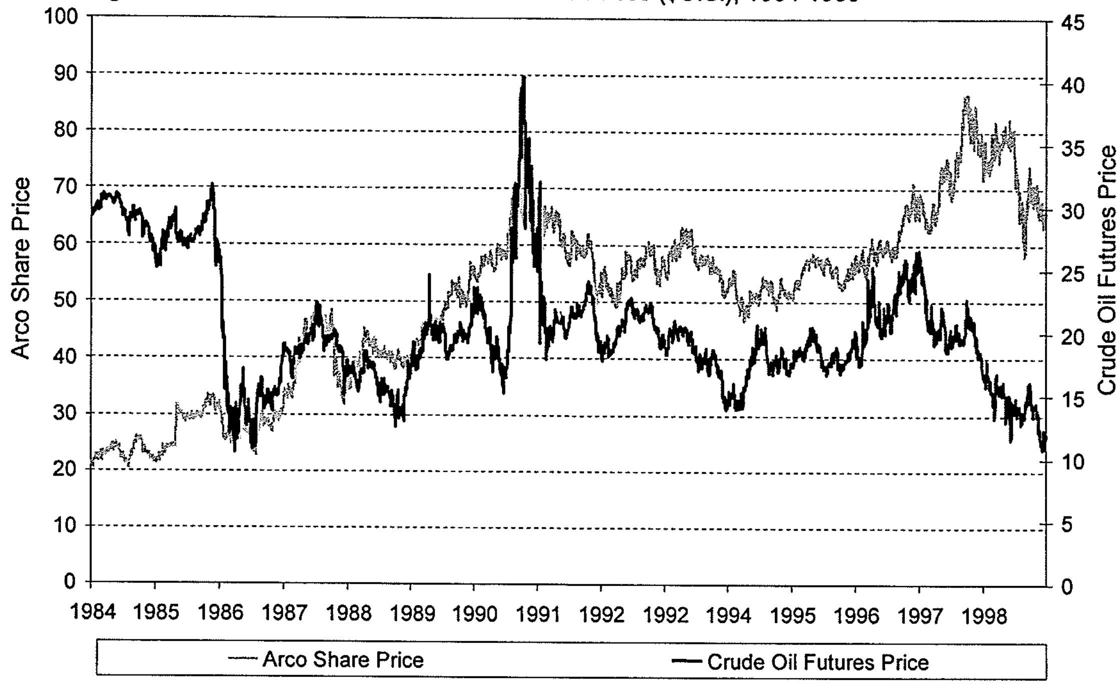


Figure A.8: Chevron Share and Crude Oil Futures Prices ($U.S.), 1984-1998

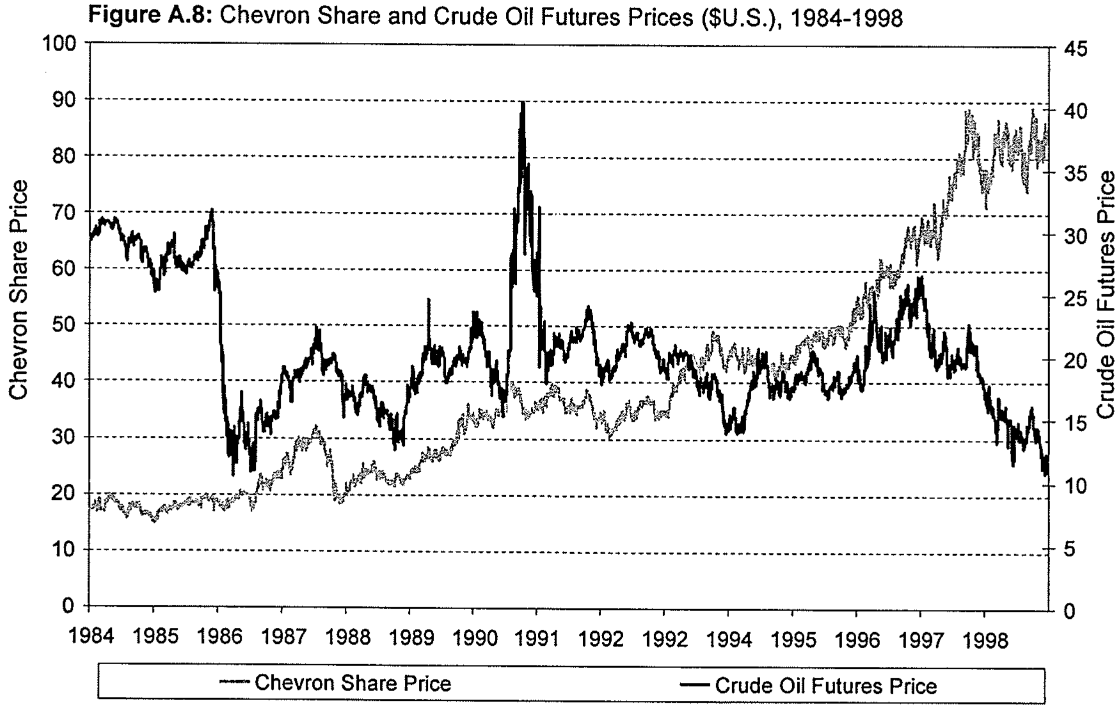


Figure A.9: Occidental Share and Crude Oil Futures Prices ($U.S.), 1984-1998

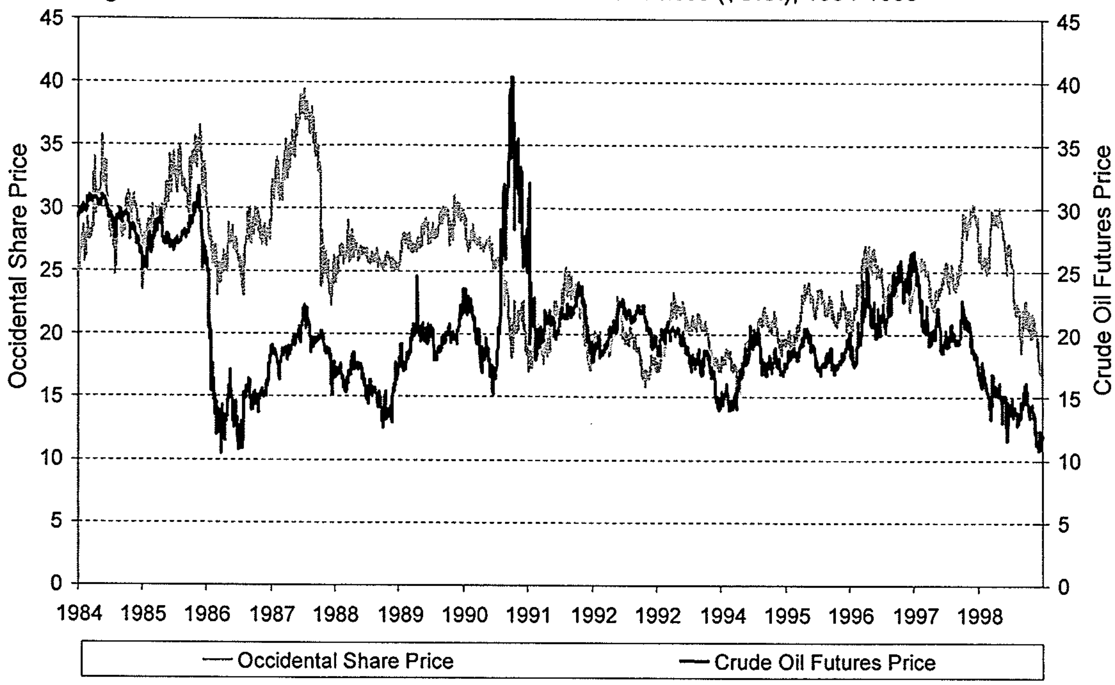
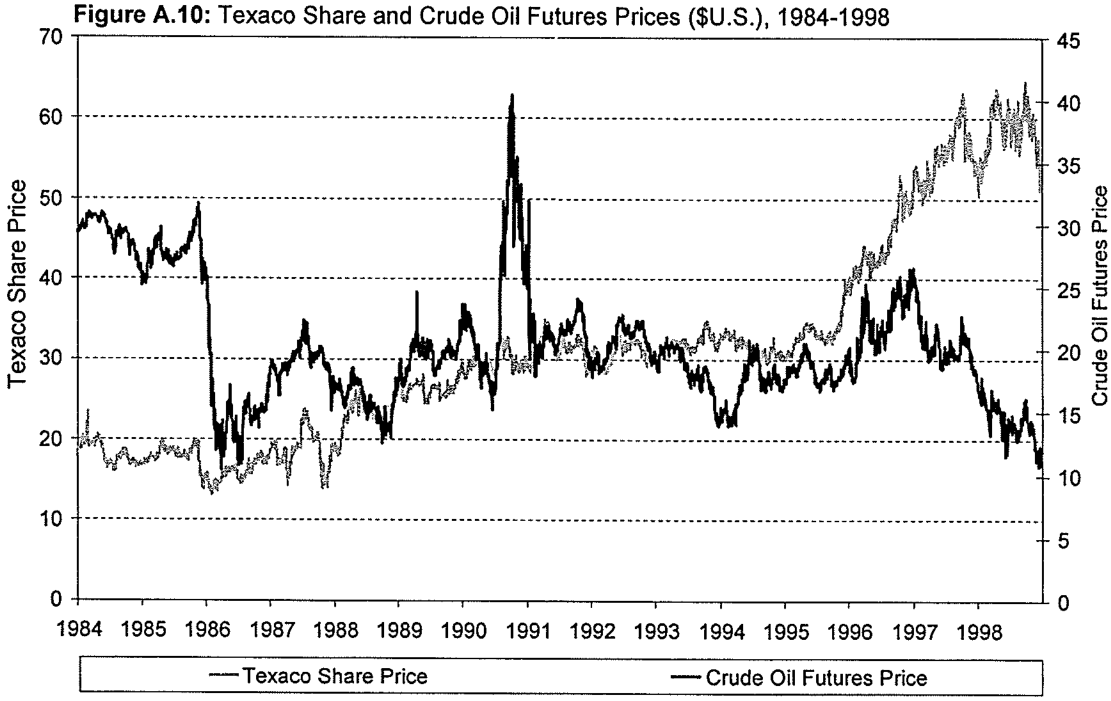


Figure A.10: Texaco Share and Crude Oil Futures Prices ($U.S.), 1984-1998



Appendix B

Figure B.1: Monsanto Share and S&P 500 Index Futures Prices ($U.S.), 1984-1998

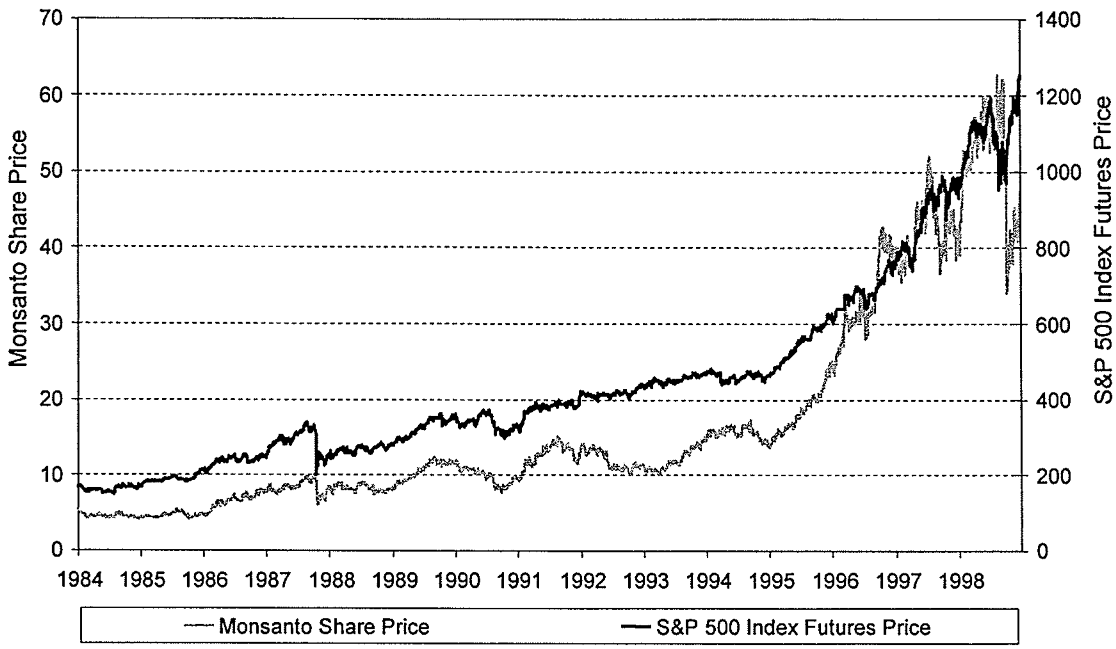


Figure B.2: Consolidated Edison Inc. Share and S&P 500 Index Futures Prices ($U.S.), 1984-1998

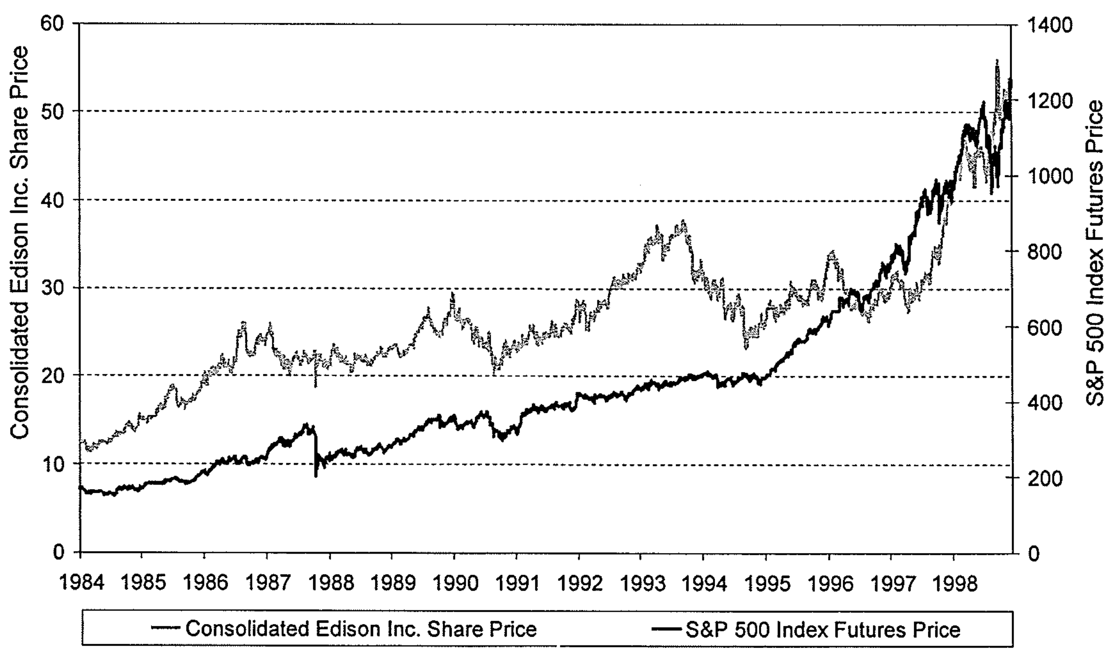


Figure B.3: GTE Corp. Share and S&P 500 Index Futures Prices ($U.S.), 1984-1998

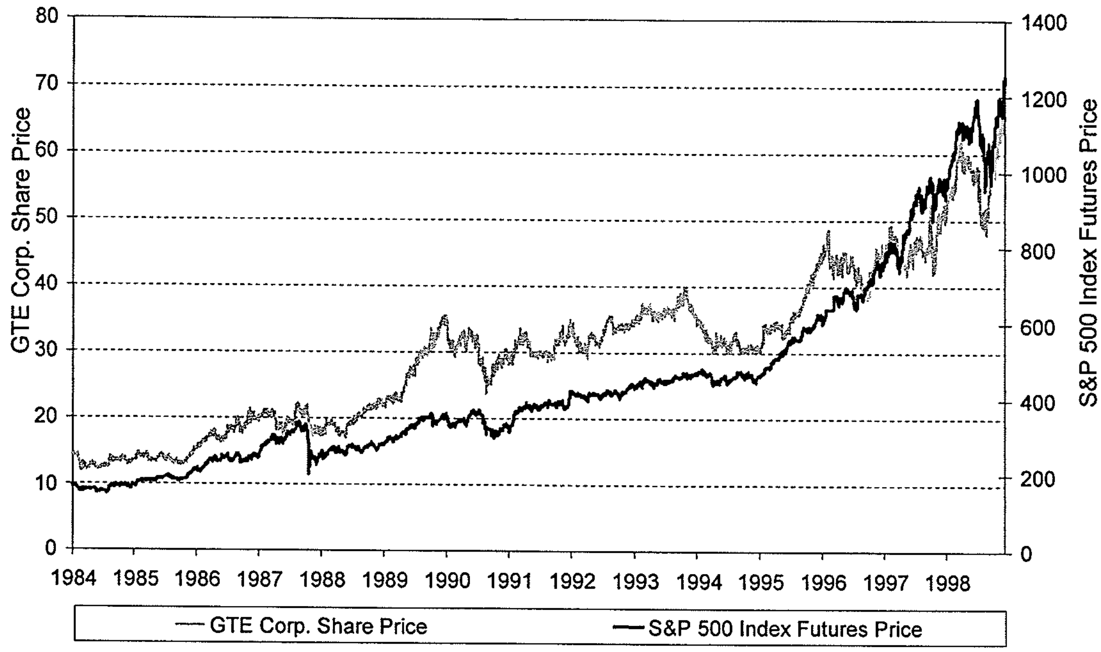


Figure B.4: Champion International Share and S&P 500 Futures Prices ($U.S.), 1984-1998

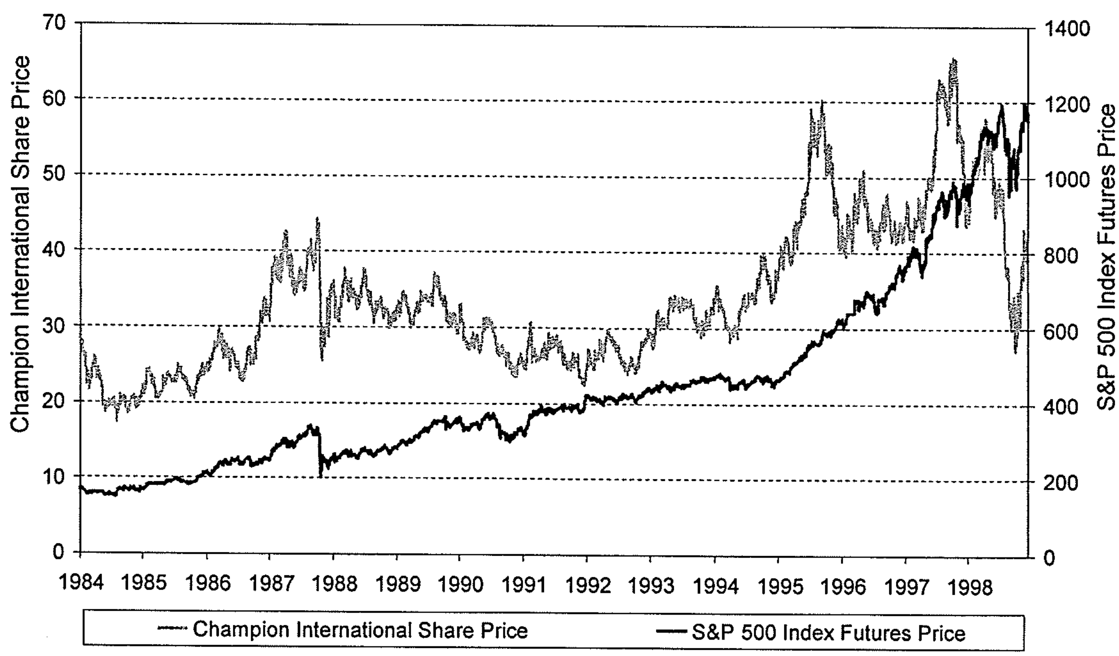


Figure B.5: Georgia-Pacific Share and S&P 500 Index Futures Prices ($U.S.), 1984-1998

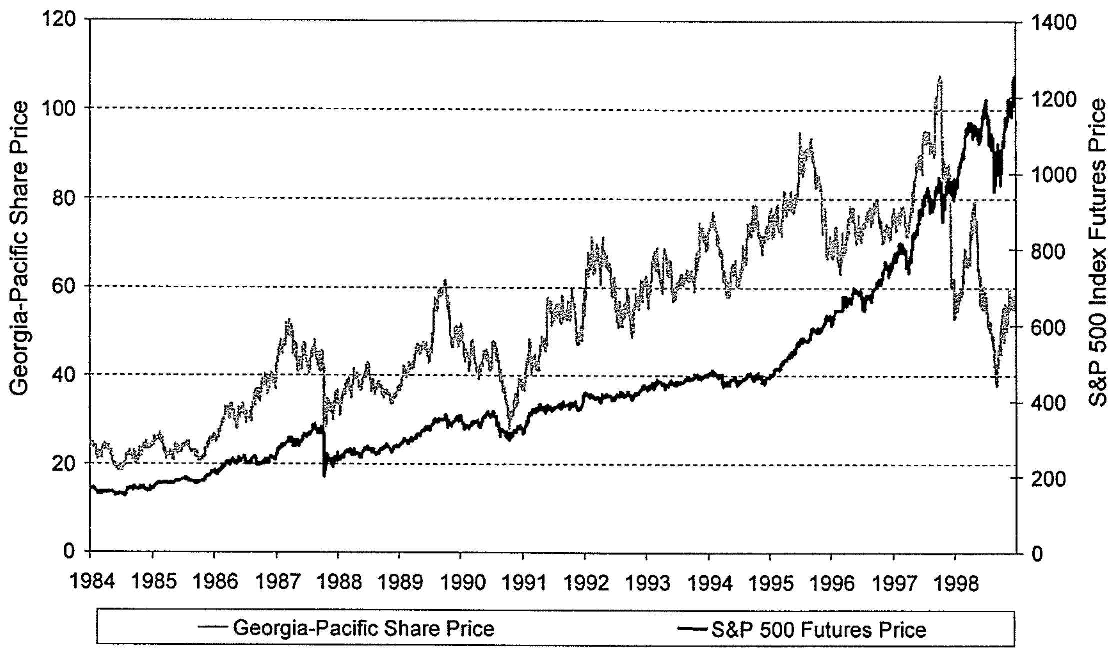


Figure B.6: Weyerhaeuser Share and S&P 500 Index Futures Prices ($U.S.), 1984-1998

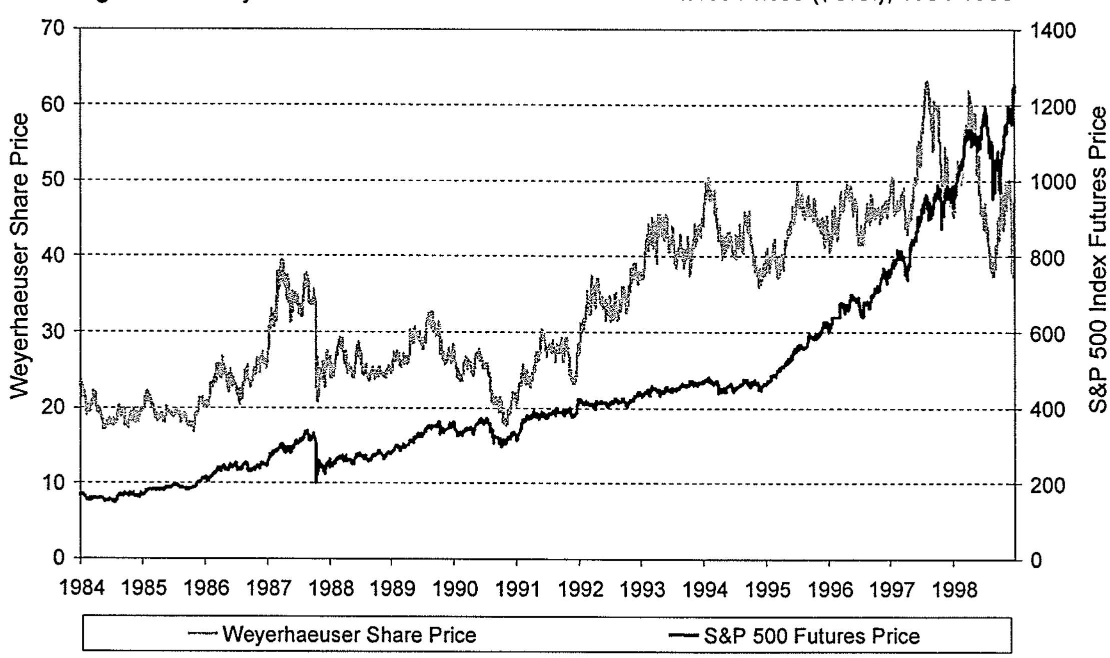


Figure B.7: Chevron Share and S&P 500 Index Futures Prices ($U.S.), 1984-1998

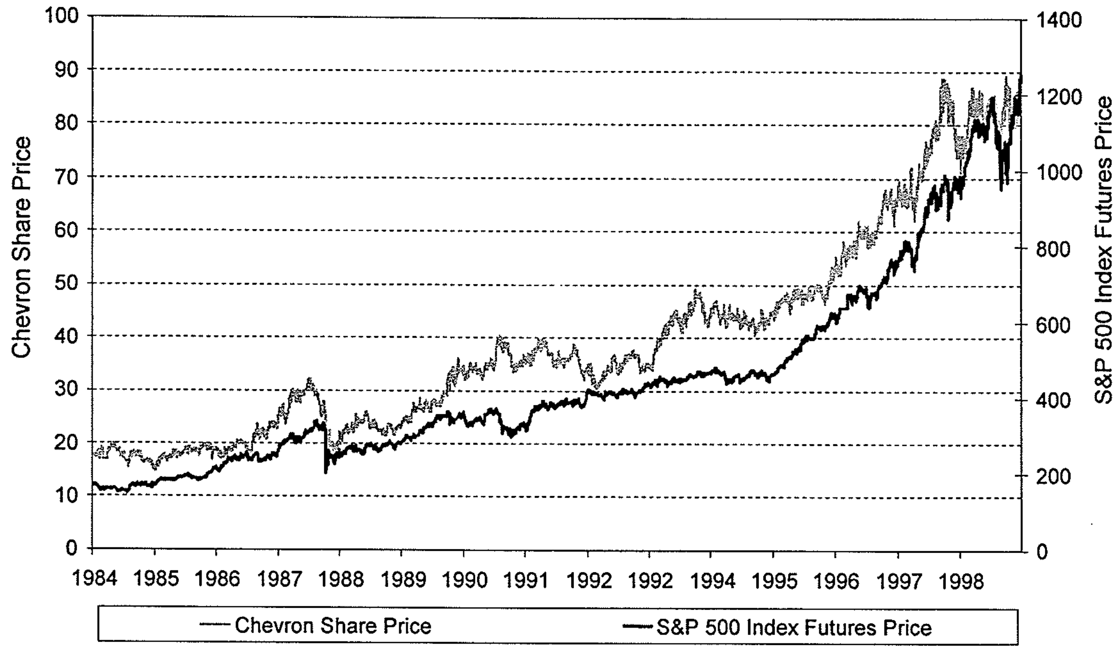


Figure B.8: Exxon Share and S&P 500 Index Futures Prices ($U.S.), 1984-1998

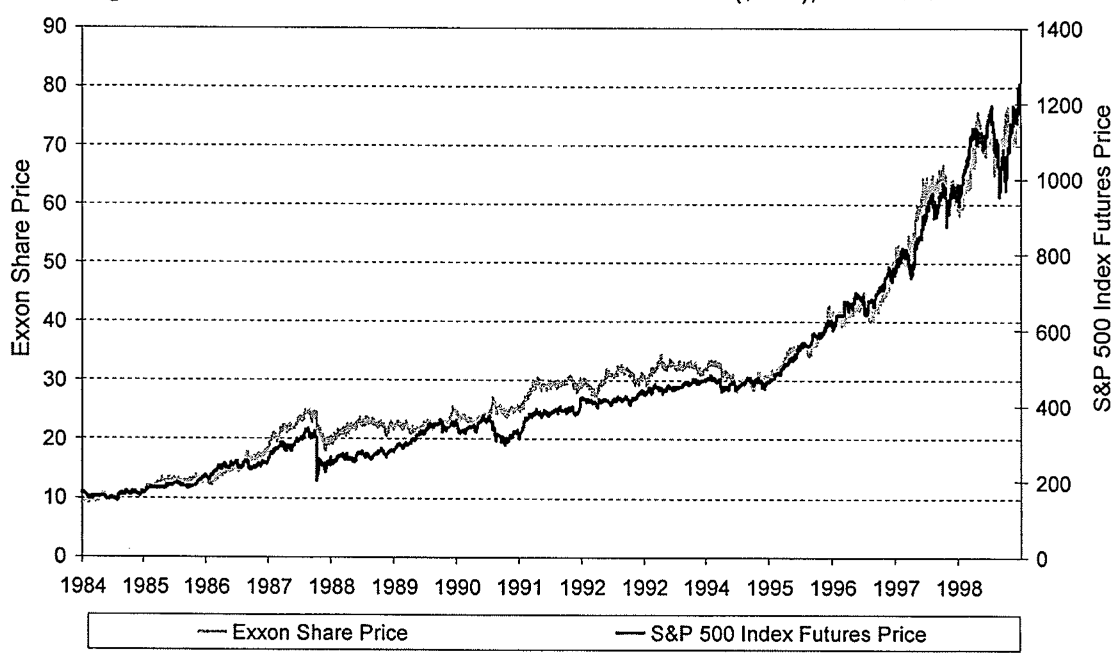


Figure B.9: Mobile Corp. Share and S&P 500 Index Futures Prices ($U.S.), 1984-1998

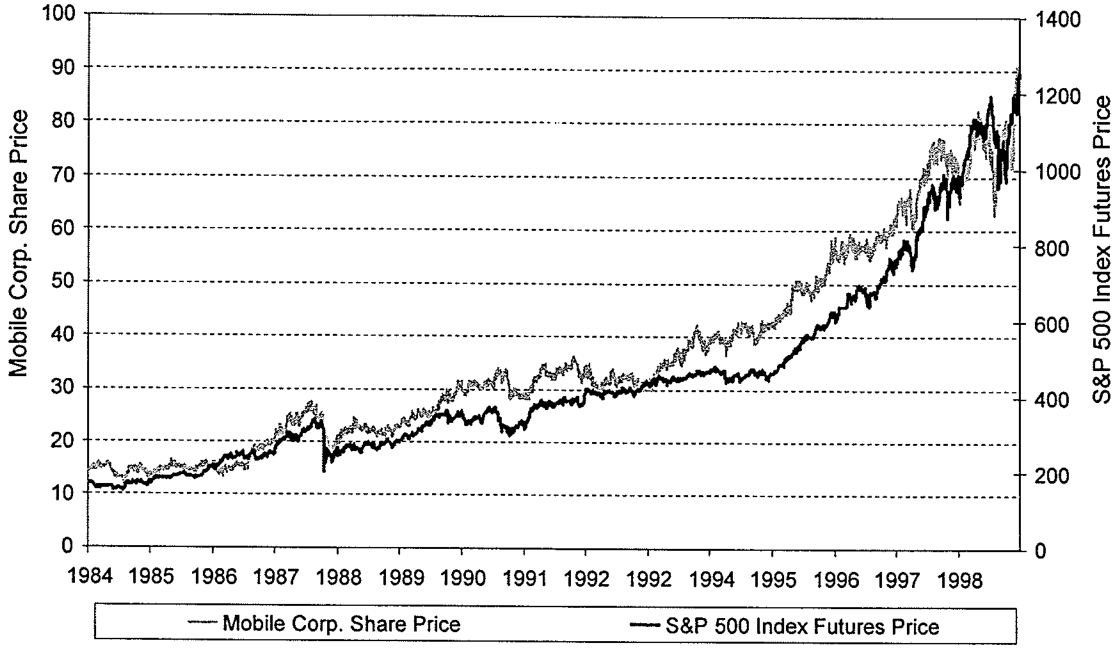
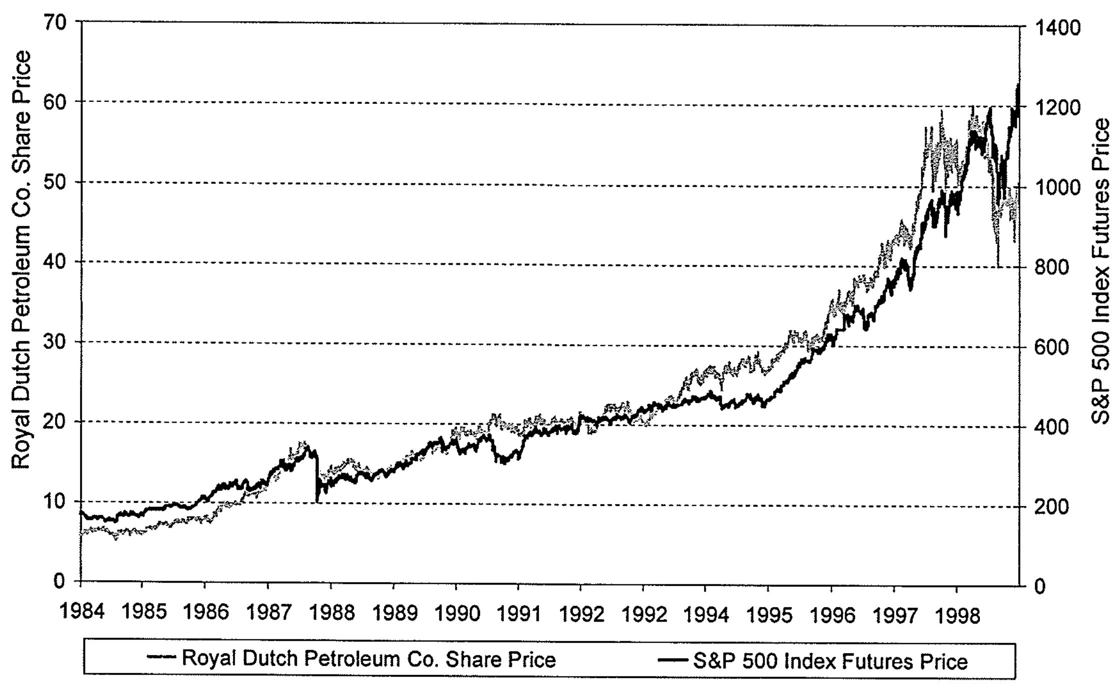


Figure B.10: Royal Dutch Petroleum Co. Share and S&P 500 Index Futures Prices ($U.S.), 1984-1998



Appendix C: Monthly Price Transmission Coefficients from Commodity Futures Price to Stock Price: Returns Model (1984-1998)

Sector	Dependent Stock price	Independent Commodity Futures Price	Coefficient	Alpha	R^2	DW Statistic
Agriculture	Deere & Co.	Soybeans	0.05	0.57	0.00	1.89
			(0.52)	(0.89)		
	Monsanto	Soybeans	0.00	1.19*	0.00	2.03
			(0.04)	(2.20)		
Interest Rates	Bell Atlantic	U.S. T-Bonds[a]	0.63*	0.80*	0.14	2.19
			(5.44)	(2.14)		
	Con. Edison Inc.	U.S. T-Bonds	0.68*	0.55*	0.19	2.30
			(6.51)	(1.63)		
	GTE Corp.	U.S. T-Bonds	0.68*	0.59	0.16	2.26
			(5.80)	(1.59)		
Resources	Champion International	Lumber	0.11*	0.17	0.02	1.99
			(1.72)	(0.29)		
	Georgia-Pacific Corp.	Lumber	0.17*	0.42	0.03	1.93
			(2.45)	(0.64)		
	Weyerhaeuser	Lumber	0.10	0.42	0.01	2.04
			(1.60)	(0.76)		
Metals	Phelps Dodge	Copper	0.66*	0.81	0.24	2.26
			(7.46)	(1.20)		
	Coeur d'Alene Mines Corp.	Gold	1.94*	-0.49	0.25	2.32
			(7.73)	(-0.55)		
	Homestake Mining Co.	Gold	1.46*	0.05	0.29	2.41
			(8.49)	(0.09)		
	Newmount Mining Corp.	Gold	1.39*	0.07	0.14	2.06
			(5.41)	(0.08)		

Appendix C (continued): Monthly Price Transmission Coefficients from Commodity Futures Price to Stock Price: Returns Model (1984-1998)

Sector	Dependent Stock price	Independent Commodity Futures Price	Coefficient	Alpha	R^2	DW Statistic
Petroleum Integrated	Arco	Crude Oil	0.30* (6.72)	0.81 (1.90)	0.20	2.11
	Chevron	Crude Oil	0.22* (5.30)	1.00* (2.52)	0.14	2.07
	Exxon	Crude Oil	0.11* (3.16)	1.21* (3.74)	0.05	2.13
	Mobil Corp.	Crude Oil	0.18* (4.27)	1.09* (2.84)	0.09	2.10
	Occidental	Crude Oil	0.22* (3.68)	0.00 (0.01)	0.07	1.97
	Royal Dutch Petroleum Co.	Crude Oil	0.17* (4.50)	1.27* (3.55)	0.10	1.97
	Texaco	Crude Oil	0.24* (5.40)	0.79 (1.86)	0.14	2.18
Producers	Apache Corp.	Crude Oil	0.39* (5.40)	0.58 (0.87)	0.14	2.10
	Ranger Oil	Crude Oil	0.42* (5.60)	-0.25 (-0.35)	0.15	2.32
Services	Global Marine Inc.	Crude Oil	0.61* (3.73)	0.42 (0.27)	0.07	2.10
	Halliburton Co.	Crude Oil	0.34* (4.43)	0.38 (0.52)	0.10	2.08
	Schlumberger Ltd.	Crude Oil	0.26* (3.98)	0.07 (0.11)	0.08	2.16

Appendix C (continued): Monthly Price Transmission Coefficients from Commodity Futures Price to Stock Price: Returns Model (1984-1998)

Sector	Dependent Stock price	Independent Commodity Futures Price	Coefficient	Alpha	R^2	DW Statistic
Services	Smith International	Crude Oil	0.69* (6.69)	0.44 (0.46)	0.20	1.84

* Beta is statistically significant at the 5 percent level.
T-Ratio in parenthesis.
[a] A positive sign indicts that interest rates and utility stock prices are negatively related. T-Bill futures prices are represented as (1 - T-Bill Rate), so a positive regression coefficient represents a negative relationship between stock prices and interest rates when using T-Bill futures.

Appendix D: Monthly Price Transmission Beta from S&P 500 Index to Stock Price: Returns Model (1984-1998)

Sector	Dependent Stock Price	Independent S&P 500 Index Futures Price	Beta	Alpha	R^2	DW Statistic
Agriculture	Deere & Co.	S & P 500	1.17*	-0.72	0.34	1.81
			(9.63)	(-1.36)		
	Monsanto	S & P 500	0.89*	0.22	0.27	2.02
			(8.16)	(0.46)		
Interest Rates	Bell Atlantic	S & P 500	0.57*	0.38	0.20	2.13
			(6.73)	(1.02)		
	Con. Edison Inc.	S & P 500	0.28*	0.48	0.06	2.14
			(3.28)	(1.29)		
	GTE Corp.	S & P 500	0.74*	0.02	0.34	2.19
			(9.52)	(0.06)		
Resources						
Lumber	Champion International	S & P 500	1.19*	-1.10*	0.40	2.02
			(10.78)	(-2.27)		
	Georgia-Pacific Corp.	S & P 500	1.18*	-0.82	0.33	2.00
			(9.29)	(-1.48)		
	Weyerhaeuser	S & P 500	1.19*	-0.85*	0.46	2.11
			(12.35)	(-2.02)		
Metals	Phelps Dodge	S & P 500	1.26*	-0.54*	0.26	2.14
			(7.95)	(-0.78)		
	Coeur d'Alene Mines Corp.	S & P 500	0.39	-1.20	0.01	2.33
			(1.63)	(-1.14)		
	Homestake Mining Co.	S & P 500	0.36*	-0.55	0.02	2.16
			(2.12)	(-0.75)		
	Newmount Mining Corp.	S & P 500	1.04*	-1.27	0.11	2.27
			(4.79)	(-1.33)		

Appendix D (continued): Monthly Price Transmission Beta from S&P 500 Index to Stock Price: Returns Model (1984-1998)						
Sector	Dependent Stock Price	Independent S&P 500 Index Futures Price	Beta	Alpha	R^2	DW Statistic
Petroleum Integrated	Arco	S & P 500	0.59*	-0.01	0.16	1.92
			(5.78)	(-0.01)		
	Chevron	S & P 500	0.65*	0.17	0.23	2.12
			(7.35)	(0.44)		
	Exxon	S & P 500	0.60*	0.50*	0.33	2.15
			(9.34)	(1.77)		
	Mobil Corp.	S & P 500	0.65*	0.28	0.27	2.15
			(8.07)	(0.78)		
	Occidental	S & P 500	0.69*	-0.86*	0.29	1.81
			(8.48)	(-1.76)		
	Royal Dutch Petroleum Co.	S & P 500	0.60*	0.52	0.26	1.93
			(7.86)	(1.55)		
	Texaco	S & P 500	0.45*	0.17	0.10	2.16
			(4.39)	(0.37)		
Producers	Apache Corp.	S & P 500	0.48*	-0.15	0.09	1.95
			(4.18)	(-0.22)		
	Ranger Oil	S & P 500	0.72*	-1.27*	0.18	2.00
			(6.29)	(-1.81)		
Services	Global Marine Inc.	S & P 500	1.20*	-1.22	0.06	2.04
			(3.27)	(-0.76)		
	Halliburton Co.	S & P 500	1.15*	-1.06	0.24	2.06
			(7.38)	(-1.56)		
	Schlumberger Ltd.	S & P 500	0.87*	-1.02*	0.18	2.08
			(6.30)	(-1.69)		
	Smith International	S & P 500	0.94*	-0.96	0.08	1.63
			(3.83)	(-0.89)		

Appendix D (continued): Monthly Price Transmission Beta from S&P 500 Index to Stock Price: Returns Model (1984-1998)

* Statistically significant at the 5 percent level.
T-Ratio in parenthesis