MARKET TIMING, FORECAST ABILITY AND
INFORMATION FLOW IN PETROLEUM
FUTURES MARKETS

DISTRIBUTATION

Presented to the Graduate Council of the
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For the Degree of
DOCTOR OF PHILOSOPHY

By

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Denton, Texas
December, 1997
Three petroleum futures contracts are examined over a ten-year period from 1986 to 1996. Intertemporal changes in futures prices and the net open interest positions of three trader types are compared to determine what, if any, market timing ability the traders have. Seasonal variation is considered and a simple trading rule is adopted to determine the dollar-return potential for market participation and shed light on issues of market efficiency.

This study utilizes a methodology proposed by Cumby and Modest (1985) and applied to futures markets by Hartzmark (1991) and Leuthold, Garcia and Lu (1994). Forecast consistency is measured by univariate and multivariate logistical regressions and Henriksson-Merton's conditional probability estimation procedures. Forecast conviction is measured by univariate and multivariate OLS regressions modified by White's heteroskedasticity correction procedure.
The ten-year analysis allows examination of long
cyclical patterns in crude oil futures and shorter seasonal
patterns in heating oil and unleaded gasoline futures.
Tests are conducted on each model's sensitivity to measurement interval, trader position and the coincidental
observation of reported positions.

For all three petroleum futures contracts, univariate
tests exhibit systematic evidence of a priori forecast power
information in the net open interest position of large
speculators. Of additional significance is the consistently
perverse signal sent by the large hedger's position. Notably, nonreporting traders do not appear to play a
significant role in the petroleum futures market.

Multivariate tests, on the other hand, indicate caution is warranted in concluding that returns to large
speculators are due to superior information. The notion
that a trader's position is determined independently is not
supported. Seasonality does not appear to be a significant
factor, though transaction costs do. Additional research is
needed to advance the findings of this investigation.
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DISSERTATION

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# TABLE OF CONTENTS

## TABLE OF TABLES

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>v</td>
</tr>
</tbody>
</table>

## CHAPTER I

**INTRODUCTION**

- An Overview of Futures Markets .......... 1
- Purpose, Problem and Significance ......... 3
- Purpose of the Study .......................... 11
- Research Design and Methodology .......... 12
- Significance ..................................... 14

## CHAPTER II

**LITERATURE REVIEW**

- Theoretical Issues ............................... 16
- Risk/Return Theory ................................ 16
- Theories of the Basis ............................ 20
- Asymmetric Information Theory ............... 22
- Methodological Issues .......................... 28
- Expectations Approach .......................... 29
- The Cost-of-Carry Approach .................... 34
- The Asymmetric Information Approach ....... 37
- Summary ............................................. 43

## CHAPTER III

**DATA AND METHODOLOGY**

- Data ................................................. 44
- Methodology ....................................... 55
- Forecast Consistency (Direction Tests) .... 56
- Forecast Conviction (Magnitude Tests) ...... 68
- Seasonal Estimation .............................. 74
- Transaction Costs and Dollar Returns ....... 75
TABLE OF TABLES

Table 1.1--Keynes' Theory of Normal Backwardation: ........... 8
Table 2.1--Previous Methodologies................................. 18
Table 2.2--Forecast Power and Risk Premium Tests:............... 19
Table 3.1--Characteristics of NYMEX Energy Contracts........... 46
Table 3.2--Contract Descriptive Statistics.......................... 48
Figure 3.1--Average Yearly Open Interest By Contract............. 49
Table 3.3--Descriptive Statistics on Return Series:.............. 50
Table 3.4--Descriptive Statistics on Heating Oil Market:......... 52
Table 3.5--Descriptive Statistics on Unleaded Gasoline.......... 53
Table 3.6--Descriptive Statistics on Crude Oil Market........... 54
Figure 3.2--Henriksson-Merton Prediction Table.................... 61
Table 3.7--Transaction Costs by Contract Type.................... 77
Table 4.1--Estimating Forecast Consistency in Crude Oil:......... 88
Table 4.2--Estimating Forecast Consistency in Crude Oil:........ 92
Table 4.3--Forecast Conviction for Crude Oil..................... 95
Table 4.4--Multivariate Logit Regression Results
  for Crude Oil............................................. 101
Table 4.5--Multivariate OLS Regression Results
  for Crude Oil............................................. 104
Table 4.6A--Seasonal OLS Regression for Crude Oil............... 112
Table 4.6B--Seasonal OLS Regression for Crude Oil............... 113
Table 4.7--Forecast Consistency in Heating Oil.................... 121
Table 4.8--Forecast Consistency in Heating Oil.................... 125
Table 4.9--Average Percentage Net Open Interest of the
  Three Trader Types in the Heating Oil
  and Crude Oil Markets:...................................... 129
Table 4.10--Forecast Conviction for Heating Oil................... 131
Table 4.11--Multivariate Logit Regression Results for
  Heating Oil................................................. 136
Table 4.12--Multivariate OLS Regression Results for
  Heating Oil................................................. 138
Table 4.13A--Seasonal OLS Regression Results for
  Heating Oil................................................. 143
Table 4.13B--Seasonal OLS Regression Results for
  Heating Oil................................................. 144
Table 4.14--Estimating Forecast Consistency for Unleaded
  Gasoline.................................................... 152
Table 4.15--Estimating Forecast Consistency for Unleaded Gasoline ........................................... 155
Table 4.16--Average Percentage Net Open Interest of the Trader Types in the Unleaded Gasoline Market. 159
Table 4.17--Forecast Conviction For Unleaded Gasoline ... 161
Table 4.18--Multivariate Logit Regressions For Unleaded Gasoline ........................................... 166
Table 4.19--Multivariate OLS Regression Results for Unleaded Gasoline ................................. 168
Table 4.20A--Seasonal OLS Regression Results for Unleaded Gasoline ................................. 173
Table 4.20B--Seasonal OLS Regression Results for Unleaded Gasoline ................................. 174
CHAPTER I

INTRODUCTION

An Overview of Futures Markets

Evidence of a forward market in which asset prices are agreed upon at time $t$, the present, and delivered at $t+1$, a future date, dates back several thousand years. Theories of the underlying role of a particular forward market, the futures market, in efficient resource allocation have existed since the early 1900s. Yet, given this long history, no unique theoretical paradigm linking market participants to futures market operation has emerged.

Accordingly, researchers continue to examine a variety of related issues in an effort to develop unified theories of futures market structure and function.

The issues given the most attention in the literature include (1) the development of a robust futures contract pricing model, (2) the value of information contained in the basis, (3) the role of speculators and hedgers in the price
discovery process, (4) the source of risk and return from holding a long or short position in a futures contract and (5) the appropriate method for determining the optimal hedge ratio.

Taken together these five independent research lines converge on the theoretical and empirical search for a unique definition of the role of futures markets and the pricing parameters in a futures contract. Though significant progress has been made, the core issues are still hotly debated. For example, theoretically, the two primary functions of the organized futures markets are to provide (1) a means of transferring risk and (2) a forum in which price discovery can take place. However, the acceptable risk/return model is not agreed upon, and why price discovery in an organized futures market should be superior to price discovery in the corresponding spot market is still unclear.

The respective roles of speculators and hedgers in the price formation process are important to the search for a generalizable risk/return relationship. As essential market participants, speculators (defined as having no
interest in holding the underlying asset for production purposes) play a significant role by providing hedgers (those with an economic interest in the underlying asset) the means to transfer price risk.

The question then remains whether the demand for speculative services is motivated by the speculators' roles as actuarial agents, gamblers, market specialists (those who have and trade on superior information) or opportunists (those taking advantage of institutional anomalies). Of course, all four motivational elements may be present. Though recent attempts to define the actions of speculators in the market have borne some fruit, no single motivational proposition has been demonstrated consistently over any set of futures market contracts.

Purpose, Problem and Significance

Three petroleum futures contracts traded on the New York Mercantile Exchange are used to extend a historical debate that has persisted for roughly 65 years. The crucial question at the center of the debate is: What market characteristics motivate the seemingly continuous supply of net speculative services in active futures markets? Since
Keynes defined the role of forward contracts as risk transfer agreements in 1930, many scientific investigations have been conducted along three major lines to link Keynes’ seminal article theoretically to the organized futures market.

The first line of research, generally attributed to Keynes, maintains that, ex ante, speculators are awarded a risk premium for assuming the price risk associated with holding a long position in the underlying asset. The argument is made that the risk premium results from speculators agreeing to pay a downward-biased price of the expected future spot price for the asset such that

$$F_{i,(t,T)} < E(S_{i,(T)}),$$

where $F_{i,(t,T)}$ denotes the futures price of asset $i$ at time $t$ for delivery at time $T$, $E$ is the expectation operator, and $S_{i,(T)}$ is the prevailing spot price of asset $i$ at time $T$. Keynes defined this relationship as normal backwardation.

The second line of research, proposed by Kaldor (1939), Working (1949) and Telser (1958), maintains the

---

1 Keynes actually defined normal backwardation as $F_{i,(t)} < S_{i,(t)}$, where $F$ is a forward contract and $S$ is the current cash price of the commodity.
futures price, ex ante, is an unbiased estimate of the expected future spot price such that

\[ \tilde{F}_{t,T} = E\{S_{t,T}\} . \]

This relationship between spot and futures prices falls under the general theory of rational expectations.

Within the second line of research is the well-established ex post theory of storage, modeled as

\[ \tilde{F}_{t,T} - S_t = S_t (\tilde{K}_{t,T} + \tilde{I}_{t,T} - \tilde{C}_{t,T}) , \]

which maintains that the difference between contemporaneous futures and spot prices, the basis, \((\tilde{F}_{t,T} - S_t)\) reflects the opportunity costs (interest, \(S_t \tilde{K}_{t,T}\), and storage costs, \(\tilde{I}_{t,T}\)) of holding the underlying asset in inventory, offset by the benefits associated with a positive inventory supply \((\tilde{C}_{t,T})\).

Though the ex post theory of storage is not controversial, little agreement exists on whether futures prices are determined by the demand for transference of risk or by the need for disclosure of information valuable for forecasting future spot prices.

Risk transfer activity implies hedgers use futures contracts to pass the price risk of the underlying asset to
speculators. In return hedgers are thought to pay a premium and accept basis risk. Price discovery implies that information contained in futures prices improves the prediction of the future spot price of the underlying asset.

To date, empirical examination of these two trade motivating paradigms has produced mixed and often conflicting results (e.g. Dusak 1973, Carter, Rausser and Schmitz 1983, Cohen et al. 1983). Although a single source of this apparent disparity between theory and practice may be difficult to pinpoint, it is likely due in part to the variety of data, methodological approaches and theoretical constructs employed. Nevertheless, as in any financial market, a non-redundant, risk-dependent, efficient price discovery role demands that futures prices adjust quickly and accurately to the arrival of economically significant information and that futures prices contain information not otherwise available. Thus, the empirical investigation of the information content in futures market price series has centered on the relationship between futures prices and the respective spot prices of the underlying asset.

Though the price adjustment process of financial assets has received much attention in the literature, gener-
alizable results have been limited to securities with well-defined predictive models and distributions readily adapted to empirical analysis. However, in the case of futures contracts, empirical examinations employ a wide variety of theoretical and methodological constructs.

For example, one explanation offered for the uncertainty of the exact role futures contracts play in the spot price adjustment process is the seeming intractability of the cost-of-carry model (Kaldor 1939, Working 1949, Brennan 1958, Telser 1958). That is, investigations of the cost-of-storage theory to date have failed to unambiguously separate the price discovery from risk transfer components thought to be impounded in the futures price (Fama and French 1987).

The variety of empirical investigations purporting to test the impact of information arrival on the value of futures contracts is illustrated in Table 1.1. Following Chang (1985), previous research efforts are categorized in the table according to the assumptions adopted by the authors. The assumptions relaxed conform to Chang’s interpretation of Keynes’ (1930) original article defining the economic role of futures markets and the theory of normal backwardation.
The critical limiting assumptions from Chang’s perspective were the following: (1) Investors are averse to risk. (2) Speculators always hold net long positions. (3) Speculators are unable to forecast future spot prices.

Table 1.1--Keynes' Theory of Normal Backwardation: Empirical Examinations and Conclusions

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Tended to Support</th>
<th>Tended to Reject</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Breeden (1980)</td>
<td>Telser (1958,60)*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bodie &amp; Rosansky (1980)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jagannathan (1985)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fama &amp; French (1987)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chang et al. (1990)</td>
</tr>
<tr>
<td>Net Long and Forecast</td>
<td></td>
<td>Houthakker (1957)*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rockwell (1967)*</td>
</tr>
<tr>
<td>Ability</td>
<td></td>
<td>Hartzmark (1991)</td>
</tr>
</tbody>
</table>

* No statistical tests were performed.

Even as these assumptions are relaxed, as shown in table 1.1, contentious conclusions exist across a wide variety of empirical examinations.

Until recently attempts to disaggregate the risk premium from the price discovery elements of the basis have assumed a symmetric distribution of the information set for
hedgers, speculators and small or nonreporting traders. If, however, as some finance theorists suggest (Hawtry 1940, Houthakker 1957, Danthine 1978, Chang 1985, Khoury and Martinel 1986), speculators are better informed on conditions impacting the value of a specific commodity or possess some unique trading advantage, they may be characterized as specialists or opportunists from the market's perspective.

Given that asymmetric information is present in the equilibrating process, agency theory would support the notion that the informed trader has a self-serving motive to withhold the exact nature of the information. Therefore, factors influencing risk/return tradeoff that would otherwise revise the uninformed trader's predictions may not be directly disclosed. If, on the other hand, market institutional structure has placed speculators in a uniquely advantageous position, the factors influencing risk/return tradeoff may be disclosed but unavoidable.

Accordingly, futures market price movements have been examined empirically under alternative restrictive assumptions in order to explain the demand for speculative services and the potential information impounded in futures
prices. Recent efforts (Hartzmark 1991, Leuthold, Garcia and Lu 1994) along this line have again resulted in conflicting evidence in support of the theory of normal backwardation, the demand for speculative services and the significance of futures contracts in the efficient allocation of resources.

Though resolution of all these apparent conflicts may not be possible, I adopt an experimental design that (1) is not constrained by the assumption of the independence of forecast ability and magnitude of return, (2) incorporates variables to account for seasonal variance in the information set, (3) investigates the role of the representative speculator rather than that of individual traders, (4) recognizes the simultaneous nature of the positions taken by various traders and (5) calculates a hypothetical small trader's returns net of transaction costs.

This approach represents a significant step toward clarifying the competing arguments. Hartzmark (1991) and Leuthold et al. (1994) did take the independence assumption into account, improving upon Chang's (1985) design. However, no previous research in the areas of market timing and asymmetric information has taken into account seasonal
variation, transaction cost-constrained trading or the simultaneous nature of observed trader positions.

Purpose of the Study

This work draws on the theoretical constructs presented by Henriksson and Merton (1981), Khoury and Martel (1985, 1986, 1989) and Fama and French (1987); it extends the empirical results of Khoury and Yourougou (1991) and, more important, those of Chang (1985), Hartzmark (1991) and Leuthold et al. (1994). An examination of the intertemporal price adjustment process and distributions of three petroleum-based contracts is conducted under a modified Cumby-Modest (1987) framework.

This research framework (1) extends Chang's investigation, utilizing an improved data set and enhanced statistical procedures, (2) provides additional evidence extending Cumby and Modest's research paradigm so that it may be applied to a larger cross-section of industries and futures contracts, (3) extends the methodological design to account for seasonality and the independent forecast assumption in the open interest positions of traders and (4) measures dollar returns constrained by transaction costs.
Research Design and Methodology

In this study I employ published weekly and semi-monthly petroleum-based data derived in a United States futures market. Data include daily futures prices and net open interest trader positions as well as surveyed margin and transaction cost data. The combined data set is used to examine and test for market timing ability possessed by large speculators, large hedgers and nonreporting traders. The tests utilize petroleum data not examined in previous studies and apply the methodology and theoretical paradigms proposed by Henriksson and Merton (1981), tested by Chang (1985) and modified by Cumby and Modest (1987) in petroleum futures market analysis for the first time.

Taken together, the extensions in this study test the following substantive hypothesis:

Speculators, hedgers and nonreporting traders (the participants) in a futures market transaction are, on average, motivated by heterogeneous expectations (a result of either asymmetric information or dissimilar utility functions), risk premia, inventory cycle adjustments or some other institutional phenomenon regarding the return generat-
ing process. Consequently, the forecast of the best positioned trader contains valuable information that causes rational investors to revise their expectations concerning the probability distribution of future asset returns.

Daily price data for contract open, close, high, low and open interest were obtained from Prophet Information Services Inc. Pinnacle Data Corporation supplied semimonthly and weekly net open interest positions for large speculators, hedgers and nonreporting traders.

The futures contracts examined are traded on the New York Mercantile Exchange and include crude oil, heating oil and unleaded gasoline. The three petroleum futures contracts are examined over a ten-year interval from January 1986 to December 1995. Daily return data are aggregated consistent with weekly, semimonthly and biweekly commitment of trade report observations. Futures data for the petroleum industry have not been examined in the market timing literature to date,\(^2\) nor in the literature that attempts to

\(^2\) This is surprising considering these markets are among the largest in terms of total open interest and total value currently trading on any exchange.
unwind the forecast power and risk transfer properties thought to reside in the basis.

Significance

In recent years the asymmetric information hypothesis has been extended to the futures market. In the main, the objective has been to unwind the separate effects risk and forecast ability.

This investigation presents evidence that: First, the large speculator does not trade based on a superior information set that is independently determined. Second, the large hedger's forecast is perverse. Third, the nonreporting trader is, at best, a free rider whose trading activity serves to line the pockets of dealers. Therefore, the net open interest position of participants in the futures market should not signal valuation adjustments that result in abnormal returns.

These extensions are important because, if a backwardation equilibrium exists market participants are either asymmetrically informed, paid a risk premium or anticipating inventory cycle adjustments. The evidence presented herein suggests that although the a priori trader position's of
large speculators and nonreporting traders tend to anticipate the subsequent direction and magnitude of price movement. This is not sufficient to conclude risk premiums are paid or that the market is either asymmetrically informed or informationally inefficient.

In summary, this investigation adds significantly to the existing trail of evidence by (1) applying the Cumby and Modest (1987) research paradigm and methodology to petroleum futures markets, (2) comparing the sensitivity of the return-generating process to portfolio composition and alternative intervals of the arrival of new information in liquid US futures markets, (3) providing systematic evidence of signal interpretation efficiency by market participants and (4) incorporating transaction costs in the returns model.
CHAPTER II

LITERATURE REVIEW

Theoretical Issues

Three important research trails are significant in determining the validity of the empirical questions addressed in this investigation. The first concerns the continued search for a meaningful relationship between risk and return in organized futures markets. The second is the role the basis plays in the price discovery and risk transfer process. The third is the value of superior information, often referred to as asymmetric information, in an efficient markets context.

Risk/Return Theory

The first research trail has evolved from attempts to define an exact pricing relationship consistent with risk/return theory. Three alternative views of the expected return to holding futures contracts have emerged in the literature. The first, originally proposed by Keynes (1930)
and supported by Hicks (1946) and Cootner (1960), maintains that speculators should earn a positive risk premium for bearing the price risk associated with holding a long position in the underlying commodity. The second started with Dusak’s (1973) effort to apply modern portfolio theory to the problem of defining the risk/return relationship for futures contracts using the capital asset pricing model (CAPM) as the predictive model. Third and finally, Telser (1960) divided speculators into two groups (professional and amateur) and argued that, although risk exists in the futures markets, speculators on average will earn no return because the positive returns of the professionals will be exactly offset by the negative returns of the amateurs.

To date, empirical research has failed to resolve the dispute over which of the alternative theoretical relationships is best suited to measuring risk and return in futures markets. The results differ not only across the spectrum of commodities tested but also over various modifications of the experimental design employed by researchers.

The range of theoretical and empirical studies and variety of methodologies employed in previous investigations are summarized in table 2.1. The variety of the contracts
tested and the contradictory results obtained are further identified in Table 2.2. The empirical examinations of Dusak (1973), Carter, Rausser and Schmitz (1983) and Chang (1985) are of particular importance to the first line of research.

Table 2.1--Previous Methodologies

<table>
<thead>
<tr>
<th>CAPM</th>
<th>CCAPM*</th>
<th>COST OF CARRY</th>
<th>EX ANTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DOLLAR BETA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rockwell (1967)*</td>
</tr>
<tr>
<td>Chang, Chen &amp; Chen (1990)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: CCAPM is consumption-based CAPM. *No statistical tests were performed. **Employed an asymmetric information approach.

Initially, Dusak (1973) argued that futures contracts have little or no systematic risk and therefore should provide no return to speculators. The Carter et al. (1983) study modified the composition of the market portfolio used by Dusak (1973) and discriminated between the long and short positions of speculators. Carter et al. (1983) (contrary to Dusak) obtained evidence of positive returns and signifi-
cant systematic risk coefficients for corn, wheat and soybeans.

Table 2.2--Forecast Power and Risk Premium Tests: Methodology Used and Contracts Tested

<table>
<thead>
<tr>
<th>METHODOLOGY</th>
<th>CONTRACT</th>
<th>FA</th>
<th>RP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dusak (1973)</td>
<td>CAPM</td>
<td>Wheat, Corn &amp; Soybeans</td>
<td>N/A</td>
</tr>
<tr>
<td>Breeden (1980)</td>
<td>CCAPM</td>
<td>17 Different</td>
<td>N/A</td>
</tr>
<tr>
<td>Carter et al. (1983)</td>
<td>CAPM</td>
<td>Wheat, Corn &amp; Soybeans</td>
<td>N/A</td>
</tr>
<tr>
<td>Hazuka (1984)</td>
<td>CCAPM</td>
<td>Wheat, Corn &amp; Soybeans</td>
<td>N/A</td>
</tr>
<tr>
<td>Figlewski (1984)</td>
<td>CAPM</td>
<td>Stock Index</td>
<td>N/A</td>
</tr>
<tr>
<td>Chang (1985)</td>
<td>Henriksson-Merton</td>
<td>Wheat, Corn &amp; Soybeans</td>
<td>Some</td>
</tr>
<tr>
<td>So (1987)</td>
<td>CAPM</td>
<td>Wheat, Corn &amp; Soybeans</td>
<td>N/A</td>
</tr>
<tr>
<td>Fama &amp; French (1987)</td>
<td>Cost of Carry</td>
<td>21 Different</td>
<td>10 of 21</td>
</tr>
<tr>
<td>Chang et al. (1990)</td>
<td>CAPM</td>
<td>Copper, Silver &amp; Platinum</td>
<td>N/A</td>
</tr>
<tr>
<td>Hartzmark (1991)</td>
<td>Likelihood Ratio and CLS</td>
<td>5 Commodities &amp; 2 Financial</td>
<td>None</td>
</tr>
<tr>
<td>Khoury &amp; Yourougou (1991)</td>
<td>Cost of Carry</td>
<td>Barley, Oats &amp; Canola</td>
<td>Weak</td>
</tr>
</tbody>
</table>

Note: FA = forecast ability; RP = risk premiums.
Chang's (1985) research design extended Telser's (1958) notion and relaxed Carter et al.'s (1983) assumptions by classifying speculators as large or small and adopting a nonparametric methodology. Similar to Carter et al. (1983), Chang observed significant risks and returns for all three contracts.

So (1987) also examined corn, wheat and soybean futures, suspecting Dusak's (1973) results stemmed from her assumption of a stationary beta coefficient. So found that contract betas were, in fact, nonstationary but insignificant. The fact that the contradictory results are not limited to Dusak's (1973) three agricultural contracts is also noteworthy. Figlewski's (1984) examination of stock index futures and Chang, Chen and Chen's (1990) examination of copper, platinum and silver both confirmed Dusak's results.

Theories of the Basis

The second research trail examines relationships within and properties of the basis. The basis is defined as the difference between the spot or cash price and the futures price for an underlying asset. Four competing, but
not entirely mutually exclusive, theories of the properties and role of the basis are predominant in the literature.

The first, proposed by Keynes (1930) and Hicks (1946), holds that the differences in the spot and futures prices reflect a risk premium awarded to speculators for assuming the price risk of the underlying asset. The second follows Houthakker's (1957) and Telser's (1958) argument that the futures price represents an unbiased expectation of the future spot price. The third approach, proposed by Working (1955, 1962), Johnson (1960) and Stein (1961), suggests that the basis reflects a portfolio approach to hedging, where speculators and hedgers use the same distributional properties to arrive at spot and futures prices. The fourth, proposed by Hawtry (1940), Danthine (1978) and Khoury and Martel (1985), suggests that speculators hold superior information concerning the future demand/supply functions of a commodity and earn a return commensurate with the value of obtaining superior (asymmetric) information. This last hypothesis seems to have a great deal of intuitive appeal and yet has received little attention in the futures market literature.
Asymmetric Information Theory

The third research trail, a more recent paradigm on the futures market theoretical scene, is the asymmetric information (AI) hypothesis. Thus far, this alternative paradigm has not been empirically tested across a sufficient number of contracts to be considered generalizable. However, research assuming a symmetrical information set for all market participants has received much attention. Therefore, this review begins with the results and conclusions emanating from tests under the assumption of a homogeneous information set in order to document the advances and limitations identified along this line of research.

Stein (1961) developed a theoretic model in which spot and futures prices were simultaneously determined to explain the choice between hedged and unhedged portfolios of commodity stocks. In a liquidity preference, utility-maximizing framework, Stein proposed that (1) a widening of the basis and increase in the spot price signaled a positive change in the futures price while (2) an increase in the spot accompanying a narrowing of the basis, when the spot price and aggregate demand are positively correlated, would not be expected to change the futures price.
Garbade and Silber (1983) conducted an empirical analysis of the determination of spot and futures prices with a model sensitive to the elasticity of storage and held in parity by arbitrage. Although they did not test the information impact of the basis directly, Garbade and Silber's results indicated that for commodities in continuous production, market integration is evident for short-horizon trading. They concluded market integration mitigated, to some extent, the impact of storage cost changes on the cost-of-carry model.

French (1986) extended Garbade and Silber by developing a forecasting model to detect the characteristics affecting the ability of the futures price to predict the expected spot price. According to French the predictive power of the basis was a positive function of the degree of variance in seasonal inventory levels and storage costs.

Fama and French (1987) disaggregated the basis into two components. The information component captured the predictive power of futures prices relative to expected future spot prices, and the risk premium component measured the speculator's reward implied in the intertemporal change
in spot prices. Fama and French tested 21 different commodities, and their results tended to confirm the presence of both components in only a limited number of contracts. Consequently, Fama and French concluded the results were weak citing the inability of their proposed model to disaggregate the separate effects of risk and forecast power and data limitations constraining the power of the tests.

Taken together these results support the idea that the asymmetric information paradigm deserves a closer look for three reasons: (1) Not only does a change in the basis contain information, but the relationship of the independent spot and futures prices during that change signals market expectations as well. (2) The heterogeneous physical characteristics of the underlying asset on which the futures contract is written potentially weight the elements of the cost-of-carry model differently and complicate the development of a single predictive model. (3) Limiting the tests to a theoretical model with homogeneous expectations fails to explain many of the risk/return characteristics extant in the futures market trading process.
Although the empirical tests for the impact of asymmetric information on the trading process are recent, the idea is not new in futures market theory. Khoury and Martel (1985) point out in a quotation from Hawtry (1940) that the notion of a superiorly informed trader in futures markets dates back more than 50 years. Although data and methodological constraints limited empirical testing of this hypothesis in the futures market until recently, the AI paradigm has received significant attention under the general heading of financial signaling as it applies to explanatory models in corporate and financial market analysis.

In the area of corporate finance, Leland and Pyle (1977) were the first to apply the notion of asymmetric information to a firm's choice of debt or equity financing. Myers and Majluf (1984) extended Leland and Pyle's study to suggest that pecking-order choices are driven by asymmetric information held by management and shareholders and may result in forgone positive net present value projects. Miller and Rock (1985) presented a cash flow argument for dividend policy determination under conditions of asymmetric
information. Asquith and Mullins (1986) examined dividend announcements, stock repurchases and equity issues and empirically identified some of the costs and benefits inherent in asymmetrically informed markets.

In more recent work the asymmetric information paradigm has been enhanced and extended. Wang (1994) used an AI model of competitive stock trading to show that heterogeneous information results in price adjustment delays due to informational and noninformational trading. Deakins and Guhlum (1994) identified moral hazard and adverse selection problems for banks evaluating risk characteristics in the presence of AI. In two studies extending Myers and Majluf (1984), Raymar (1993) showed that the market's interpretation of the leverage signal under AI conditions depended on the level of outstanding debt and that in a multiperiod world the market does not interpret all equity issues as signals of overvaluation of the firm (Viswanath 1993).

also proposed tests in the AI framework. Khoury and Yourougou (1991) purportedly tested the Khoury and Martel (1985) model using data from the Canadian barley, oats and canola futures markets and concluded that the basis reveals information to the cash market.

Two additional applications of the AI framework in futures market research seem to support the contention that asymmetric information between speculators and hedgers is extant in the market equilibrating process. First, Choi and Avanidhar (1994) analyzed the effect of the introduction of a futures contract on the bid/ask spread in the spot market and concluded that contract introduction increased the degree of AI in the market. Second, Kumar and Seppi (1992) used a two-period asymmetric information model to capture the effects of market manipulation with cash settlement.

The preceding examples illustrate the variety of asymmetric information applications to futures market research and provide evidence that the paradigm is receiving increased attention. Next, tracing the methodological developments in futures market research will clarify the implications and benefits of adopting the AI framework as an appropriate research design.
Methodological Issues

In a one-period framework, Keynes (1930) proposed a theoretical relationship between the forward price $F$ and spot price $S$ at any time $t$ that reflects a risk premium awarded to speculators for accepting the price risk of the underlying asset between $t$ and $t+1$. That is, $F_t < E(S_{t+1})$. Keynes defined this relationship as normal backwardation. Since Keynes' seminal article, a significant body of work has examined the validity of his pricing theory using an arbitrage restrictive payoff, general equilibrium framework (i.e. expectations) or arbitrage restrictive carrying cost (i.e. theory of storage) experimental design.

The expectations approach\(^1\) proposed by Working (1955, 1962) was empirically tested by Dusak (1973) and others in the CAPM framework. The cost-of-carry model proposed and extended by Kaldor (1939), Working (1948), Brennen (1958) and Telser (1958) has also been repeatedly tested. Importantly, these two views differ markedly in their assumptions and results are often difficult to compare. In addition,

\(^1\) That empirical investigations purport to examine a priori beliefs of speculators using ex post data is an issue pursued later in this paper.
the heterogeneous nature of the underlying assets and model restrictions also complicate the comparative process. The following review of results and constraints for both the linear expectation and cost-of-carry paradigms illuminates these issues and lends support for the adoption of an asymmetric information framework.

Expectations Approach

Dusak's (1973) attempt to define the risk/return relationship in terms of the capital asset pricing model (Sharpe 1964, Lintner 1965) beta coefficient has resulted in many efforts in three general directions to explain and extend her results. The first track includes those investigations that altered and argued the composition of the market portfolio proxy over which excess returns should be measured. The second track modified the statistical procedures and definitions adopted to identify risk components and rates of return present in various futures price series. The third track suggested that returns were a function of the investor's preference for intertemporal consumption smoothing.
Although admittedly each of the three tracks contains elements of the other two, each offers a unique contribution to the puzzle. But at least one common thread predominates this literature. While most attempts to define a predictive model of futures contract returns have applied a traditional or modified version of a previously accepted asset pricing model, all, in one manner or another, purported to test Keynes' (1930) theory of normal backwardation.²

Keynes argued that speculators were rewarded returns above the risk-free rate for absorbing price risk, which they accomplished by agreeing to pay \( F(t) \), a downward-biased price of the expected future spot price of the underlying asset.³ At maturity \( T \) the asset would supposedly be sold by the speculator at the higher expected spot price \( S_T \), thus producing a positive return commensurate with the price

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² Recalling that Keynes defined backwardation as \( F(t) < S(t) \), note that a backwardation equilibrium will exist any time that \( F(t) < E(F_T) \). More important, the sufficiency conditions for obtaining a backwardation equilibrium have been demonstrated over several competing paradigms including risk premiums (Keynes 1930, Cootner 1960), attitudes toward risk (Danthine 1978), informational asymmetries (Danthine 1978, Khoury and Martel 1985) and inventory cycle adjustments (Houthakker 1957, 1968, Fort and Quirk 1988).

³ Keynes assumed speculators were always net long the contract.
risk absorbed. Early counterintuitive empirical results and numerous plausible explanations have led to a variety of approaches to a solution. Modifications to the experimental design seem, for the most part, to have been motivated by both recent advances in statistical inference theory and divergent economic interpretations of Keynes' (1930) hypothesis.

The latter motive may forever remain a contentious point, since Keynes is no longer available to clarify his position. However, the rationale for modifying experimental design to accommodate advances in statistical inference theory has merit. Although advanced econometric techniques have generally been applied to widely accepted predictive asset pricing models or hypothesized relationships, they are often used to unravel particularly complex relationships.

Since an empirically robust baseline prediction model of commodity futures prices has not been agreed upon, (1) the CAPM and its derivatives may be wholly unsuited for pricing the risk/return relationship of a wide selection of commodity and financial futures contracts and/or (2) characterizing the basis as a risk premium alone may ignore
important attributes contributing to the difference between spot and futures prices. Interestingly these observations may be due to the underlying explicit assumption that all market participants are symmetrically informed (i.e. homogeneous expectations).

For example, Dusak (1973) attempted to sort out the conflicting results obtained by Cootner (1960) and Telser (1958, 1960) by applying the dollar beta CAPM to futures contracts for wheat, corn and soybeans and failed to find a statistically significant beta coefficient or a mean return. Dusak rejected the Keynesian (total risk) hypothesis in favor of the portfolio theoretic explanation that returns on any capital asset (a futures contract in this case) should

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4 Cootner argued for and Telser against the normal backwardation theory presented by Keynes.

5 Dusak (1973), Bodie and Rosansky (1980) and Carter et al. (1983) all suggest that Keynes' hypothesis is subject to interpretation. However, even if, as Dusak points out in her footnote, Keynes defined the risk that is priced as a function of the asset's own price variability, how a zero beta/zero return result rejects Keynes is still unclear. For example, within the CAPM framework, if all the risk were unsystematic and therefore diversifiable, then Dusak's results would not necessarily contradict Keynes. On the other hand, if the risk of a price change were partially systematic, then the market model would yield a positive excess return and slope coefficient (beta), and this result would suggest that Keynes' hypothesis overstates the required return.
be dependent upon that asset's risk contribution to a large well diversified portfolio. The absence of a significant return then led her to conclude (consistent with Telser) that no evidence emerged to support Keynes' hypothesis.

Carter et al. (1983) argued that Dusak's approach was flawed in two ways. First, she implicitly assumed that speculators were net long over the life of the contract, and second, she chose an inappropriate proxy for the market portfolio. Carter et al. furthermore, maintained that Dusak's model was incorrectly specified and that the futures contracts she chose were unlikely to contain a systematic risk component.

Carter et al. were among the first in the futures market literature to suggest that the composition of the market portfolio was not independent of the characteristics of the asset of interest. This assumption motivated Carter et al. and others to incorporate modifications of the compo-

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6 Although this may not be their interpretation, it is an implied condition of an efficient capital market, priced in equilibrium, in a mean/variance framework, that all investors hold the same risky portfolio in varying degrees. Therefore, the suggestion that the composition of the market portfolio is a dynamic function of the individual's preference over the investment opportunity set seems contrary to the theory.
sition of the market portfolio. Using Bodie and Rosansky's (1980) finding that common stock and commodity futures returns were negatively correlated, Carter et al. constructed an equally weighted portfolio of the Standard and Poor's (S&P) 500 and Dow Jones commodity futures index (admitting alternative constructs may be equally applicable). Carter et al.'s arguments seemed to hold promise, as their results differed from Dusak (1973) for the same three contracts. Carter et al. attributed their findings to the market portfolio composition, the sensitivity of their analysis to the net long (short) position of large speculators and the admission of stochastic alpha and beta parameters.

The Cost-of-Carry Approach

The cost-of-carry (theory of storage) framework (Kaldor 1939, Working 1948, Telser 1958) is widely regarded as an alternative explanation of the basis. Recently, however, it has been applied to the risk premium/price forecast theories of French (1986) and Fama and French (1987), with mixed results. Unlike the CAPM and its derivatives, the theory of storage model lends itself to multifactor analysis. Most examinations of this arbitrage equilibrating
model attempt to define the futures price in terms of the stochastic or deterministic properties (depending on the assumptions) of the widely accepted variables in the model: spot prices, storage costs, interest rates and convenience yields.

An empirical functional form of the model is:

\[ F(t, T) = S(t) - R(t, T) + I(t, T) - C(t, T) \]

where \( F(t, T) - S(t) \) is the basis, \( S(t) - R(t, T) \) is the opportunity cost of interest forgone from choosing to hold a spot position from \( t \) to \( T \) in the underlying asset, \( I(t, T) \) is the marginal storage cost and \( C(t, T) \) is the marginal convenience yield.

The cost-of-carry model has a great deal of intuitive appeal and has provided researchers with reasonable results for some classes of assets. For example, Aliber (1973) and Frenkel and Levich (1975) tested the model on foreign currency futures with positive results. Rendleman and Carabini (1979) and Cornell (1985), using treasury bill and S&P 500 futures, respectively, also demonstrated support for the cost-of-carry relationship. However, both Klemkosky and
Lasser's (1985) examination of treasury bonds and Elton, Gruber and Rentzler's (1984) study of treasury bill futures concluded the cost-of-carry model was unable to eliminate arbitrage profits, citing convenience yield as the source of difficulty.

Kaldor (1939) was the first to formalize the convenience yield component of the theory of storage, and Brennan (1958) and Telser (1958) were the first to extensively test the theory. While the evidence is mixed concerning support for the theory of storage, proponents and opponents seem to agree that the convenience yield factor is the source of greatest debate.

Whereas proponents of the theory of storage rely on evidence of a negative relationship between convenience yields and inventory levels, opponents argue that optimal inventory levels for the hedger are difficult to determine. Likewise, opponents further argue the assumptions of constant cost of storage, a flat term structure of interest rates and risk neutrality render the theory of storage useless in explaining a positive basis (i.e. where $S_{t,T} > F_{t,T}$).
The rationale for the AI framework is best illustrated by carrying this analysis a step further. Comparing and contrasting the respective efforts of Fama and French (1987) with those of Chang (1985) and Khoury and Yourougou (1991) provide both (1) insightful clues for reconciling the competing theories of storage and expectations and, more important, (2) a motivation for the alternative methodology employed in this study.

The Asymmetric Information Approach

Chang (1985) suggested Carter et al. (1983) did not go far enough and were constrained by two unnecessary assumptions. The first assumption was a result of the theoretical framework adopted to construct the market portfolio, and the second was a function of the definition of rate of return employed by Carter et al. Both assumptions were relaxed by Chang in his examination by utilizing a nonparametric model developed by Henriksson and Merton (1981).

Chang’s testable hypothesis maintained that no valid test of the theory of normal backwardation should be based on “whether the market ever provided speculators with prof-
its in any period"; rather it should be based on "whether or not a risk premium was systematically rewarded to naive speculators." If, as Chang suggested, speculators determine a priori their respective position (long or short) on the basis of inside information (i.e. superior forecasting skills) in addition to the publicly available information set, then Keynes' (1930) notion of biasedness was insufficient since he failed to account for the possibility that the futures price series might be driven by this additional variable.

However, this omission does not provide sufficient grounds for the rejection of Keynes' theory. Likewise, the results obtained by Cootner (1960), Dusak (1973) and Carter et al. (1983) by imposing the statistical limitation of normality on the returns distributions in their respective studies were equally suspect, according to Chang, since "the

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9 Rockwell (1967) recognized the importance of separating returns rewarded for risk-taking and those for possessing superior forecasting skills. He defined the naive investor as a speculator who followed a strategy of being long when hedgers are net short and short when hedgers are net long.
statistical properties of the return distribution are essentially unknown."^{10}

Partitioning speculative investors and hedgers in the sample according to the number of trades made and the percentage of total open interest, Chang attempted to identify the presence of asymmetric information and distinguish returns made from superior information from those for assuming price risk. Comparing the results of what might appropriately be termed the informed trader (in the context of Grossman 1977) with those of the uninformed trader, Chang found evidence supporting the hypothesis that some large (informed) traders, on average,^{11} systematically make positive profits in the wheat, corn and soybean futures markets.

Chang's experimental design was a radical departure from prior studies and was the first application of the Henriksson-Merton (1981) methodology to futures markets. Chang's conclusion, that Keynes' theory of normal backwardation was supported by the results, however, failed to account for the magnitude of ex post returns (positive and

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11 Chang averaged the returns of large speculators and did not examine the profitability of individual large speculators.
negative) earned by speculators and assumed that intertemporal variance was constant.

Cumby and Modest (1987) demonstrated the equivalence of Henriksson-Merton (1981) methodology (used by Chang 1985) to a likelihood ratio test and extended Chang (1985) by incorporating a magnitude test in an ordinary least-squares (OLS) regression. Based on their results, Cumby and Modest concluded that no evidence supported market timing ability for foreign currency advisors under the Henriksson-Merton paradigm, but that inclusion of the magnitude proxy in the OLS regressions greatly improved the power of the tests. Both Chang (1985) and Cumby and Modest (1987) argued that the results of their respective tests generally supported the existence of an asymmetrically informed market.

Utilizing the Cumby and Modest (1987) extension of Henriksson and Merton (1981) to examine a much improved data

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12 Cumby and Modest and Hartzmark considered the impact of one critical assumption of Chang’s application of the Henriksson-Merton methodology (i.e. the independence of the conditional probability of obtaining a correct forecast and the magnitude of the resulting returns from that forecast) and both tested the validity of this assumption. To put their concern in practical terms, consider for example a speculator who correctly forecasts three consecutive up movements in the market, each providing a return of one dollar, and then incorrectly forecasts a fourth up movement when the market actually declines by four dollars.
set, Hartzmark (1991) produced evidence contrary to Chang (1985). Hartzmark (1991) found little support for the notion of large speculators' having superior forecasting ability, and what he found, he attributed to luck. Accordingly, Hartzmark rejected Keynes' (1930) theory of normal backwardation, citing the absence of risk premiums and an asymmetrically informed market and finding instead that speculators tended to be net losers in futures markets.

Khoury and Martel (1985, 1986, 1989) also challenged the conventional wisdom of accepting both the theory of storage and the expectations theory as exhaustive explanations for the variability in the basis. The essence of their argument was that hedgers and speculators were still motivated to trade despite the market's opinion that future spot prices would either remain unchanged \((\bar{F}_{(t,T)} = S_{(t)})\) or fall \((\bar{F}_{(t,T)} < S_{(t)})\).

To formalize their argument, Khoury and Martel (1985) assumed that hedgers were not as well informed as speculators concerning the next period's spot and futures prices \((\bar{S}_1, \bar{F}_1, \text{respectively})\). Khoury and Martel further assumed that hedgers formed expectations of \(\bar{S}_1\) and \(\bar{F}_1\), based
upon the superior information held by speculators, and revised their predictions. That is, the variance associated with the hedgers’ expectations of $\bar{S}_1$ and $\bar{F}_1$ is greater than the variance associated with the speculators’ expectations:

Thus,

$$\sigma^2 \bar{S}_1 \left( h \right) > \sigma^2 \bar{S}_1 \left( s \right),$$

and

$$\sigma^2 \bar{F}_1 \left( h \right) > \sigma^2 \bar{F}_1 \left( s \right),$$

where $\sigma^2 \left( h \right)$ and $\sigma^2 \left( s \right)$ denote the variances around the prior expectations of hedgers and speculators, respectively, concerning subsequent spot and futures prices.

Khoury and Yourougou (1991) reportedly tested the Khoury-Martel (1985) asymmetric information model empirically in the Canadian barley, oats and canola markets. However, examination of the research design employed suggests otherwise. Consistent with Khoury and Martel, Khoury and Yourougou examined the signal provided by the basis for the presence of asymmetric information. In contrast to Khoury and Martel, Khoury and Yourougou conducted their tests in a one-period framework and were not concerned with the optimal hedge ratio but rather with the ability of the
model to predict the direction of spot and futures price movement between time $t$ and time $T$. Interestingly, Khoury and Yourougou employed the same predictive model as Fama and French and discriminated only in the testable hypotheses examined.

Summary

Taken together, the results and conclusions drawn from previous research suggest the following: First, the theory of normal backwardation has a variety of interpretations, and research outcomes may be sensitive to these alternative definitions. Second, tests that rely on any of the variety of specific forms of predictive returns models are constrained by not only the specified form of the model but also the model's respective assumptions, including (a) distributional properties of the price series, (b) sample size, (c) distributional properties of the error terms, (d) the definition of asset return and (e) qualitative and quantitative data constraints. Third, the role of futures markets in the efficient allocation of resources is still clearly contentious.
CHAPTER III

DATA AND METHODOLOGY

Data

Petroleum futures contracts have been traded on US and international futures exchanges since the early 1970s and 1980s, respectively. The first domestic contract, propane, began trading in 1971 on the New York Cotton Exchange (NYCE) and subsequently transferred to the New York Mercantile Exchange (NYMEX). Although initial popularity was marginal at best, propane was followed closely by the introduction of the first crude oil contract, offered by NYCE, and the first heating oil contract (Bunker C), offered by NYMEX, in 1974. Unfortunately, low trading volume in all three contracts resulted in their eventual extinction and was evidence of the oil industry's antagonistic attitude toward the concept of futures trading. Not until 1978 did the NYMEX again introduce a modified heating oil contract, No. 2 heating oil. Though No. 2 heating oil began trading
like its predecessors, by 1979-80 the volatility in spot prices enabled this contract to establish a firm footing.

Following the modestly successful introduction of the No. 2 heating oil contract, the International Petroleum Exchange (IPE) introduced a heating oil contract, trading in London in April 1981. Leaded gasoline contracts began trading on both the NYMEX and IPE in 1982, and a crude oil contract based on West Texas Intermediate crude was also offered by NYMEX in 1982. Coincidentally, the Chicago Board of Trade (CBT) offered contracts on heating oil, unleaded regular gasoline and crude oil, based on Light Louisiana Sweet. Of these contracts, only the NYMEX crude oil and IPE heating oil contracts remain.

Though several petroleum-based futures contracts have been introduced on both domestic and international exchanges with mixed results, none has achieved the stature of the NYMEX contracts for crude oil, heating oil and unleaded gasoline. In fact, since the early 1980s no other commodity contract traded on any exchange has grown faster or traded at higher volumes (based on open interest) than these three.
The important characteristics of each of the futures contracts focused on in this study are set out in Table 3.1. The futures market trading data were obtained from Prophet Information Services. The data were collected on a daily basis for the examination period January 1, 1986 to December 31, 1995. Each daily observation in the data set includes values for the trading day, day of the week, contract month, open, lag open, close, lag close, volume of trade, open interest and contract year.

Table 3.1—Characteristics of NYMEX Energy Contracts

<table>
<thead>
<tr>
<th>Contract</th>
<th>Inception Year</th>
<th>Daily Price Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 2 Heating Oil</td>
<td>1978</td>
<td>$4.20 $840</td>
</tr>
<tr>
<td>Unleaded Gasoline</td>
<td>1986</td>
<td>$4.20 $840</td>
</tr>
<tr>
<td>West Texas Intermediate Crude</td>
<td>1982</td>
<td>$10.00 $1,000</td>
</tr>
</tbody>
</table>

Note: For all three contracts, each year has 12 delivery months, contract size is 42,000 gallons, trading hours are between 10:00 AM and 2:45 PM EST and trading ceases the last trading day in the month preceding the delivery month.

Important to this study of the petroleum futures market is a proxy for ex ante forecasts of futures market price movements, based on the Commitment of Trade reports collected by the Commodity Futures Trading Commission (CFTC)
and provided by Pinnacle Data Corporation. The data depicting the net open interest of each trader type were collected on a semimonthly basis from January 1, 1986 to September 30, 1992 and on a weekly basis from October 1, 1992 to December 30, 1995. Included in these reports are the net long and short positions for each contract held by large hedgers and speculators and nonreporting or small traders.

Data integrity and accuracy were checked for both data sets. In all cases in which missing observations were noted, the [Wall Street Journal](https://www.wsj.com/) for the corresponding date was consulted to insure the market was indeed closed or the contract was not trading. In addition, thirty observations for each contract were randomly selected and compared to [Wall Street Journal](https://www.wsj.com/) values on randomly chosen days to insure accuracy. Finally, outlying values from the histograms produced by each raw data series were compared to [Wall Street Journal](https://www.wsj.com/) and quarterly Commodity Futures Trading Commission reports to insure validity.

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1 Missing observations were present only in the daily futures market data from Prophet Information Services.
The statistical properties of the futures price and total open interest series over the ten-year period examined are reported in table 3.2. The most notable characteristic observed in the futures price series for heating oil (HO), unleaded gasoline (HU) and crude oil (CL) is the similarity in the descriptive statistics.² Open interest statistics

Table 3.2--Contract Descriptive Statistics for Price Series and Total Open Interest, 1986 to 1995

<table>
<thead>
<tr>
<th>Futures Price Series:</th>
<th>HEATING OIL</th>
<th>UNLEADED GASOLINE</th>
<th>CRUDE OIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>0.89</td>
<td>0.89</td>
<td>29.98</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.35</td>
<td>0.33</td>
<td>11.57</td>
</tr>
<tr>
<td>Mean</td>
<td>0.523</td>
<td>0.539</td>
<td>18.47</td>
</tr>
<tr>
<td>Median</td>
<td>0.52</td>
<td>0.54</td>
<td>18.35</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.067</td>
<td>0.071</td>
<td>2.354</td>
</tr>
<tr>
<td>Skewness</td>
<td>1.460</td>
<td>0.889</td>
<td>0.770</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>5.325</td>
<td>4.418</td>
<td>3.903</td>
</tr>
<tr>
<td>Range</td>
<td>0.54</td>
<td>0.56</td>
<td>18.41</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Open Interest:</th>
<th>Total</th>
<th>Total</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>211,272</td>
<td>158,545</td>
<td>452,469</td>
</tr>
<tr>
<td>Minimum</td>
<td>28,396</td>
<td>2,582</td>
<td>64,007</td>
</tr>
<tr>
<td>Mean</td>
<td>111,027.2</td>
<td>70,850.01</td>
<td>302,874.1</td>
</tr>
<tr>
<td>Median</td>
<td>114,425</td>
<td>69,394</td>
<td>326,158</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>41,526</td>
<td>30,574.54</td>
<td>98,017.04</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.0525</td>
<td>0.041373</td>
<td>-0.59159</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-0.7224</td>
<td>0.218932</td>
<td>-0.62112</td>
</tr>
<tr>
<td>Range</td>
<td>182,876</td>
<td>155,963</td>
<td>388,462</td>
</tr>
</tbody>
</table>

Note: N = 331 for all contracts.

² Calculating crude oil values on a per gallon rather than a per barrel basis the max, min and standard deviation are .71, .275 and .056, respectively.
on heating oil and unleaded gasoline contracts, however, are significantly different from those for crude oil.

Figure 3.1 contrasts and shows the trading activity differential between the yearly average open interest for the three contracts and the relative growth of each. For purposes of this study, return is defined as the natural log of the closing price on day t minus the closing price on day t-1 divided by the closing price on day t-1.

Figure 3.1—Average Yearly Open Interest By Contract

![Graph showing average yearly open interest by contract from 1986 to 1995.]

Note: HU = Unleaded Gasoline, HO = Heating Oil and CL = Crude Oil.

For the semimonthly CFTC data reported between January 1986 and September 1992, the return values represent 15-day averages of the daily percentage change in price. For
the weekly reported CFTC period, between October 1992 and December 1995, the return series data generally represented a five-day average\(^1\) of the percentage change in price.

The descriptive statistics in table 3.3 represent the combined semimonthly and weekly observations for each contract. As expected, the mean return for all contracts is close to zero, given continuous, random trading and constant portfolio composition. Even when annualized, the magnitude of the gain or loss is only an approximate .4% for heating oil, .25% for unleaded gasoline and .6% for crude oil.

Table 3.3--Descriptive Statistics on Return Series: All Three Contracts, 1986 to 1995

<table>
<thead>
<tr>
<th>Contract Return</th>
<th>HEATING OIL</th>
<th>UNLEADED GASOLINE</th>
<th>CRUDE OIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>0.02278</td>
<td>0.02629</td>
<td>0.02853</td>
</tr>
<tr>
<td>Minimum</td>
<td>-0.02008</td>
<td>0.02176</td>
<td>-0.02053</td>
</tr>
<tr>
<td>Mean</td>
<td>-8.64E-05</td>
<td>4.74E-05</td>
<td>-0.00013</td>
</tr>
<tr>
<td>Median</td>
<td>0.00012</td>
<td>0.00011</td>
<td>0.00019</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.00512</td>
<td>0.00552</td>
<td>0.00488</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.03657</td>
<td>0.02069</td>
<td>0.14773</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.82419</td>
<td>3.11578</td>
<td>5.07387</td>
</tr>
<tr>
<td>Range</td>
<td>0.04286</td>
<td>0.04805</td>
<td>0.04906</td>
</tr>
</tbody>
</table>

Note: N = 331 for all three contracts.

\(^1\) The NYMEX is closed on many national and religious holidays and contracts in all three markets begin and expire midweek. Thus averages were computed over fewer than five days in some cases.
The remaining statistics are also similar, with the exception of the degree of skewness. Though crude oil is skewed further right than heating oil, unleaded gasoline is skewed left. The distributional properties of the return series (as defined above) were computed and ranked by chi-square, Kolmogorov-Smirnov and Anderson-Darling tests of goodness of fit. The total open interest, by market, in table 3.2 is further decomposed in tables 3.4, 3.5 and 3.6 and reflects the net open interest by trader type for heating oil, unleaded gasoline and crude oil, respectively. The net open interest (as a percent of total open interest) represents that portion of the commercial traders (hedgers) not offset by opposing commercial positions. The inequality between the demand and supply of long or short commercial positions produces a demand for speculative (noncommercial) services that may be filled by large or small traders.

The CFTC's reportable positions (commercial, noncommercial and nonreportable) vary according to the contract traded. For net contract commitments\(^4\) in heating oil, unleaded gasoline and crude oil traded on the NYMEX, the

\(^4\) Net contracts equal long positions minus short positions for any given trader type.
reporting levels are greater than 249, 149 and 299 contracts, respectively. All trader positions at these levels and below do not report their trading status to the CFTC and, therefore, may be either hedgers or speculators. For purposes of this examination the terms nonreporting and small trader are used interchangeably.

The statistics reported in table 3.4 show that, despite the willingness of the three trader types to engage in long or short futures positions, heating oil market hedgers tend to be short, speculators long but marginally so and small traders long. The rest of the raw data statistics

<table>
<thead>
<tr>
<th>Heating Oil</th>
<th>HEDGERS</th>
<th>SPECULATOR</th>
<th>NONREPORTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>0.18091</td>
<td>0.23239</td>
<td>0.22859</td>
</tr>
<tr>
<td>Minimum</td>
<td>-0.33477</td>
<td>-0.15586</td>
<td>-0.07802</td>
</tr>
<tr>
<td>Mean</td>
<td>-0.09229</td>
<td>0.01458</td>
<td>0.07770</td>
</tr>
<tr>
<td>Median</td>
<td>-0.08039</td>
<td>0.01294</td>
<td>0.07550</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.10585</td>
<td>0.06612</td>
<td>0.06118</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.17905</td>
<td>0.24409</td>
<td>0.07917</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-0.60637</td>
<td>0.22676</td>
<td>-0.86141</td>
</tr>
<tr>
<td>Mean Absolute Value</td>
<td>0.0005</td>
<td>0.0263</td>
<td>0.1126</td>
</tr>
<tr>
<td>Range</td>
<td>0.51568</td>
<td>0.38824</td>
<td>0.30661</td>
</tr>
</tbody>
</table>

Note: N = 331 for all three trader types.
suggest the three trader types have similar standard deviations and minimal skewness or kurtosis. Testing the
distributional properties of each series for best fit
against 18 possible distributional forms, hedgers, specula-
tors and small trader positions are approximately normal (-
.09,.11), normal (.014,.066) and normal (.077,.06), respec-
tively.

The unleaded gasoline market, table 3.5, appears to
contain similar divergence across trader classifications.

<table>
<thead>
<tr>
<th>Unleaded Gasoline</th>
<th>HEDGERS</th>
<th>SPECULATORS</th>
<th>NONREPORTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>0.20789</td>
<td>0.34264</td>
<td>0.16583</td>
</tr>
<tr>
<td>Minimum</td>
<td>-0.41859</td>
<td>-0.14704</td>
<td>-0.18026</td>
</tr>
<tr>
<td>Mean</td>
<td>-0.04667</td>
<td>0.02932</td>
<td>0.01734</td>
</tr>
<tr>
<td>Median</td>
<td>-0.04512</td>
<td>0.02543</td>
<td>0.02021</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.10349</td>
<td>0.07098</td>
<td>0.05173</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.16561</td>
<td>0.94710</td>
<td>-0.45051</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>0.34816</td>
<td>2.35628</td>
<td>1.06562</td>
</tr>
<tr>
<td>Mean Absolute Value</td>
<td>0.1425</td>
<td>0.0673</td>
<td>0.1481</td>
</tr>
<tr>
<td>Range</td>
<td>0.62647</td>
<td>0.48968</td>
<td>0.34609</td>
</tr>
</tbody>
</table>

Note: N = 331 for all three trader types.

Though the range appears larger, the standard deviation
statistics indicate little additional variance. Again, the
distributional properties of the three series indicate that
hedgers' net open interest is distributed approximately normal (-.047, .10), speculators' logistic (.029 .039) and small traders' normal (.017, .051).

In the crude oil market, table 3.6, contrary to the heating oil and unleaded gasoline markets, large hedgers tend to maintain slightly long positions while speculators and small traders tend to sell crude oil futures. Also, the ranges and standard deviations are smaller between maximum

<table>
<thead>
<tr>
<th>Crude Oil</th>
<th>HEDGERS</th>
<th>SPECULATORS</th>
<th>NONREPORTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>0.28799</td>
<td>0.18664</td>
<td>0.11462</td>
</tr>
<tr>
<td>Minimum</td>
<td>-0.22092</td>
<td>-0.15941</td>
<td>-0.15132</td>
</tr>
<tr>
<td>Mean</td>
<td>0.00017</td>
<td>-0.002825</td>
<td>-0.00305</td>
</tr>
<tr>
<td>Median</td>
<td>0.00177</td>
<td>-0.00604</td>
<td>0.00147</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.09124</td>
<td>0.06306</td>
<td>0.04080</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.16102</td>
<td>0.54435</td>
<td>-0.34384</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-0.38686</td>
<td>0.31304</td>
<td>-0.14762</td>
</tr>
<tr>
<td>Mean Absolute value</td>
<td>0.0704</td>
<td>0.0046</td>
<td>0.0460</td>
</tr>
<tr>
<td>Range</td>
<td>0.50891</td>
<td>0.34605</td>
<td>0.26594</td>
</tr>
</tbody>
</table>

Note: N = 331 for all three trader types.

and minimum net open interest positions for all three trader types. Distributionally, hedgers, speculators and small traders are approximately normal (.00017, .091), normal (-.0028, .063) and normal (-.003, .048), respectively.
Methodology

The substantive hypothesis for this study is: Speculators and hedgers (the participants) in a futures market transaction are, on average, motivated by heterogeneous expectations (a result of asymmetric information, risk premia, inventory cycle adjustments or some other market phenomena) regarding the return-generating process. Consequently, the superiorly positioned participant's ex ante forecast contains valuable information that causes rational investors to revise their expectations concerning the probability distribution of future asset returns.

Henriksson and Merton’s (1981) methodology, in two statistical variants,\(^5\) is used to test whether a particular category of trader is consistently able to forecast the direction of futures price changes. The first variation of the test is accomplished by computing conditional probability estimates of a correct up or down forecast by trader type. The results are then compared to those from the non-parametric logistical regression procedure shown by Cumby

\(^5\) This is done to compare results for consistency.
and Modest (1987) to be an equivalent test. Together these tests indicate whether statistically significant market direction information resides in the net open interest positions of market participants. They thus demonstrate what, if any, forecast power advantage exists in the market-equilibrating process.

Ordinary least-squares (OLS) regressions, corrected for unknown sources of heteroskedasticity, will test the inclination of traders to take their largest positions when they forecast the greatest change in price. That is, the magnitude of the trader's position, ex ante, is compared to the ex post change in return. In addition, the OLS methodology is extended to identify seasonal components of the forecast series.

Forecast Consistency (Direction Tests)

The first statistical methodology employed in this study applies Cumby and Modest's (1987) extension of Henriksson and Merton's (1981) paradigm in a nonparametric statistical procedure. This procedure is used to test for the first element of market timing ability (referred to herein as forecast consistency).

Henriksson and Merton (1981) presented a formal test of Merton's (1981) contention that for a forecast to contain information of value, it must cause the rational investor to revise prior convictions concerning the probability distribution of future asset returns. Merton's theorem maintained that a necessary and sufficient condition, in the absence of an equilibrating returns model, for the revision of prior beliefs is that the "sum of the two conditional probabilities of a correct forecast exceed one."6 Henriksson and

Merton's test depended on three important assumptions: (1) Better informed market participants are able to ordinally rank investment alternatives, and their rankings are available. (2) The probability of a correct forecast is independent of the magnitude of the actual returns on the investment. (3) The joint probabilities underlying the distribution are constant over time.

To understand the implications of these assumptions, one must consider the following detailed examination of Chang's (1985) adoption of the Henriksson-Merton methodology to capture returns to speculators in the wheat, corn and soybean markets. Chang defined a risk-averse rational speculator as one who will be long in a futures market only when the price is below expected terminal value of the underlying asset, \( F(t) < E(S(T)) \), and short in a futures market only when the price is above the expected terminal value, \( F(t) > E(S(T)) \).

Chang's adaptation of the Henriksson-Merton procedure defined \( \Delta \tilde{F}_{(t-T)} \) as the change in the futures price over some interval, \( t-T \), such that \( \Delta \tilde{F}_{(t-T)} = \tilde{F}(T) - \tilde{F}(t) \). Because the
rational speculator forecasts \( \Delta \tilde{F}_{(t-T)} \) before deciding whether to take a long \( (\Delta \tilde{F}_{(t-T)} > 0) \) or short \( (\Delta \tilde{F}_{(t-T)} \leq 0) \) position in the futures market, define \( \lambda(t) \) as a forecast variable such that \( \lambda(t) = 1 \) if \( \Delta \tilde{F}_{(t-T)} > 0 \) and \( \lambda(t) = 0 \) if \( \Delta \tilde{F}_{(t-T)} \leq 0 \). Further, define the conditional (conditioned on the realization of prices in the market between \( t \) and \( T \)) probabilities of obtaining either of these values as \( \Pi_1(t) \) and \( \Pi_0(t) \), respectively. Therefore,

\[
P_0(t) = \text{prob} \{ \lambda(t) = 0 \mid \Delta \tilde{F}_{(t-T)} \leq 0 \}
\]
\[
P_1(t) = \text{prob} \{ \lambda(t) = 1 \mid \Delta \tilde{F}_{(t-T)} > 0 \}.
\]

Note that both \( \Pi_0(t) \) and \( \Pi_1(t) \) represent conditional probabilities of an accurate forecast. Merton maintained and Chang tested the null hypothesis that

\( H_0: \Pi_0(t) + \Pi_1(t) \leq 1 \),

where the necessary and sufficient condition for the speculator's information to have value is:

\( H_1: \Pi_0(t) + \Pi_1(t) > 1 \).

Chang's application of the Henriksson-Merton methodology to futures markets mitigated several problems associated with unknown distribution properties, the absence of an equilibrium model and the definition of asset return.
But Chang failed to account for the possibility of time-varying return magnitudes. Cumby and Modest (1987) relaxed the assumption of independence between forecast ability and the ex post magnitude of returns and identified two other important drawbacks to relying exclusively on the Henriksson-Merton framework. The most questionable assumptions, according to Cumby and Modest, are that intertemporal probabilities are homogeneous and that small-sample properties of the Henriksson and Merton tests are not detrimental to the power of the test statistics.

Cumby and Modest (1987) proposed an alternative and equivalent methodology to Henriksson and Merton (1981) that (1) allowed a "fuller understanding of the implications for market equilibrium given conditional probabilities $\Pi_0(t)$, $\Pi_1(t)$ are constant over time, (2) derived a power function for the test and (3) extended the test under less restrictive assumptions."\(^7\)

Cumby and Modest began with a comparative examination of the two methodologies to demonstrate their equivalence.

They first represented the Henriksson and Merton test in a 2x2 prediction table in the form of figure 3.2, where $P_{ij}(t)$ is the joint probability that an observation will belong to the $i$th row and $j$th column and $P_{i.}$ and $P_{.j}$ are the marginal probabilities that observations will belong to the $i$th row and $j$th column, respectively. Thus the conditional probabilities $\Pi_0(t)$ and $\Pi_1(t)$ are given by

$$\Pi_1(t) = \frac{P_{11}(t)}{P_{i.}(t)}$$

$$\Pi_0(t) = \frac{P_{22}(t)}{1 - P_{i.}(t)}.$$

The null hypothesis tested in this framework is that...
\( \Pi_1(t) + \Pi_0(t) = 1 \), against the alternative hypotheses that 
\( \Pi_1(t) + \Pi_0(t) < 1 \) (inferior ability) and \( \Pi_1(t) + \Pi_0(t) > 1 \) (superior ability).

Following Cumby and Modest (1987) and adapting the arguments to the current study, define a dichotomous random variable \( \lambda(t) \), where \( \lambda(t) = 1 \) when \( \Delta \tilde{F}_{(t-T)} > 0 \) (an up market) and \( \lambda(t) = 0 \) when \( \Delta \tilde{F}_{(t-T)} \leq 0 \) (a down market). In addition, suppose the speculator possesses information superior to that of the hedger concerning the price that will prevail at the contract's termination date (equivalent to the advisor's forecast in Cumby and Modest), defined as \( \phi(t) \). The binary variable \( \phi(t) = 1 \) if \( \Delta \tilde{F}_{(t-T)} > 0 \) and the speculator takes a net long position in the futures market and \( \phi(t) = 0 \) otherwise.

Cumby and Modest assumed the probability distribution of \( \phi(t) \) was conditional on \( \lambda(t) \) and was given by any distribution for which the sum of the \( \phi(t) \) and the sum of the product of \( \phi(t) \) and \( \lambda(t) \) were sufficient statistics. In Cumby and Modest's case a logistic distribution was chosen.
The Logistic Distribution is asymptotically bounded at 0 and 1, and the corresponding probability distributions are given by:

\[ Pr[\phi(t) = 1|\lambda(t)] = \frac{\exp(\alpha + \beta \lambda(t))}{1 + \exp(\alpha + \beta \lambda(t))}, \]

\[ Pr[\phi(t) = 0|\lambda(t)] = \frac{1}{1 + \exp(\alpha + \beta \lambda(t))}, \]

where \(\alpha\) and \(\beta\) are the defining parameters of the distributions.

In the logistical regression framework, \(\alpha\) and \(\beta\) are estimated by the standard maximum-likelihood estimation (MLE) procedure. The theoretical form of the model is derived by taking the log odds that \(A \tilde{F}_{(t,T)} > 0\), thus:

\[ \log\left[ \frac{Pr\{\phi(t)=1\}}{Pr\{\phi(t)=0\}} \right] = \alpha + \beta \lambda(t). \] (1)

Testing that speculators have a superior market position when forming their a priori assessment of an up or down market is a matter of determining whether the log-odds ratio improves as a function of the observed position of the trader. Improvement is identified by a positive sign and statistical significance of the beta coefficient.

\[ ^9 \text{This is equation 1 in Cumby and Modest (1987).} \]
Define $\Delta \tilde{R}_{(t-T)}$ as the mean percentage change in the closing price between times $t$ and $T$; that is,

$$
\Delta \tilde{R}_{(t-T)} = \frac{1}{T-t} \sum_{n=t}^{T} \ln \left( \frac{F_{(T)}}{F_{(t)}} \right).
$$

The equivalent empirical form of the model is the logistical regression of:

$$
\text{RETDUM}_{(t-T)} = \alpha + \beta (i,t) \text{POSDUM}_{(t)} + \epsilon(i,t),
$$

where $\text{RETDUM}_{(t-T)} = 1$ if $\Delta \tilde{R}_{(t-T)}>0$ and $\text{RETDUM}_{(t-T)} = 0$ if $\Delta \tilde{R}_{(t-T)} \leq 0$ and $\text{POSDUM}_{(t)} = 1$ if trader $i$ takes a long position (i.e. the a priori forecast) and $\text{POSDUM}_{(t)} = 0$ otherwise. Whether or not speculators possess some trading advantage is a matter of determining whether $\beta$ is positive and statistically different from zero.

For speculative traders the $\beta$ coefficient is expected to be positive and statistically different from zero. For hedgers $\beta$ is expected to be negative and statistically different from zero. The testable hypotheses associated with this methodology are:

$H_1$: Speculators, on average, have no greater ability to forecast the direction of price changes than
hedgers.

H_2: Forecast consistency did not change over the ten-year period examined.

H_3: Model robustness is insensitive to measurement interval (i.e. semimonthly, weekly, combined or biweekly).

Cumby and Modest performed comparison tests of the Henriksson-Merton methodology employing the prediction table and equation 1 for a variety of sample sizes, up and down markets, correct forecasts and critical values for the tests. Two important conclusions were derived from the results. First, the robustness of the Henriksson-Merton methodology is a positive function of sample size. Second, the Henriksson-Merton methodology appears to be prone to type II error (failing to reject the null when the alternative H_1 is true) if, for example, the speculator possesses only a slight degree of asymmetric information.\(^\text{10}\)

\(^{10}\) Note that for either model, given that speculators are no better informed than hedgers on the factors influencing asset prices, the null hypothesis H_0: markets are symmetrically informed (β = 0) is still dependent on constant intertemporal expected returns and relative risk premium. Violation of either of these assumptions would influence the log-odds ratio and thus bias the estimation of β away from 0 even when information was symmetrically held by hedgers and speculators. Though Cumby and Modest did not
Additionally, Cumby and Modest's test results may have been biased or restricted by their choice of measurement interval (daily), a relatively short sample period (two years) and sample selection bias (the participants and the data sampled were voluntary). Hartzmark (1991) attempted to overcome several objections to the Cumby-Modest study by employing a significantly improved data set.

Hartzmark (1991) was the first to apply the Cumby-Modest modification of the Henriksson-Merton methodology to futures markets. Hartzmark investigated 2,229 individual traders, over a 4½-year period, using daily data and a

\[
\log\left(\frac{Pr\{\phi(t) = 1\}}{Pr\{\phi(t) = 0\}}\right) = \alpha + \beta_1 \lambda_{it} + \beta_2 \Gamma(t),
\]

where \(\Gamma(t)\) denotes time-varying risk premium and \(\beta_2\) is the coefficient that captures the significance of changing risk premium in the model.

Here again the research paradigm alters the definition of normal backwardation. By testing individual traders Hartzmark failed to incorporate the notion of naive speculators in the tests. Moreover, though he did not specifically reject the theory of normal backwardation in that study, his (1987) conclusions specifically rejected Keynes' theory based on similar results.
broader set of assets, including oats, wheat, pork bellies, live cattle, feeder cattle, T-bonds and T-bills.

Hartzmark partitioned traders into two categories, commercial (hedgers) and noncommercial (speculators), according to their primary lines of business. To categorize the traders Hartzmark utilized the Commodities Futures Trading Commission's confidential files and defined returns to trading positions in dollar terms. He conducted tests for consistent forecast ability using equation 1. Based on those results, Hartzmark argued the null hypothesis of uniformly informed markets could not be rejected. Moreover, he found no significant difference between the distributions of speculators and hedgers except that, if anything, speculators appeared to be poorer forecasters than hedgers on average.

An interesting issue, omitted in previous research, is whether the contemporaneous\textsuperscript{12} positions reported by hedgers, speculators and nonreporting traders provide

\textsuperscript{12} Not only do the net open interest positions of the three traders always sum to zero, thus producing perfect collinearity, but the rational trader will observe all three positions simultaneously in the CFTC's Commitment of Trade report.
independent forecasts. That is, a natural extension of the univariate logistical regression in equation 1A will extend the analysis of the results and test statistics reported from equation 1A.

I have termed this condition the "independent forecast assumption." To test the notion that a single trader's position is informationally independent of other market participants, the following multivariate logistical regression is run and compared to the results obtained from equation 1A:

\[
\text{RETDUM}_{(t-T)} = \alpha + \sum_{i=1}^{2} \beta_{(i,t)} \text{POSDUM}_{(t)} + \epsilon_{(i,t)}. \tag{1B}
\]

The null hypothesis of \( H_0 \), no change in the \( \beta \) coefficients and corresponding test statistics, is tested against the alternative hypothesis that the net open interest positions of hedgers or speculators are not independently sufficient parameters for forecast power determination.

Forecast Conviction (Magnitude Tests)

Whether the Henriksson-Merton (1981) methodology is tested by evaluating the conditional probabilities from the prediction table or the coefficients from the logit
regression, relying exclusively on these outcomes may result in unwarranted conclusions since the net return to speculators may still be negative. Cumby and Modest recognized this problem and proposed a "natural extension"\(^{13}\) of the test that would, under the restrictive assumption of constant relative risk premiums, test the forecasting skill of the speculator.

Given the conditional expectation that \( \Delta \tilde{R}_{(t-T)} \) (the percentage change in the futures price) is a linear function of \( \lambda(t) \) (the forecast variable), Cumby and Modest proposed the OLS regression, \(^{14}\)

\[
\Delta \tilde{R}_{(t-T)} = \alpha + \beta^* \lambda(t) + \mu(t),
\]

of the null hypothesis that \( \beta^* = 0 \). The alternative hypothesis, that the speculator has superior forecasting ability, will result in \( \beta^* > 0 \). To assess the dependence between forecast consistency and conviction, I adopt an empirical OLS model of the form,

\[
\Delta \tilde{R}_{(t-T)} = \alpha + \beta_{(i,t)} \text{NETPOS}_{(i,t)} + \epsilon_{(i,t)},
\]

\(^{13}\) Cumby and Modest (1987), p. 177.

\(^{14}\) This is equation 3 in Cumby and Modest (1987).
where $\Delta \bar{R}_{t,T}$ is previously defined, $\text{NETPOS}_{i,t}$ is the net open interest position of trader $i$ at time $t$ and $\varepsilon_{(i,t)}$ is a random error term containing an unknown source of heteroskedasticity.\(^{15}\)

The testable hypotheses capturing the impact of return magnitude are:

$H_3$: Model robustness is insensitive to measurement interval (i.e. semimonthly, weekly, combined or biweekly).

$H_4$: Forecast conviction did not change over the ten-year period examined.

$H_5$: The magnitude of a trader's position and the size of that trader's ex post returns are independent.

Cumby and Modest (1987) point out that equation 2A is a special case of equation 1A that allows for the inclusion of magnitude. However, both may be misspecified if relative risk premiums are time-varying. In addition, equation 2A will potentially reject the null (i.e. produce $\beta > 0$) even when no evidence of superior forecasting skill is present

\(^{15}\)To control for the effects of heteroskedasticity, White's (1981) correction procedure is used.
unless "either all other publicly available information is included on the right-hand side of the equation or one assumes that relative risk premiums are constant over the sample period."\(^{16}\)

Hartzmark (1991) and Leuthold, Garcia and Lu (1994) adopted Cumby and Modest's extension to test whether speculators held their largest positions at times when the greatest price change occurred. Both Hartzmark and Leuthold et al. tested whether the dollar return depended linearly on the net position held by the individual trader.

Using the independent variable \(LS(T)\) to denote the net position (long futures minus short futures) of the trader at time \(t,^{17}\) Hartzmark decomposed the magnitude effect into two parts, producing a joint test. The first tested whether the probability of a correct forecast was linearly dependent on the size of the net position held by the trader, and the second tested whether the probability of

\(^{16}\) Cumby and Modest (1987), p. 179.

\(^{17}\) Cumby and Modest (1987) used a dichotomous independent variable to denote an up (1) or otherwise (0) forecast by the trader in their (OLS) assessment of the importance of magnitude. (See equation 3.)
a correct forecast increased as a positive function of the subsequent price change.\textsuperscript{18}

In keeping with tests for forecast consistency, Hartzmark's results contradicted those of Chang (1985,) although in Hartzmark's opinion the additional magnitude variable added measurably to the test's significance. Speculators fared poorly in all markets except oats, and hedgers, in general, appeared to be the better informed traders. Hartzmark concluded that the bunching of coefficients around zero rejected tests of uniformity and thus that some dependence may exist across traders.\textsuperscript{19}

Extending Hartzmark's examination, Leuthold et al. (1994) increased the measurement period to nine years to investigate the futures contract for frozen pork bellies. Leuthold et al. maintained that the longer sample period increased the likelihood that traders would accrue wealth since the first test is only a test of the linearity assumption and the second is the actual magnitude test, whether the reported results stem from a violation of the first or second condition remains unclear.

\textsuperscript{19} Perhaps most important, Hartzmark contends his results tend to reject the theory of normal backwardation. However, unlike Chang's (1985) test and Keynes' theory, Hartzmark's test is not of the naive speculator (who is long when hedgers are net short and short when hedgers are net long), but rather, of a trader whose position is defined to be constant over the entire test period.
and, therefore, improve the power of their tests. Additionally, Leuthold et al. argued that, since "frozen pork bellies have long been considered highly speculative within the complex of agricultural futures," tests for asymmetric information between speculators and hedgers would prove more robust. They found, contrary to Hartzmark, that speculators were the better informed traders in both forecast consistency and conviction.

Inferences drawn from results obtained employing equation 2A are subject to the same independence of forecast assumption (i.e. observation of trader positions) as those from the logistic regression. Therefore, a multivariate extension of equation 2A having the form,

\[ \Delta \bar{R}_{(t-T)} = \alpha + \sum_{i=1}^{2} \beta_{(i,t)} \text{NETPOS}_{(i,t)} + \epsilon_{(i,t)}, \]  

(2B)

tests the null hypothesis \( H_0 \): The large speculator's position, viewed simultaneously with those of other traders, does not provide a superior forecast. That is, I test against the alternative hypothesis that the net open interest position of speculators contains information not

---

available in the positions held by hedgers or nonreporting traders.

Seasonal Estimation

To capture potential seasonal variance in asymmetrically informed markets for crude oil, unleaded gasoline and heating oil, equation 2A is modified again to include an additional dummy variable (MONDUM). Thus the seasonal estimation model has the form:

$$NETPOS_{(i,t)} = \alpha + \beta_{(i,m)} \sum_{m=2}^{12} MONDUM + \varepsilon_{(i,t)}, \quad (3A)$$

where $NETPOS_{(i,t)}$ is the percentage net open interest of trader $i$ and MONDUM is a monthly dummy variable equal to 1 in the corresponding month and 0 otherwise. The null hypothesis tested by equation 3A is $H_7$: The trader's position in the market is invariant to the time of year and thus annual cycles provide additional information. The month of January is omitted in each regression to avoid problems with multicollinearity. Therefore, January's significance is captured by the $\alpha$ coefficient in the regressions.
Seasonal patterns observed in the results from equation 3A are then compared to regressions employing equation 3B to determine whether traders have already considered the seasonal patterns in their respective net positions, long or short, in the market.

\[ \Delta \bar{R}_{(t-T)} = \alpha + \beta_{(i,t)} \text{NETPOS}_{(i,t)} + \beta_{(i,m)} \sum_{m=2}^{12} \text{MONDUM} + \varepsilon_{(i,t)}. \] (3B)

Equations 3A and 3B are used to test the following hypothesis:

\[ H_0: \text{Market timing ability is unaffected by seasonal demand shifts.} \]

Intertemporal comparison of the results from equations 3A and 3B provides evidence on a systematic component of forecast ability not previously tested in this line of research. Specifically, though demands for heating oil and unleaded gasoline change over the year and are generally considered countercyclical, traders anticipate these cycles and adjust their positions accordingly.

Transaction Costs and Dollar Returns

Based on the direction and magnitude results, a simple trading rule strategy is applied to the data. Two
conclusions emanating from this test are: (1) The dollar returns to small traders, constrained by transaction costs, are minimal at best. (2) The excess value of a publicly available information set is not close to zero in an efficient markets context.

The testable hypotheses for this examination are:

$H_0$: Transaction costs are an insignificant component of petroleum futures market trading strategies.

$H_{10}$: Large speculators are net losers in the petroleum futures market.

The trading rule proposed has the following attributes: First, assume the trader holds an equally weighted portfolio of all contracts trading in a particular commodity over a certain period. Second, assume this representative nonreporting trader takes a one-contract position, long (short) for each percentage increase above (below) 1% in the net open interest of large speculators. Third, compute the dollar return to the trader’s position both ignoring transaction costs and after deducting retail transaction costs.
As they apply to the NYMEX, the transaction costs, by contract type, for wholesale and retail traders throughout the country are depicted in table 3.7.

Table 3.7--Transaction Costs by Contract Type

<table>
<thead>
<tr>
<th></th>
<th>HEATING OIL</th>
<th>UNLEADED GASOLINE</th>
<th>CRUDE OIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYMEX Margin Requirement per Contract</td>
<td>$2025</td>
<td>$2025</td>
<td>$2025</td>
</tr>
<tr>
<td>Round-Trip Wholesale Costs</td>
<td>$22</td>
<td>$22</td>
<td>$22</td>
</tr>
<tr>
<td>Round-Trip Retail Costs</td>
<td>$102</td>
<td>$102</td>
<td>$102</td>
</tr>
</tbody>
</table>

Note: The table depicts average costs obtained from surveyed brokerage firms.

Note that these costs may occur frequently, since position traders tend to hold contracts open for only a few days (three to four) and portfolios tend to be completely rebalanced each week. Admittedly, this trading strategy in no way purports to optimize the particular position of the traders in the market. However, it is a first attempt at characterizing a backwardation equilibrium under transaction cost constraints (other than storage cost variables). Moreover, the results may be applied directly to actual market trading schemes in petroleum futures markets.
CHAPTER IV

EMPIRICAL RESULTS

The results reported in this chapter vary across the three contracts examined and are, therefore, reported by contract. Before the evaluations of the independent contracts, a brief review of the data and analytical characteristics common to all three is presented, as well as an explanation of the order of discussion. Crude oil, heating oil and unleaded gasoline results follow in turn, and a summary of the complete examination concludes the chapter.

Organization

Statistical results from tests conducted on ten years (January 1986 to December 1995) of sample data are reported in tables 4.1 through 4.20B. For each contract the entire data set is composed of 331 observations, roughly half being semimonthly and half being weekly. The sample data for each
contract are divided into four subsets or tranches.\textsuperscript{1} The first tranche (N = 162) includes observations from January 1986 to September 1992. This period is based upon a semi-monthly reporting interval in the Commitment of Trade reports produced by the Commodity Futures Trading Commission.

The second tranche (N = 169) contains observations from October 1992 to December 1995 and reflects a weekly reporting interval on trade commitments. Tranche 3 (N = 331) combines semimonthly and weekly observations into a ten-year estimation interval.

The fourth tranche (N = 246) uses a biweekly estimation interval for the ten-year period. This is done to test whether the length of the observation interval or a changing market structure is significant in the determination of market forecast ability. To accomplish this, I modify the weekly observation period by averaging price changes and net open interest positions over a two- rather than one-week

\textsuperscript{1} The term "tranche" comes from the French word "to cut." It is used throughout the derivative securities literature. I use the term in this paper to denote the way the data were split for this investigation.
interval. Thus, the resulting ten-year data set is characterized by approximately equal estimation intervals.

Forecast Consistency

Testing whether or not large hedgers, large speculators or nonreporting traders are consistently able to predict the direction of price movements in the futures market is a matter of testing the independence of the a priori trader position and the ex post price change. Therefore, the first tables presented for each market analysis contain results from the Henriksson-Merton (1981) nonparametric procedure and its logistical regression equivalent, proposed by Cumby and Modest (1987).

Recall that, under the Henriksson-Merton nonparametric procedure, perfect forecast ability would require that the sum of the conditional probability estimates equal 2. However, with less than perfect forecasting skill, the sufficient condition for a trader's position to have value is that the sum of the conditional probability estimates for up (\( \Pi_{0(t)} \)) and down (\( \Pi_{D(t)} \)) markets exceed 1. Thus,

\[ \Pi_{0(t)} = \text{prob}(\lambda(t)=1 | \Delta R(t,T) > 0) + \Pi_{D(t)} = \text{prob}(\lambda(t)=0 | \Delta R(t,T) \leq 0) > 1, \]
where $\lambda(t)$ is the position (long = 1, short = 0) taken by a particular trader.

For each contract, the individual conditional probability estimates (up and down) and their sums are reported for large hedgers, large speculators and nonreporting traders. Whether a trader's a priori position has value for predicting the resulting direction of price movement is a test of the null hypothesis $H_0: \Pi_u(t) + \Pi_d(t) = 1$ against the alternative $H_A: \Pi_u(t) + \Pi_d(t) > 1$. Statistical significance is determined by the departure of the sum of conditional probability estimates from 1; it is measured in standard deviations and is reported as a Z-score.

Because the logistical regression results provide a metric equivalent to that resulting from the Henriksson-Merton procedure, they are presented on the right-hand side of the same table. Interpretation of the beta ($\beta$) coefficient differs from that of standard linear regression analysis as the coefficients are chosen according to a maximum-likelihood rather than a least-squares criterion. That is, in logistic regression, the coefficients maximize the
probability (likelihood) of obtaining a correct forecast of the direction of price changes.

The null hypothesis of no forecast ability extant in the position of traders \( (H_0: \beta = 0) \) is tested against two alternative hypotheses: superior forecast ability \( (H_A: \beta > 0) \) and inferior forecast ability \( (H_B: \beta < 0) \). In other words, if the predictor variable (net open interest position of a class of traders) improves the odds that the price will move in the right direction (i.e. the price will rise given the trader is long and fall given the trader is short), the beta coefficient will be positive and statistically different from zero.

If the predictor variable reduces the odds, then the beta coefficient will be negative and statistically different from zero. In the case of a beta coefficient insignificantly different from zero, no forecast ability is indicated, and the null hypothesis is not rejected.

For each logit regression the alpha and beta coefficients are reported along with their respective t-ratios. The model’s chi-square statistic, the likelihood ratio test (indicating that at least one of the coefficients is statis-
tically different from zero) is also reported along with the number of observations. Statistical significance of the coefficients is denoted by one asterisk at the 0.05 level and two asterisks at the 0.01 level.

Forecast Conviction

Cumby and Modest (1987) point out that true forecast ability cannot depend solely on the direction of the price change but must also incorporate the magnitude of that change. Forecast conviction is, therefore, equally important in determining whether a particular class of traders is better informed than other traders.

Tests for independence between the magnitude of the a priori position and the magnitude of the ex post realization of the price change are conducted. That is, I test whether or not traders take their largest positions when their conviction about the subsequent price change is strongest.

Standard linear regression analysis, employing ordinary least squares with the usual test statistics and coefficient interpretations, is conducted for the three trader types and four tranches of each contract. Alpha and beta coefficients, the P-value and $R^2$ are reported for each
regression, and the statistical significance of the parameter estimates is reported as a t-ratio. Again, significance at the 0.05 level is denoted by one asterisk and at the 0.01 level by two.

The Independent Forecast Assumption

Recall the earlier discussion in chapter III concerning the fact that a prospective trader viewing the net open interest positions of other traders in the market will observe the positions of speculators, hedgers and nonreporting traders at the same time. This brings up an interesting question not addressed in any previous research: Does the position of the speculator, the hedger or the nonreporting trader contain information not impounded in the other two?

To address this question, I employ the multivariate counterpart of both the logit and OLS regressions. Although the coefficients and test statistics of the multivariate OLS are subject to the standard interpretation associated with partial derivatives, the multivariate logit coefficients deserve a brief discussion.

Although the interpretations of a coefficient's sign, significance and impact on the odds ratio are identical for
multivariate and univariate logistical regressions, the implications arising from the alternative treatments are different. This is perhaps best illustrated by expressing the essence of the multivariate logit in question form: Given that speculators appear to have significant forecast power as demonstrated by the beta coefficients from the univariate logit, what forecast power, if any, is independent of the interaction effects of the remaining traders? In other words, the coefficients for an individual trader in a univariate test may not be independent of the net open interest positions of the other traders. Hence, an important step may be to take the positions of all three traders into account at the same time, just as they are viewed.

Seasonality and Dollar Returns

Seasonality and dollar-return issues follow the simultaneity analysis for each contract. In the case of seasonal estimation, two issues are examined. The first is whether the open interest position of traders reflects a seasonal component. That is, are the open interest positions of traders relatively constant throughout the year?
The second issue is whether the observance of a trader’s open interest position is sufficient to eliminate concerns about expected shifts in aggregate demand over the year. Accordingly, the question is posed: Do the sign and magnitude of the trader’s position contain all the information necessary to anticipate seasonal variation in demand?

The results of the dollar-return analysis are presented in narrative form for each contract. The round-trip trading costs faced by the small trader are compared to those of the dealer and floor trader to examine the market’s efficiency in the presence of trading costs. A summary of the results then concludes each section.

Crude Oil

Crude oil is the raw material from which all petroleum distillates (heating oil, unleaded gasoline and others) and byproducts emanate. As such, this futures contract represents the baseline of the analysis and serves as a focal point for comparison throughout this chapter. Forecast ability is examined by testing for consistency, conviction and seasonality, and results are subjected to a variety of tests to confirm the findings.
Keynes (1930) argued that speculators engaged in futures market trading activity to earn a risk premium for assuming the price risk of the underlying asset. Houthakker (1957) and Danthine (1978) maintained that futures markets were made up of asymmetrically informed traders and that speculators had the advantage.

If one or both of these propositions are true, then speculators should more often than not be positioned on the correct side of subsequent market movements (i.e. long for an up market, short for a down market). Therefore, the first step is to test empirically for evidence supporting the notion that large speculators have consistent forecast ability when predicting the direction of price changes.

Forecast Consistency

Henriksson-Merton (1981) and Cumby-Modest (1987) subsequently designed tests that identify a trader's consistent ability to forecast the direction of price changes. Those results are presented in table 4.1. Coefficients, significance tests and the number of observations are included for both the conditional probability and logit
regression estimates of the semimonthly and weekly observation periods.

Table 4.1--Estimating Forecast Consistency in Crude Oil: Comparing Conditional Probability Estimates and Logit Regressions for Semimonthly and Weekly Tranches

<table>
<thead>
<tr>
<th>Conditional Probability Estimates</th>
<th>Logistical Regression Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Null Hypothesis: $\Pi_0 + \Pi_0 = 1$</td>
<td>Null Hypothesis: $\beta_{1,1} = 0$</td>
</tr>
<tr>
<td></td>
<td>$a_i$</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td><strong>Semimonthly</strong></td>
<td></td>
</tr>
<tr>
<td>Jan.86-Sept.92 N = 162</td>
<td></td>
</tr>
<tr>
<td>LARGE HEDGER ((-6.129))**</td>
<td>0.258</td>
</tr>
<tr>
<td>LARGE SPECULATOR ((3.842))**</td>
<td>0.536</td>
</tr>
<tr>
<td>NONREPORTING TRADER ((6.829))**</td>
<td>0.662</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Weekly</strong></td>
<td></td>
</tr>
<tr>
<td>Oct.92-Dec.95 N = 169</td>
<td></td>
</tr>
<tr>
<td>LARGE HEDGER ((-5.536))**</td>
<td>0.358</td>
</tr>
<tr>
<td>LARGE SPECULATOR ((4.892))**</td>
<td>0.648</td>
</tr>
<tr>
<td>NONREPORTING TRADER ((4.223))**</td>
<td>0.610</td>
</tr>
</tbody>
</table>

Note: T-ratios are given in brackets [ ]. Z-scores are in parentheses ( ). See footnotes 3 and 5 for details on the models and hypotheses tests.

*Significant at the 0.05 level. **Significant at the 0.01 level.
In all three trading categories and both estimation periods, the sum of the conditional probability estimates are as expected\(^2\), given that large speculators are indeed better informed than large hedgers on conditions affecting the futures price.\(^3\) Large hedgers appear to be consistent losers in the crude oil market, predicting on average only about one-third \((\Pi_c + \Pi_o = 0.65, Z = -6.12)\) of subsequent price changes correctly. Large speculators, on the other hand, appear to possess consistent and significant forecast ability, predicting approximately two-thirds of the subsequent price changes accurately \((\Pi_c + \Pi_o = 1.23, Z = 3.84)\).

Interestingly, nonreporting traders in crude oil futures also seem to be on the correct side of the market more often than not \((\Pi_c + \Pi_o = 1.38, Z = 6.82)\). However,

\(^2\)Recall that the null hypothesis of no forecast ability \(H_0: \Pi_c + \Pi_o = 1\) is tested against the alternative hypothesis of superior forecast ability \(H_a: \Pi_c + \Pi_o > 1\).

\(^3\)The individual estimates \(\Pi_c\) and \(\Pi_o\) are conditional probabilities that trader \(i\) will be long when the futures price rises and short when it falls, respectively. The sum of the conditional probabilities of a correct forecast of the direction of market movement \((\Pi_c + \Pi_o > 1\) or \(< 1\)) indicates superior or inferior forecast ability. The Z-scores, in parentheses, given the null hypothesis of no market timing ability \(\Pi_b(t) + \Pi_o(t) = 1\), indicate the relative distance above or below 1, the probability estimates lie, in standard deviations.
two potential problems with interpreting this result as indicative of superior forecasting skill should be noted, as they may lead to a spurious assessment.

The first problem is that the makeup of the nonreporting trader classification is unknown. That is, the net open interest of nonreporting traders, reported by the CFTC, may be composed of hedgers or speculators or both. The second problem is that the nonreporting traders may simply be free riders. Hence, they could be only trading off of the signal provided by the position of the large speculator.4

Logistical regression results5 for the semimonthly and weekly observation periods are consistent with the conditional probability estimates reported in table 4.1. The signs on the univariate regression coefficients and the test statistics appear to confirm the existence of an asymmetri-

---

4 The free rider problem is addressed in a later analysis. However, the classification problem must be left to future research, since the data used for this examination do not lend themselves to further disaggregation.

5 For the logit model (RETDUM_{t,T} = \alpha + \beta_{(i,t)} POSDUM_{(t)} + e_{(i,t)})
the return dummy RETDUM_{(t)} = 1 if \Delta R_{(t,T)} > 0 and 0 if \Delta R_{(t,T)} \leq 0. The position dummy (the a priori forecast) POSDUM_{(t)} = 1 if trader i takes a long position and 0 otherwise. Whether or not a particular trader has an advantage or disadvantage in the market is a matter of determining whether \beta is statistically greater than or less than 0.
cally informed market or one that rewards a risk premium or both. Large hedgers appear to be significant losers, since the observance of their position reduces the odds\(^6\) and, therefore, the probability\(^7\) of their being on the right side of the market when prices change.

Large speculators and nonreporting traders appear to have a consistent ability to forecast the direction of price movement over both observation intervals. All statistical tests, including the model chi-squares, are significant at the 0.01 level with the exception of the nonreporting trader during the weekly observation period. In that case, the t-ratio is still significant at the 0.05 level.

---

\(^6\) The coefficients from a logistical regression can be used to compute the change in the odds ratio given a change in the predictor variable. To do so simply raise the base of the natural logs e to the power of the coefficient. For example, for the large hedger during the semimonthly period compute \(e^{0.227} = 0.227\). The interpretation of this result would be that for each one-unit increase in the position of the large hedger the odds of being on the right side of the market would be reduced by 0.227.

\(^7\) Converting the coefficients from a logistic regression to a probability estimate is a simple matter. The first step is to add the constant to the product of the regression coefficient and prediction variable to obtain to value \(f\). Thus, \(f = \alpha + \beta(X)\). The second step requires inserting the value of \(f\) into the formula \(e^f/(1 + e^f)\). The resulting estimate would indicate the probability that price movement would be up given the trader was long and down otherwise.
By comparison, Table 4.2 reports the results of the same tests applied to the ten-year and biweekly observations. Ten-year and biweekly observation results for the sums of the conditional probability estimates and logit

<table>
<thead>
<tr>
<th>Conditional Probability Estimates</th>
<th>Logistical Regression Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Null Hypothesis: $H_0 + H_{10} = 1$</td>
<td>Null Hypothesis: $\beta_{(1,t)} = 0$</td>
</tr>
<tr>
<td></td>
<td>$\alpha_1$</td>
</tr>
<tr>
<td><strong>Ten-Year</strong></td>
<td></td>
</tr>
<tr>
<td>Jan. 86-Dec. 95 N = 331</td>
<td></td>
</tr>
<tr>
<td>LARGE</td>
<td>0.317</td>
</tr>
<tr>
<td>HEDGER</td>
<td>(-8.037)**</td>
</tr>
<tr>
<td>LARGE</td>
<td>0.580</td>
</tr>
<tr>
<td>SPECULATOR</td>
<td>(5.806)**</td>
</tr>
<tr>
<td>NONREPORTING</td>
<td>0.635</td>
</tr>
<tr>
<td>TRADER</td>
<td>(7.807)**</td>
</tr>
<tr>
<td><strong>Biweekly</strong></td>
<td></td>
</tr>
<tr>
<td>Jan. 86-Dec. 95 N = 246</td>
<td></td>
</tr>
<tr>
<td>LARGE</td>
<td>0.268</td>
</tr>
<tr>
<td>HEDGER</td>
<td>(-8.258)**</td>
</tr>
<tr>
<td>LARGE</td>
<td>0.568</td>
</tr>
<tr>
<td>SPECULATOR</td>
<td>(5.195)**</td>
</tr>
<tr>
<td>NONREPORTING</td>
<td>0.669</td>
</tr>
<tr>
<td>TRADER</td>
<td>(8.633)**</td>
</tr>
</tbody>
</table>

Note: T-ratios are given in brackets [ ]. Z-scores are in parentheses ( ). See footnotes 3 and 5 for details on the models and hypotheses tests.

*Significant at the 0.05 level. **Significant at the 0.01 level.
coefficients are consistent with those obtained from the semimonthly and weekly periods. Large hedgers again appear to be poor forecasters, and large speculators and nonreporting traders appear to be superior forecasters of the direction of price movement.  

Interestingly, the data in table 4.2 also indicate that a longer estimation interval, resulting in an increase in the number of observations, increased the model’s predictive power ($\chi^2$'s are significantly larger). Unfortunately, whether the increase is due to the longer time interval (Leuthold, Garcia and Lu 1994) or to an increase in the number of observations (Cumby and Modest 1987) is uncertain. What seems clear is that a heavier emphasis should be placed on results from tranches that include more observations.

In any case, based on the results in tables 4.1 and 4.2 alone, the null hypothesis of no market timing ability is rejected in favor of the alternative hypothesis that large speculators and nonreporting traders are better informed or earn a risk premium or both.

---

8 Again the reader is cautioned on the correct interpretation of the results on the nonreporting trader (see footnote 4).
Cumby and Modest (1987) point out, however, that market direction forecasts may not be independent of the magnitude of the subsequent price change. Hence, tests of a trader's ability to consistently forecast the direction of price movement are not sufficient to demonstrate that a trader's position is truly superior in the trading process.

Forecast Conviction

Following Cumby and Modest's recommendation, I test whether large speculators take their largest positions at the time the market price changes by the greatest amount. Empirical evidence supporting the notion that large speculators have conviction about their forecasts in the crude oil market is presented in table 4.3.

The results indicate that large hedgers appear to be particularly poor forecasters, since their position in the market is larger in the wrong direction the greater the price change. That is, hedgers' largest short (long) position occurs most often when the price increases (decreases) by the greatest amount. Moreover, the evidence of inferior forecast ability is consistent across all four tranches, though to a lesser degree in the semimonthly period.
Table 4.3--Forecast Conviction for Crude Oil Using OLS Regressions, by Observation Period

Model Form: \( \Delta R_{(t-t')} = \alpha_i + \beta_{(i,t)} \text{NETPOS}_{(i,t)} + \epsilon_{(i,t)} \).

Null Hypothesis: \( \beta_{(i,t)} = 0 \).

<table>
<thead>
<tr>
<th>Observation Period</th>
<th>TRADER (_{(i)})</th>
<th>( \alpha_i )</th>
<th>( \beta_i )</th>
<th>P-value</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semimonthly</td>
<td>LARGE</td>
<td>0.0004</td>
<td>-0.0140</td>
<td>0.027</td>
<td>.04</td>
</tr>
<tr>
<td></td>
<td>HEDGER</td>
<td>0.0003</td>
<td>0.0106</td>
<td>0.380</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>SPECULATOR</td>
<td>0.0002</td>
<td>0.0347</td>
<td>0.003</td>
<td>.07</td>
</tr>
<tr>
<td>Jan.86 to Sept.92</td>
<td>NONREPORTING</td>
<td>0.0002</td>
<td>0.003</td>
<td>.000</td>
<td>0.00</td>
</tr>
<tr>
<td>N = 162</td>
<td>TRADER</td>
<td>[0.515]</td>
<td>[3.674]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekly</td>
<td>LARGE</td>
<td>-0.0006</td>
<td>-0.0145</td>
<td>0.000</td>
<td>.11</td>
</tr>
<tr>
<td>Oct.92 to Dec.95</td>
<td>HEDGER</td>
<td>[-1.979]**</td>
<td>[-5.147]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 169</td>
<td>LARGE</td>
<td>-0.0007</td>
<td>0.0195</td>
<td>0.000</td>
<td>.09</td>
</tr>
<tr>
<td></td>
<td>SPECULATOR</td>
<td>[-2.294]**</td>
<td>[4.692]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NONREPORTING</td>
<td>-0.0002</td>
<td>0.0349</td>
<td>0.000</td>
<td>.11</td>
</tr>
<tr>
<td></td>
<td>TRADER</td>
<td>[-0.780]</td>
<td>[4.630]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ten-Year</td>
<td>LARGE</td>
<td>-0.0001</td>
<td>-0.0131</td>
<td>0.000</td>
<td>.06</td>
</tr>
<tr>
<td>Jan.86 to Dec.95</td>
<td>HEDGER</td>
<td>[-0.411]**</td>
<td>[-4.267]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 331</td>
<td>LARGE</td>
<td>-0.0001</td>
<td>0.0129</td>
<td>0.009</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>SPECULATOR</td>
<td>[-0.550]**</td>
<td>[2.772]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NONREPORTING</td>
<td>-0.0000</td>
<td>0.0348</td>
<td>0.000</td>
<td>.08</td>
</tr>
<tr>
<td></td>
<td>TRADER</td>
<td>[-0.019]</td>
<td>[5.581]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biweekly</td>
<td>LARGE</td>
<td>0.0000</td>
<td>-0.0131</td>
<td>0.001</td>
<td>.05</td>
</tr>
<tr>
<td>Jan.86 to Dec.95</td>
<td>HEDGER</td>
<td>[0.225]**</td>
<td>[-3.311]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 246</td>
<td>LARGE</td>
<td>0.0000</td>
<td>0.0115</td>
<td>0.075</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>SPECULATOR</td>
<td>[0.052]</td>
<td>[1.862]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NONREPORTING</td>
<td>0.0000</td>
<td>0.0349</td>
<td>0.000</td>
<td>.08</td>
</tr>
<tr>
<td></td>
<td>TRADER</td>
<td>[0.307]</td>
<td>[4.980]**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: T-ratios given in brackets [].
*Significant at the 0.05 level. **Significant at the 0.01 level.
Large speculator results are mixed across the four tranches tested. Of particular interest is the disparity between the semimonthly and weekly periods. During the semimonthly period from January 1986 to September 1992, large speculators do not appear to forecast large price changes any better than small price changes. So even though they forecast the direction of the price change correctly more often than not, as depicted in table 4.1, if the magnitude of the price change is the greatest when they forecast incorrectly, they could quite possibly be net losers.

However, during the weekly period from October 1992 to December 1995, large speculators had statistically significant (t-ratio = 4.692) forecast conviction and took their largest positions prior to prices changing by the greatest amount.9

Three plausible explanations may account for the asymmetric results. First, during the early years of market development speculators were learning the ropes, and only by becoming accustomed to the market's nuances did they gain an

---

9 A positive BETA coefficient (superior forecasting skill) depicts the percentage increase in the mean net open interest position taken by respective traders, long (short) for each 1% increment in the trader's forecasted change in the futures price above (below) zero.
advantage. Second, the number of observations (162) may be limiting the power of the test.\textsuperscript{10} Third, the forecast power of the large speculator may be sensitive to the interval over which returns are aggregated. That is, a forecast position held over a 15-day interval may not be nearly as profitable as a forecast position held for seven days.

The first explanation seems highly unlikely since it fails to account for how nonreporting traders fared so well during the same period. The second explanation may have merit, particularly since, as pointed out by Cumby and Modest (1987), the tendency in small samples is for the commission of type II error (failing to reject the null hypothesis when it is false). However, the third explanation (forecast interval) may also be likely since a Chow test of the ten-year data series suggests that the errors are not stationary. Splitting the sample at the interval change point (semimonthly to weekly), a test of stationarity is rejected at the 0.10 level ($F_{160,147} = 2.384$).

\textsuperscript{10} Recall Cumby and Modest (1987) examined the power of the test statistics for different sample sizes and for different combinations of correct and incorrect forecasts, and they concluded that the probability of type II error was large for $N < 100$. 
To see whether this result is driven by a measurement interval change or is simply an artifact of the historical time period, a Chow test was conducted on the biweekly data set as well. Evidence supporting the time-period hypothesis requires the Chow tests have similar statistics; that is, that both be significant. Evidence supporting the measurement interval hypothesis requires that the biweekly Chow tests, contrary to the ten-year tests, be insignificant. Therefore, the comparative results seem to support the notion that forecast power is a short-horizon phenomenon, given that tests of stationarity over the biweekly measurement interval cannot be rejected ($F_{159,84} = 1.032$).

Taken together, the results in table 4.3 support the notion that large speculators, relative to large hedgers, have a forecast power advantage. Moreover, this observation is consistent with results from tables 4.1 and 4.2. Interestingly, the observation periods that include shorter forecast intervals produce the strongest results (i.e. the weekly and ten-year data sets). The nonreporting trader’s position appears\(^{11}\) to be the most accurate and significant

\(^{11}\) See footnote 5.
in the crude oil futures market, since model and coefficient
tests are significant at the 0.01 level or better for all
four tranches.

Unfortunately, this last observation does not ring
true with economic theory, since no reason exists, a priori,
to suspect that small traders earn a return sufficient to
cover the costs of obtaining superior information or that
small traders are relied upon by large hedgers to accommo-
date the demand for speculative services. Do nonreporting
traders have a trading advantage on a par with large specu-
lators? Or are they simply observing the positions of other
traders and following suit (free riders)? The answer is a
matter of determining whether the positions of the three
traders are independent. That is, given that the large
speculator’s position is observed, what if any additional
information can be gleaned from the positions of the large
hedger and the nonreporting trader?

Multivariate Tests

To address these questions empirically, results from
multivariate logistical regressions are compared to those
from their univariate counterparts. That is, the data in
tables 4.1 and 4.2 are contrasted with data in table 4.4.

Following the interpretation of the coefficients from the logistical regressions reported in tables 4.1 and 4.2, the corresponding coefficients in table 4.4 indicate that the increase (decrease) in the odds ratio given each trader's position is determined independently of the positions of other traders.

A priori, based on the results in tables 4.1 and 4.2, I expect to find evidence supporting the existence of asymmetrically informed market, thus motivating the trading activity of large speculators. Hence, the coefficients for large hedgers will be negative and the coefficients for large speculators will be positive, and both will be statistically significant.

In stark contrast to the results expected and those obtained from the univariate regressions, the data in table 4.4 present an altogether different picture. As anticipated, the large hedger appears, once again, to be a consistently poor forecaster of the direction of price movement in the crude oil market. (Note the coefficients are
negative and significant at the 0.05 level or greater for all tranches.

Table 4.4--Multivariate Logit Regression Results
For Crude Oil

Model: \(\text{RETDUM}_{(t-T)} = \alpha(t) + \beta^h(t)\text{HEGDUM}_{(t)} + \beta^s(t)\text{SPCDUM}_{(t)} + \epsilon(t,i)\).

Null Hypothesis: \(\alpha, \beta^s \text{ and } \beta^h \text{ jointly } = 0.\)

<table>
<thead>
<tr>
<th></th>
<th>(\alpha)</th>
<th>(\beta^h)</th>
<th>(\beta^s)</th>
<th>(\chi^2) STAT</th>
<th>(N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semimonthly</td>
<td>1.1522</td>
<td>-1.5669</td>
<td>-0.1330</td>
<td>19.566**</td>
<td>162</td>
</tr>
<tr>
<td>Jan.86 to Sep.92</td>
<td>[2.523]**</td>
<td>[-3.260]**</td>
<td>[-0.262]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekly</td>
<td>0.5006</td>
<td>-1.1820</td>
<td>0.0875</td>
<td>15.671**</td>
<td>169</td>
</tr>
<tr>
<td>Oct.92 to Dec.95</td>
<td>[0.758]</td>
<td>[-1.821]*</td>
<td>[0.134]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ten-Year</td>
<td>0.9415</td>
<td>-1.4562</td>
<td>-0.2019</td>
<td>33.256**</td>
<td>331</td>
</tr>
<tr>
<td>Jan.86 to Dec.95</td>
<td>[2.541]**</td>
<td>[-3.824]**</td>
<td>[-0.527]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biweekly Jan.86</td>
<td>1.3969</td>
<td>-1.9471</td>
<td>-0.04764</td>
<td>36.370**</td>
<td>246</td>
</tr>
<tr>
<td>to Dec.95</td>
<td>[3.176]**</td>
<td>[-4.305]**</td>
<td>[-1.040]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Because of the significance of the intercepts a de-trended data set was constructed, using an ARIMA (1,1) model, and tested to insure that trends in the price series were not driving the results. As suspected trends in the price series were not a factor. Based on the results from the univariate logit regressions, the alternative hypotheses are: \(\beta^h < 0\) and \(\beta^s > 0\) for the hedger and speculator, respectively. T-ratios given in brackets.

* Significant at the 0.05 level. ** Significant at the 0.01 level.

However, the large speculator's forecast ability is now insignificant for all tranches and is in the wrong direction in three of four tranches. In essence, the large speculator's position appears to be highly dependent upon the position taken by the large hedger. Moreover, appar-
ently, when large speculators are limited to their own information resources, they are no better forecasters of the direction of price movement than a futures trader whose open interest position is chosen at random.

Of additional importance, are the sign and significance of the intercepts. The correct interpretation of the significant positive coefficients is that when the large speculator mimics the large hedger, that is, both are short (long) the probability that the price will rise (fall) increases\textsuperscript{12}. This is evident in three of four observation periods, and further supports the contention that trader positions are not determined independently.

Nonreporting traders were intentionally omitted from this analysis since interpretation their results would require unsupported conjecture. Recall the nature of traders classified as nonreporting is not disclosed, the possibility remains that a particular trader may be classified as nonreporting during one period but not during others. Hence, "nonreporting trader" does not necessarily imply a small speculator. Additionally, one cannot argue convincingly

\textsuperscript{12} See footnote 7 for computational details.
that the nonreporting position is made up of traders who have no ability to offset losses in the futures market with profits in the spot market or to generate returns sufficient to cover the cost of becoming informed.

In order to analyze the true demand for speculative services, the exact classification (hedger or speculator) of traders in the nonreporting category would need to be incorporated into the calculation of the net open interest. This would allow the complete set of speculators and hedgers trading at the margin to be compared in order to determine the true demand for speculative services. This seems particularly important considering the results obtained from the multivariate OLS tests for forecast conviction, presented in table 4.5. Two points of comparison are needed to evaluate the results in table 4.5. The first examines forecast conviction, testing whether the magnitude of a trader’s position is independent of the size of the price change when determined independently of (table 4.5), rather than collec-

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13 This would require a data set similar to Hartzmark’s (1991) and Leuthold et al.’s (1994) obtained from the confidential files of the CFTC. However, unlike these previous studies, conclusions offered would reflect hedgers offset by speculators only, thus testing for the presence of asymmetric information using the marginal demand for speculative trading.
tively with (table 4.3), other traders. The second examines the market microstructure issues emanating from a comparison of the details reported in tables 4.4 and 4.5.

Table 4.5—Multivariate OLS Regression Results for Crude Oil

<table>
<thead>
<tr>
<th>Model: $\Delta R_{t,T} = \alpha(t) + \beta^H(t) \text{NETHEG}(t) + \beta^S(t) \text{NETSPC}(t) + \epsilon_{t,t}$</th>
<th>Null Hypothesis: $\alpha$, $\beta^S$ and $\beta^H$ Jointly $= 0.$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\alpha$</td>
</tr>
<tr>
<td>Semimonthly</td>
<td></td>
</tr>
<tr>
<td>Jan.86 to Sep.92</td>
<td>0.00002</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekly</td>
<td></td>
</tr>
<tr>
<td>Oct.92 to Dec.95</td>
<td>-0.0004</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Ten-Year</td>
<td></td>
</tr>
<tr>
<td>Jan.86 to Dec.95</td>
<td>-0.0000</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Biweekly</td>
<td></td>
</tr>
<tr>
<td>Jan.86 to Dec.95</td>
<td>0.0000</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: By construction, the intercept ($\alpha$) represents nonreporting traders. Based on the results from the univariate OLS regressions, the alternative hypotheses are: $\beta^H < 0$, $\beta^S > 0$ and $\alpha > 0$ for the hedger, speculator and nonreporting traders, respectively. T-ratios are given in brackets. * Significant at the 0.05 level. ** Significant at the 0.01 level.

Theoretically, trading in the futures market is motivated by the desire to gamble (Telser 1960), an advantage in information access (Khoury and Martel 1987) and/or the demand for a risk premium (Keynes 1930). Results in table 4.3 suggest that earning positive returns in the crude oil fu-
tures market is not a matter of gambling, but rather of just mimicking the large speculator. However, whether the large speculator’s position was determined by superior information, risk premiums or both is still an open question. To attempt to discriminate between the risk premium and asymmetric information explanations, consider the fact that large speculators who are left to their own devices appear to have no better information on factors affecting price than large hedgers.

A necessary condition for large speculators to be viewed as the superiorly informed traders in the market is this: When the positions of other traders are taken into consideration, the position of the large speculator still has predictive power for both the direction and magnitude of any price change. Results shown in table 4.5 indicate otherwise and cast doubt on the notion that large speculators are the better informed traders. Also interesting to note is that the tranches that tend to indict the theory of backwardation equilibrium the most, in an asymmetric information context, are those containing the longer estimation intervals. That is, the semimonthly, ten-year and biweekly
tranches depict the large speculator as a very inferior trader. The weekly tranche, on the other hand, simply suggests that the large speculator is neither inferior nor superior.

The question is: Why the difference? Does this relative improvement stem from the model’s inability to avoid type II error, a permanent shift in the speculator’s information set or the benefit of a shorter forecast interval? While supporting any one explanation over another may be impossible, given the aforementioned data limitations, two observations lead me to suspect, as before, that shorter estimation intervals increase the power of the forecast.

First, the sample data in the weekly tranche are split nearly evenly (86 up markets, 83 down markets, N = 169), thus minimizing the possibility that the results were driven by the failure to reject a false null. Second, as pointed out in an earlier discussion, little evidence supports a shift in the information set.

Taking the analysis a step further, recall the results from the univariate OLS model (table 4.3) indicated

\[14\] Recall the comparative Chow tests for the ten-year and biweekly tranches.
large speculators and nonreporting traders did indeed take their largest positions just prior to the most substantial price movements, more often than not. The results from the multivariate OLS (table 4.5), like the multivariate logit (table 4.4), present a much different picture for both large speculators and nonreporting traders.

Although the large hedger's coefficients in table 4.5 are consistent with the results from table 4.4, the large speculator's and nonreporting trader's coefficients differ markedly. Of particular interest is the large speculator, who now appears to be on equal footing with the large hedger (slippery at best).

Additionally, nonreporting traders appear to have no advantage. That is, large speculators and hedgers acting independently not only are now poor forecasters of the direction of the price change, but make their worst forecasts when prices change by the greatest amount. Nonreporting traders taking a position independent of the other traders' positions (i.e. not knowing the others' positions) have no forecast conviction at all. Understanding the ramifications of these observations requires that they be reconciled with
the competing theories of futures market price determination.

Beginning with the nonreporting trader, one plausible explanation for the shift in forecast power significance is the migration of traders between nonreporting and reporting categories. If, when prices are anticipated to change by a significant amount the only firms or individuals remaining in the nonreporting classification are those who are under-capitalized or those who have limited exposure or both, then the results support Telser's argument. That is, the futures market for the nonreporting trader neither is asymmetrically informed nor provides a risk premium since returns on average equal zero. However, Telser's argument is unsatisfactory when considering the results for large hedgers and speculators.

Recall that the sum of the three trading positions always equals zero. Therefore, given that the nonreporting traders are not filling the incremental increase in demand for speculative services when large changes in price are

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15 In effect a true “small trader.”

16 Perhaps of even more importance is that this is the first strong evidence in this examination to suggest the true nonreporting small trader is in fact a free rider.
anticipated, that demand must be met by the large speculator. If, as noted in table 4.4, large speculators independently have no forecast ability and significant free rider migration occurs from the nonreporting category, then the forecast conviction of large speculators should increase, but in the wrong direction, as indicated in table 4.5. But this poses an additional question dealing directly with the motivation for speculative trading: Why are the interaction effects of the three traders so critical to individual traders’ positions being on the correct side of a price change?

To this point, evidence of an asymmetrically informed trader who earns a backwardation equilibrium return is weak at best for large speculators and nonreporting traders. However, the results for the large hedger are uniquely consistent over the ten-year period tested, irrespective of the method of data aggregation (the tranche) and seemingly independent of the statistical methodology employed. Though large hedgers appear to be systematically poor forecasters of both the direction and the magnitude of price changes, one alternative explanation implies just the opposite.
Quite probably most large hedgers in the crude oil futures market are constrained by significant operating and financial leverage, as this is an industry characteristic. Consequently, they are highly motivated to acquire information and employ risk reduction techniques as necessary to mitigate price risk, subject to the usual cost/benefit criteria. Thus, if the large hedger is the better informed participant in the crude oil futures market, large hedgers may use this information advantage to entice large speculators to take a position at the margin. Hence the large speculator's beliefs are revised, concerning the probability distribution of future asset returns.

Importantly, this is not inconsistent with an efficient market explanation. The risk premium offered is just enough to clear the demand in the market for speculative services. Moreover, it is consistent with Henriksson and Merton's (1981) theory, since the observance of the forecast variable appears to significantly alter the position of the uninformed trader.

Finally, this result has significant implications for tests designed to separate the rewards for risk bearing from
those derived from superior information. This is true because the risk premium offered by a large hedger who is better informed will be net of the cost of obtaining information. Additional evidence is presented in support of this market paradigm momentarily. However, seasonal considerations are dealt with first because they may affect the timing of returns in the crude oil futures market.

Seasonality

A priori, seasonal trends in the crude oil market are expected to be minimal. As the raw material from which other distillates are produced, crude oil's daily production levels are fairly constant. Two factors account for this consistency. First, storage and refining facilities are capital intensive, must operate at near capacity to be profitable and are therefore in limited supply. Second, production quotas domestically and abroad, though not always adhered to, set an upper limit on daily output that is nearly always met.

Tables 4.6A and 4.6B confirm the suspicion that seasonality in the crude oil futures market is minimal. Model A is used to identify any months when a trader's net open
Table 4.6A--Seasonal OLS Regression Results for Crude Oil from January to June, by Trader Type, Comparing Model A to Model B

<table>
<thead>
<tr>
<th>Trader Type</th>
<th>N</th>
<th>F-STAT(A)</th>
<th>R²(A)</th>
<th>F-STAT(B)</th>
<th>R²(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LARGE HEDGER</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>331</td>
<td>0.715</td>
<td>.0262</td>
<td>2.380**</td>
<td>.0882</td>
</tr>
<tr>
<td>DJAN</td>
<td></td>
<td></td>
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<tr>
<td>DFEE</td>
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<tr>
<td>DMAR</td>
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<tr>
<td>DAPR</td>
<td></td>
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</tr>
<tr>
<td>DMAY</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DJUN</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>α_i^A</td>
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<td>0.0061</td>
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</tr>
<tr>
<td></td>
<td>[0.436]</td>
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<tr>
<td>β_m^A</td>
<td>-0.0012</td>
<td>-0.0195</td>
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</tr>
<tr>
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<td>[-1.387]</td>
<td>[-1.925]^*</td>
<td>[0.297]</td>
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<tr>
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<td>-0.0005</td>
<td>0.0010</td>
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<td>β_m^B</td>
<td>-0.0126</td>
<td></td>
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<td>0.0006</td>
<td>-0.0011</td>
</tr>
<tr>
<td></td>
<td>[-4.059]^**</td>
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</tr>
<tr>
<td></td>
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<td>.0602</td>
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<tr>
<td>DJUN</td>
<td></td>
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<tr>
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<tr>
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<td>[0.477]</td>
<td>[0.194]</td>
<td>[1.300]</td>
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</tr>
<tr>
<td></td>
<td>[-0.065]</td>
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<tr>
<td>β_m^B</td>
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<td>-0.003</td>
<td>-0.0013</td>
<td>0.0006</td>
<td>-0.0011</td>
</tr>
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<td>[-0.316]</td>
<td>[1.498]</td>
<td>[0.738]</td>
<td>[-1.192]</td>
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<tr>
<td>β_m^B</td>
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<td></td>
<td></td>
<td>0.0006</td>
<td>-0.0011</td>
</tr>
<tr>
<td></td>
<td>[2.729]^**</td>
<td></td>
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<tr>
<td><strong>NONREPORTING</strong></td>
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<td></td>
<td>331</td>
<td>1.592</td>
<td>.0514</td>
<td>2.986**</td>
<td>.1084</td>
</tr>
<tr>
<td>DJAN</td>
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<td></td>
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<tr>
<td>DFEE</td>
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<td>DMAR</td>
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<td>DAPR</td>
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<td>DMAY</td>
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<td>DJUN</td>
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</tr>
<tr>
<td>α_i^A</td>
<td>-0.0105</td>
<td></td>
<td></td>
<td>0.0019</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[-1.961]^*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>β_m^A</td>
<td>-0.0004</td>
<td>0.0125</td>
<td>0.0305</td>
<td>0.0298</td>
<td>0.0019</td>
</tr>
<tr>
<td></td>
<td>[-0.042]</td>
<td>[1.398]</td>
<td>[2.806]^**</td>
<td>[2.178]^*</td>
<td>[0.189]</td>
</tr>
<tr>
<td>α_i^B</td>
<td>0.0003</td>
<td></td>
<td></td>
<td>0.0002</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.591]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>β_m^B</td>
<td>-0.0018</td>
<td>-0.0007</td>
<td>0.0004</td>
<td>0.0002</td>
<td>-0.0012</td>
</tr>
<tr>
<td></td>
<td>[-1.436]</td>
<td>[-0.567]</td>
<td>[0.459]</td>
<td>[0.248]</td>
<td>[-1.417]</td>
</tr>
<tr>
<td>β_m^B</td>
<td>0.0335</td>
<td></td>
<td></td>
<td>0.0002</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[5.120]^**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: T-ratios are given in brackets [ ].
*Significant at the 0.05 level. **Significant at the 0.01 level.
Table 4.6B--Seasonal OLS Regression Results for Crude Oil from July to December, by Trader Type, Comparing Model A to Model B

<table>
<thead>
<tr>
<th>LARGE HEDGER</th>
<th>N</th>
<th>F-STAT (A)</th>
<th>R² (A)</th>
<th>F-STAT (B)</th>
<th>R² (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DJUL</td>
<td>331</td>
<td>0.715</td>
<td>0.0262</td>
<td>2.380**</td>
<td>0.0882</td>
</tr>
</tbody>
</table>

\[ \beta^A_h = \begin{bmatrix} 0.0079 & -0.0042 & 0.0003 & -0.0078 & 0.0085 & 0.0080 \\ 0.336 & -0.196 & 0.015 & -0.405 & 0.379 & 0.366 \end{bmatrix} \]

\[ \beta^B_h = \begin{bmatrix} 0.0007 & 0.0006 & -0.0003 & -0.0005 & -0.0012 & 0.0004 \\ 0.660 & 0.453 & -0.255 & -0.631 & -1.150 & 0.419 \end{bmatrix} \]

<table>
<thead>
<tr>
<th>LARGE SPECULATOR</th>
<th>N</th>
<th>F-STAT (A)</th>
<th>R² (A)</th>
<th>F-STAT (B)</th>
<th>R² (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DJUL</td>
<td>331</td>
<td>0.503</td>
<td>0.0170</td>
<td>1.581</td>
<td>0.0602</td>
</tr>
</tbody>
</table>

\[ \beta^A_h = \begin{bmatrix} -0.0170 & -0.0016 & -0.0069 & -0.0078 & -0.0087 & -0.0062 \\ -1.070 & -0.110 & -0.421 & -0.563 & -0.590 & -0.421 \end{bmatrix} \]

\[ \beta^B_h = \begin{bmatrix} 0.0008 & 0.0007 & -0.0002 & -0.0003 & -0.0012 & 0.0004 \\ 0.766 & 0.496 & -0.193 & -0.396 & -1.118 & 0.385 \end{bmatrix} \]

<table>
<thead>
<tr>
<th>NONREPORTING</th>
<th>N</th>
<th>F-STAT (A)</th>
<th>R² (A)</th>
<th>F-STAT (B)</th>
<th>R² (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DJUL</td>
<td>331</td>
<td>1.592</td>
<td>0.0514</td>
<td>2.986**</td>
<td>0.1084</td>
</tr>
</tbody>
</table>

\[ \beta^A_h = \begin{bmatrix} 0.0090 & 0.0059 & 0.0065 & 0.0157 & 0.0002 & -0.0017 \\ 0.959 & 0.764 & 0.814 & 2.088 & 0.025 & -0.173 \end{bmatrix} \]

\[ \beta^B_h = \begin{bmatrix} 0.0003 & 0.0004 & -0.0005 & -0.0009 & -0.0013 & 0.0004 \\ 0.288 & 0.350 & -0.423 & -1.131 & -1.291 & 0.380 \end{bmatrix} \]

Note: T-ratios are given in brackets.
* Significant at the 0.05 level. ** Significant at the 0.01 level.

interest position is systematically different. That is, model A addresses the question: Does the time of the year explain the trader's commitment in the market? Model B addresses the question of whether the trader's position is sufficient to capture any seasonal component extant in the return series.
Model A identifies only three months as statistically significant at the 0.05 level or greater for any of the three trader classifications. The large hedger position was significant only in May, and the nonreporting traders only in April, May and October. I can only speculate as to why this is true. Perhaps some anticipation of an increase in demand for crude oil is due to an expected increase in use of unleaded gasoline in the spring and heating oil in the fall.

Model B, however, indicates that if a trader is able to observe the position of the large hedger or speculator or that of the nonreporting trader, the month of the year has no additional explanatory power. Therefore, I conclude that the annual calculation of dollar returns to a trading classification would, most likely, not be materially different from returns adjusted for seasonal variation in either the open interest position or the price series.

\[ \text{Model A: } \text{NETPOS}_{t} = \alpha + \beta_{(M,t)} \sum_{n=1}^{\infty} \text{MONDUM} + \epsilon_{(i,t)} \]

\[ \text{Model B: } \Delta R_{t} = \alpha + \beta_{(i,t)} \text{NETPOS}_{t} + \beta_{(M,t)} \sum_{n=1}^{\infty} \text{MONDUM} + \epsilon_{(i,t)} \]
Dollar Returns

While interpreting the results from multivariate tests of forecast consistency and conviction, I suggested that large hedgers may entice large speculators into the market by offering a risk premium. I will now present the additional evidence that spawned this notion.

First, the results from the multivariate tests of forecast consistency and conviction suggest that the relative forecast power in the large speculator’s ex ante position should be conceded. Yet the univariate tests indicate that indictment of the absolute power of the position may be premature. The empirical question emanating from these contradictory indications of forecast ability is: Can the casual investor profit from observing the position of the large speculator? If so, what accounts for this market phenomenon?

To test this, I compute the dollar returns to a representative large speculator in the crude oil market for the year 1995. This representative trader is characterized as follows: The trader holds an equally weighted portfolio of all contract months trading on the NYMEX crude oil contract
and does so throughout the entire year. The trader opens
and closes his/her total position once each week, thus earn-
ing an average weekly return.

Recall the univariate forecast conviction tests indi-
cated large speculators take their largest positions when
prices change by the greatest amount. Thus the representa-
tive speculator adjusts his/her total open interest position
up 100 contracts, from a base of 300, for each 1% increase
(above 1%) in the total open interest of the large specula-
tor category. Hence, if the total open interest in the
large speculator category is long or short 5%, the repre-
sentative trader would hold a 600-contract position, and so
on.

Based on these criteria the representative large
speculator in 1995 held an average of 830 (rounded to the
nearest 10) contracts per week, the maximum being 1,800
and the minimum zero. The average weekly return to this
hypothetical trader was a positive $12,640. The maximum and
minimum were positive $153,860 and negative $78,080, respec-

---

19 The average of 830 contracts may seem large but repre-
sents approximately 3.5% of the average net open interest
of large speculators in 1995 and only .002% of the average
total open interest during that year.
tively. Given the initial margin requirements for crude oil (table 3.6) of $2,025 per contract, the representative trader would have been required to post an average of $1,700,000 and a maximum of $3,500,000 in risk-free interest bearing securities. The maximum cash needed to cover margin calls would have been $104,000 ($61,000 and $43,000 in two consecutive weeks followed the next week by a $102,000 gain). In summary, considering the CFTC reported net open interest position of the large speculator only, a representative trader having $3.5 million in treasuries, no transaction costs and $105,000 cash on hand would have made in excess of $632,000 from the large hedger’s position in 1995.\footnote{Dollar returns were also calculated for the entire ten-year period under investigation, with similar results.}

To see if opportunities for profit exist when a trader is subject to round-trip transaction costs, consider the nonreporting trader with 10% of the weekly commitment of the large speculator above. This particular trader would have held an average of 83 contracts per week, a maximum of 180 and a minimum of zero. The weekly average profit, before round-trip dealer transaction costs, would have been
$1,264, and the trader would have needed $170,000 and
$10,500 to cover the initial and maintenance margins, re-
spectively.

Unfortunately, encumbered by retail-level weekly
transaction costs, the trader would have paid round-trip
costs exceeding $8,000 per week, resulting in an average
weekly loss of $6,756.

Obviously, this trading scheme is far from optimal.
However, it does shed light on the continuous efforts of
dealers to recruit investors into what appears to be a lu-
crative market, for the dealer!

In conclusion, I find no evidence supporting the
notion of an asymmetrically informed crude oil futures mar-
et. Although the null hypothesis of the large speculator
having no forecasting ability is rejected by the univariate
logit and OLS tests, the multivariate tests do not permit
the rejection of the null. Rather, the combined results
suggest that the Cumby and Modest (1985) methodology is not
sufficient for the determination of market timing ability

\[21\] It is interesting to note that even the large speculator
with round-trip costs at the wholesale level of
$22/contract would have incurred substantial losses.
when more than one a priori forecast variable is available and/or transaction costs are included.

What seems clear is that large hedgers are net losers in the crude oil futures market and may be intentionally motivating the supply of speculative services. What is less clear is the benefit or market convention that promotes or encourages exchange.

Heating Oil

Heating oil is a derivative of the crude oil refining process delivered mostly to midwestern and northeastern areas of the United States. Because heating oil is used primarily for residential and industrial purposes, demand for it is seasonal and relatively inelastic. Moreover, the futures contract written on heating oil is considered by many to be highly speculative. As such, this futures contract is promoted nationally by dealers in the fall and early winter months as an opportunity to generate abnormal returns.

22 The term speculative used here refers to heating oil's price volatility. Supply shocks in this market may be large due to the tendency of refiners to not overproduce the product. This is due to the vastly lower demand for heating oil in the summer months and nontrivial cost of storage.
Evidence of the forecast power extant in the net open interest positions of large hedgers and speculators and nonreporting traders is tested for consistency, conviction and seasonality. Results from the forecast power analysis are then compared to dollar returns earned by two traders in 1995 to further clarify the findings.

Recall that Keynes (1930) argued speculators are motivated by a risk premium for assuming the price risk of the underlying asset and that Houthakker (1957) and Danthine (1978) maintained that traders were asymmetrically informed. Thus consistent with the crude oil analysis, the first step is to test empirically for evidence supporting the notion that large speculators have consistent forecast ability when predicting the direction of price changes.

Forecast Consistency

Again results of the Henrikkson-Merton (1981) and Cumby-Modest (1987) tests are presented first, identifying the presence of consistent ability to forecast the direction of price changes. Results for both conditional probability and logit regression estimates of the semimonthly and weekly observation periods are reported in table 4.7, along with
Table 4.7--Estimating Forecast Consistency in Heating Oil: Comparing Conditional Probability Estimates and Logit Regressions; Semimonthly and Weekly Tranches

<table>
<thead>
<tr>
<th></th>
<th>Conditional Probability Estimates</th>
<th>Logistical Regression Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Null Hypothesis: $\Pi^<em>_0 + \Pi^</em>_{10} = 1$</td>
<td>Null Hypothesis: $\beta_{(i,t)} = 0$</td>
</tr>
<tr>
<td></td>
<td>$\Pi_c$ $\Pi_0$ $\Pi^<em>_0 + \Pi^</em>_{10}$</td>
<td>$\alpha_1$ $\beta_1$ $\chi^2$ STAT</td>
</tr>
<tr>
<td>Semimonthly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan.86-Sept.92</td>
<td>$N = 162$</td>
<td></td>
</tr>
<tr>
<td>LARGE</td>
<td>0.393 0.378 0.771</td>
<td>0.4340 -0.9330 6.888*</td>
</tr>
<tr>
<td>HEDGER</td>
<td>(-3.696)**</td>
<td>[2.293]* [-2.584]** 11.825**</td>
</tr>
<tr>
<td>LARGE</td>
<td>0.597 0.671 1.268</td>
<td>-0.3946 1.1055</td>
</tr>
<tr>
<td>SPECULATOR</td>
<td>(4.821)**</td>
<td>[-1.698]* [3.375]**</td>
</tr>
<tr>
<td>NONREPORTING</td>
<td>0.720 0.591 1.311</td>
<td>-0.9444 1.3136</td>
</tr>
<tr>
<td>TRADER</td>
<td>(4.050)**</td>
<td>[-2.120]* [2.747]** 8.386*</td>
</tr>
<tr>
<td>Weekly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct.92-Dec.95</td>
<td>$N = 169$</td>
<td></td>
</tr>
<tr>
<td>LARGE</td>
<td>0.486 0.391 0.878</td>
<td>0.0548 -0.4966 1.199</td>
</tr>
<tr>
<td>HEDGER</td>
<td>(-1.539)</td>
<td>[0.331] [-1.083]</td>
</tr>
<tr>
<td>LARGE</td>
<td>0.559 0.535 1.093</td>
<td>-0.2363 0.3752</td>
</tr>
<tr>
<td>SPECULATOR</td>
<td>(1.681)</td>
<td>[-0.967] [1.189]</td>
</tr>
<tr>
<td>NONREPORTING</td>
<td>0.333 0.491 0.824</td>
<td>0.6931 -0.7299</td>
</tr>
<tr>
<td>TRADER</td>
<td>(-1.193)</td>
<td>[0.800] [-0.829] 0.728</td>
</tr>
</tbody>
</table>

Note: T-ratios are given in brackets []. Z-scores are in parentheses (). See footnotes 3 and 5 for details on the models and hypotheses tests.

*Significant at the 0.05 level. **Significant at the 0.01 level.

Z-scores are in parentheses (). See footnotes 3 and 5 for details on the models and hypotheses tests.

Similar to findings reported for the crude oil market, statistics on the sum of the conditional probability coefficients, significance tests and the number of observations by aggregation period (tranche).
estimates are as expected\(^2\) during the semimonthly tranche. That is, large speculators appear to be better informed than large hedgers on conditions affecting the futures price.

Once again, large speculators and nonreporting traders consistently forecast the direction of price changes, predicting approximately 63\% \((\Pi_u + \Pi_d = 1.26, Z = 4.82)\) and 65\% \((\Pi_u + \Pi_d = 1.31, Z = 4.05)\), respectively, of the direction of subsequent price changes accurately. Large hedgers in the semimonthly tranche are, as they were in the crude oil market, consistent losers in the heating oil market, predicting only about 38\% \((\Pi_u + \Pi_d = 0.77, Z = -3.69)\) of subsequent price changes correctly.

Unlike the crude oil results in table 4.1, the weekly tranche is devoid of significance for all three traders. That is, no trader's forecast power, measured by the sum of the conditional probability estimates, differs meaningfully from 1. Perhaps even more interesting is the fact that the

---

\(^2\)Recall that the null hypothesis of no forecast ability \(H_0: \Pi_u + \Pi_d = 1\) is tested against the alternative hypotheses of superior forecast ability \(H_a: \Pi_u + \Pi_d > 1\).
nonreporting trader may have become an inferior forecaster of the direction of a price change.\textsuperscript{24}

Logistical regression results, on the right-hand side of table 4.7, for the semimonthly and weekly observation periods are consistent with the conditional probability estimates. The signs on the univariate regression coefficients and the test statistics appear to confirm the existence of an asymmetrically informed market or one that rewards a risk premium in the semimonthly but not in the weekly tranche.

For the semimonthly observation period, the Cumby-Modest alternative confirms that large hedgers in the heating oil market are inferior forecasters. Thus assessing the market's movement based on their position reduces the odds\textsuperscript{25} and, therefore, the probability\textsuperscript{26} of a correct forecast.

Large speculators and nonreporting traders appear to have a consistent ability to forecast the direction of price

\textsuperscript{24} Recall that two potential problems (classification and free rider) were noted in the crude oil discussion when interpreting this result as superior or inferior forecasting skill. These same issues will be addressed for heating oil momentarily.

\textsuperscript{25} Refer to footnote 6 for the details on interpretation.

\textsuperscript{26} Refer to footnote 7 for computational amplification.
movement, however. As with the conditional probability estimates, only the semimonthly tranche is significant. Statistical tests, including the model chi-squares, are significant (at the 0.05 level or greater) only during this period. Also interesting is the finding that the large speculator's regression is the most significant (at the 0.01 level).

Table 4.8 contains results of consistency tests applied to the ten-year and biweekly tranches. Conditional probability estimates for both tranches support the notion of an asymmetrically informed market, with large speculators and nonreporting traders appearing to have an informational advantage over the large hedger. Significance tests are at the 0.01 level for all traders in the ten-year tranche and for the nonreporting trader in the biweekly tranche. Large hedger and speculator estimates in the biweekly tranche are significant at the 0.05 level.

Results from the logistical regressions alternative, reported coincidentally, tend to support the conditional probability estimates for both tranches. However, though
the signs on the coefficients are consistent, the statistical significance diminishes in two of the six tests.

Table 4.8--Estimating Forecast Consistency in Heating Oil: Comparing Conditional Probability Estimates and Logit Regressions; Ten-Year and Biweekly Tranches

<table>
<thead>
<tr>
<th>Ten-Year</th>
<th>Conditional Probability Estimates</th>
<th>Logistical Regression Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Null Hypothesis: $\Pi_0 + \Pi_0 = 1$</td>
<td>Null Hypothesis: $\beta_{(1,t)} = 0$</td>
</tr>
<tr>
<td></td>
<td>$\alpha_i$, $\beta_i$, $\chi^2$ STAT</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LARGE</td>
<td>HEDGER</td>
</tr>
<tr>
<td>Jan.86-Dec.95</td>
<td>$\Pi_0$, $\Pi_0$, $\Pi_0+\Pi_0$</td>
<td>$0.445$, $0.382$, $0.827$</td>
</tr>
<tr>
<td>N = 331</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LARGE</td>
<td>0.579</td>
<td>0.597</td>
</tr>
<tr>
<td>HEDGER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NONREPORTING</td>
<td>0.645</td>
<td>0.537</td>
</tr>
<tr>
<td>TRADER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biweekly</td>
<td>$\Pi_0$, $\Pi_0$, $\Pi_0+\Pi_0$</td>
<td>$0.447$, $0.434$, $0.881$</td>
</tr>
<tr>
<td>Jan.86-Dec.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 246</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LARGE</td>
<td>0.554</td>
<td>0.552</td>
</tr>
<tr>
<td>HEDGER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NONREPORTING</td>
<td>0.642</td>
<td>0.594</td>
</tr>
<tr>
<td>TRADER</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: T-ratios are given in brackets [ ]. Z-scores are in parentheses ( ). See footnotes 3 and 5 for details on the models and hypotheses tests.

*Significant at the 0.05 level. **Significant at the 0.01 level.

An overall comparison of the varied results across traders and tranches is somewhat difficult, since the ten-
year and biweekly tranches include observations from the semimonthly tranche and that alone may account for the inconsistency. However, the finding that the positions of the large speculator and nonreporting trader appear to vary the most is noteworthy. That is, the position of the large speculator is significant in the semimonthly (at the 0.01 level) and ten-year (at the 0.05 level) tranches and insignificant in the weekly and biweekly tranches. The nonreporting trader's position is significant in all but the weekly tranche.

Interestingly, in contrast to the crude oil analysis, the use of a longer estimation interval did not materially improve the power of the tests for the heating oil analysis. Thus, little evidence from the heating oil market supports the notion that either a longer time interval (Leuthold et al. 1994) or an increase in the number of observations (Cumby and Modest 1987) improves the results. What is clear is that results from tranches that include observations from earlier years generally support differential market power among traders, whereas that power appears to dissipate in later years.
As noted in the crude oil analysis, seeming variation in trader advantage may be due to a variety of factors. For the heating oil market, two plausible explanations may be that (1) a major shift in the market paradigm occurred or that (2) the efficiency of information transmission increased over the years of market operation.

A valid explanation based upon reduced information asymmetry over time would require the significance of the tranches containing data from the later time period to be systematically lower than the significance of the tranches containing data from the earlier periods. While this is true for the semimonthly versus the weekly results, the biweekly versus the ten-year tranche is puzzling. Though the large hedger’s and speculator’s forecast power differentials do appear to converge to zero with an increase in the holding period, that of the nonreporting trader increases.\textsuperscript{27} Thus diminishing intertemporal forecast ability is unlikely to provide an adequate explanation of the results.

\textsuperscript{27} Recall that I maintained that in the crude oil analysis a longer aggregation period may mitigate the power of the forecast. However, that does not explain why the nonreporting trader’s performance improves.
The next step is to determine whether a structural change may have occurred in the heating oil market over the ten years examined. Due to constraints in the data set, discussed earlier, the analysis is limited to identifying any significant shifts in the net open interest positions of traders. Hence, the market paradigm shift explanation is tested by calculating the within-sample means of the net open interest of the three traders and noting whether those means appear to be consistent across both intervals.

Results from the analysis, given in table 4.9, portray the heating oil market as having both a shifting market structure and a market whose demand for speculative services is largely met by the nonreporting traders. Due to the theoretical inconsistency of this observation, the same analysis was conducted for the crude oil market for comparison purposes.

As can also be seen in table 4.9, the crude oil market appears to conform to both theoretical and consistency criteria. Large hedger demand for speculative services is met by the large speculator, and the quantity demanded does
not change materially over the ten-year period. The implication of this comparison is that a particular market's

table.

Table 4.9--Average Percentage Net Open Interest of the Three Trader Types in the Heating Oil and Crude Oil Markets:
Jan. 86 to Sept. 92 and Oct. 92 to Dec. 95

<table>
<thead>
<tr>
<th></th>
<th>Heating Oil</th>
<th>Crude Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Semimonthly</td>
<td>Weekly</td>
</tr>
<tr>
<td>N</td>
<td>162</td>
<td>169</td>
</tr>
<tr>
<td>Large Speculator</td>
<td>1.3</td>
<td>1.6</td>
</tr>
<tr>
<td>Large Hedger</td>
<td>-7.5</td>
<td>-10.7</td>
</tr>
<tr>
<td>Nonreporting Trader</td>
<td>6.2</td>
<td>9.1</td>
</tr>
</tbody>
</table>

function, and therefore efficiency, may vary due to idiosyncratic factors.

While this conjecture is somewhat unsettling, it does help to illuminate the divergent results across tranches and traders, though it in no way explains them. Suffice it to say, the promotion of the heating oil contract over time as a get-rich-quick scheme may have encouraged market participation by small traders, who, on the advice of their
brokers, have been on the correct side of the market's movement more often than not.

Explanations notwithstanding, the results in tables 4.7 and 4.8 provide substantial support in earlier years and limited support in later years in favor of the alternative hypothesis that large speculators and nonreporting traders are the better informed traders in the market.

Cumby and Modest (1987) point out, however, that market direction forecasts may not be independent of the magnitude of the subsequent price change. Hence tests of a trader's ability to consistently forecast the direction of price movement are not sufficient to demonstrate that a trader's position is superior in the trading process.

Forecast Conviction

Following Cumby and Modest's recommendation, I test whether large speculators take their largest positions at the time market prices change by the greatest amount. Empirical evidence supporting the notion that large speculators have conviction about their forecasts in the heating oil market is presented in table 4.10.
Consistent with results from the crude oil market, the results shown in table 4.10 depict the net open interest position of large hedgers as a perverse forecast of direction and magnitude of subsequent price changes. That is,

Table 4.10--Forecast Conviction for Heating Oil Using OLS regressions; by Observation Period.

Model Form: $\Delta R_{(t-T)} = \alpha_i + \beta_i \text{NETPOS}_{(t,t)} + \epsilon_{(t,t)}$.

Null Hypothesis: $\beta_{(t,t)} = 0$.

<table>
<thead>
<tr>
<th>TRADER</th>
<th>$\alpha_i$</th>
<th>$\beta_i$</th>
<th>P-value</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semimonthly</strong>&lt;br&gt;Jan.86 to Sep.92&lt;br&gt;N = 162</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LARGE</td>
<td>-0.0011</td>
<td>-0.0186</td>
<td>0.000</td>
<td>.14</td>
</tr>
<tr>
<td>HEDGER</td>
<td>[-2.435]**</td>
<td>[-5.220]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LARGE</td>
<td>-0.0001</td>
<td>0.0296</td>
<td>0.000</td>
<td>.13</td>
</tr>
<tr>
<td>SPECULATOR</td>
<td>[-0.361]</td>
<td>[5.228]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NONREPORTING</td>
<td>-0.0012</td>
<td>0.0241</td>
<td>0.001</td>
<td>.07</td>
</tr>
<tr>
<td>TRADER</td>
<td>[-2.298]*</td>
<td>[3.320]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Weekly</strong>&lt;br&gt;Oct.92 to Dec.95&lt;br&gt;n = 169</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LARGE</td>
<td>-0.0012</td>
<td>-0.0078</td>
<td>0.043</td>
<td>.03</td>
</tr>
<tr>
<td>HEDGER</td>
<td>[-2.384]**</td>
<td>[-2.569]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LARGE</td>
<td>-0.0004</td>
<td>0.0078</td>
<td>0.193</td>
<td>.01</td>
</tr>
<tr>
<td>SPECULATOR</td>
<td>[-1.403]</td>
<td>[1.910]*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NONREPORTING</td>
<td>-0.0016</td>
<td>0.0136</td>
<td>0.046</td>
<td>.03</td>
</tr>
<tr>
<td>TRADER</td>
<td>[-2.338]**</td>
<td>[2.390]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ten-Year</strong>&lt;br&gt;Jan.86 to Dec.95&lt;br&gt;n = 331</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LARGE</td>
<td>-0.0012</td>
<td>-0.0132</td>
<td>0.000</td>
<td>.07</td>
</tr>
<tr>
<td>HEDGER</td>
<td>[-3.596]**</td>
<td>[-5.433]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LARGE</td>
<td>-0.0003</td>
<td>0.0190</td>
<td>0.000</td>
<td>.06</td>
</tr>
<tr>
<td>SPECULATOR</td>
<td>[-1.246]</td>
<td>[5.284]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NONREPORTING</td>
<td>-0.0014</td>
<td>0.0172</td>
<td>0.000</td>
<td>.04</td>
</tr>
<tr>
<td>TRADER</td>
<td>[-3.205]**</td>
<td>[3.865]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Biweekly</strong>&lt;br&gt;Jan.86 to Dec.95&lt;br&gt;n = 246</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LARGE</td>
<td>-0.0003</td>
<td>-0.0094</td>
<td>0.012</td>
<td>.03</td>
</tr>
<tr>
<td>HEDGER</td>
<td>[-1.058]</td>
<td>[-3.253]**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
hedgers' largest short (long) position occurs most often when the price increases (decreases) by the greatest amount. Furthermore, the large hedger's inferior forecast ability in the heating oil market is consistent across all four tranches.

Large speculator results are again mixed across the four tranches tested. But in contrast to the crude oil market, large speculators now appear to hold their largest positions when forecasted price changes are greatest.

Hence, given the improvement in forecast ability as prices change by increasing amounts (compare results in tables 4.7 and 4.8 to those in table 4.10) large speculators may not participate in the market unless a significant change in the price is anticipated.

Biweekly results for large speculators, however, fail to demonstrate statistically significant (t-ratio = 1.411)
forecast conviction, though this may again be due to a longer price series aggregation interval. That is, a forecast position held over a 15-day interval may not be nearly as profitable as a forecast position held for seven days.

Recall in the crude oil market the forecast interval explanation was examined using a comparison of Chow tests for the ten-year and biweekly data series. The first Chow test split the ten-year sample at the changeover point (semimonthly to weekly) to test for stationarity. Results for heating oil \( F_{160,167} = 4.537 \) strongly support the alternative of nonstationarity over the null hypothesis at the 0.01 level.

A second Chow test was conducted on the biweekly data set to see whether the source of nonstationarity is a measurement interval change or is simply an artifact of the historical time period. Recall that evidence supporting the time-period hypothesis requires that the Chow tests have similar statistics; that is, that both be significant. Evidence supporting the measurement interval hypothesis requires the biweekly Chow tests, contrary to the ten-year Chow tests, be insignificant.
Comparing results from the two tests, I find even greater support than existed in the crude oil market that forecast power is a short-horizon phenomenon. The null hypothesis of stationarity over the biweekly measurement interval cannot be rejected ($F_{(160,84)} = 0.771$).

Taken together, the results in table 4.10 support the notion that large speculators, relative to large hedgers, have a forecast power advantage or earn a risk premium or both. Again this observation is generally consistent with results from tables 4.7 and 4.8. Interestingly, the nonreporting trader's position again appears\textsuperscript{28} to be the most accurate and significant, just as it was in the crude oil futures market, since model and coefficient tests are significant at the 0.05 level or better for all four tranches.

However, as noted in the crude oil analysis, this observation does not ring true with economic theory. Do nonreporting traders have a market advantage over even the large speculators? Or are they again simply observing the position of the large speculator and walking in step?

\textsuperscript{28} See footnotes 2 and 8.
To answer these questions for the heating oil market I again determine whether the positions of the three traders are independent. That is, given that the large speculator's position is observed, what if any additional information can be gleaned from the positions of the large hedger and the nonreporting trader?

Multivariate Tests

First, results from multivariate logistical regressions are compared to those from their univariate counterparts. That is, details from tables 4.7 and 4.8 are contrasted with those from table 4.11. Recalling the interpretation of the coefficients from the logistical regressions reported in tables 4.7 and 4.8, the corresponding coefficients in table 4.11 indicate the increase (decrease) in the odds ratio, given that each trader's position is determined independent of the position of other traders.

A priori, based on the results in tables 4.7 and 4.8, I expect to find evidence supporting the existence of an asymmetrically informed market with respect to the direction of price movement, thus motivating the trading activity of large speculators. That is, the signs of the coefficients
Table 4.11--Multivariate Logit Regression Results for Heating Oil

Model Form: \( RETDUM_{t,T} = \alpha_{(t)} + \beta^H_{(t)}HEGDUM_{t} + \beta^S_{(t)}SPCDUM_{t} + \epsilon_{(t,T)} \)

Null Hypothesis: \( \alpha, \beta^H \text{ and } \beta^S \text{ jointly } = 0. \)

<table>
<thead>
<tr>
<th></th>
<th>( \alpha )</th>
<th>( \beta^H )</th>
<th>( \beta^S )</th>
<th>( \chi^2 ) STAT</th>
<th>( N )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semimonthly</td>
<td>-0.2134</td>
<td>-0.3290</td>
<td>0.9324</td>
<td>12.369**</td>
<td>162</td>
</tr>
<tr>
<td>Jan.86 to Sept.92</td>
<td>[-0.635]</td>
<td>[-0.738]</td>
<td>[2.324]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekly</td>
<td>-0.1344</td>
<td>-0.3196</td>
<td>0.2765</td>
<td>1.818</td>
<td>169</td>
</tr>
<tr>
<td>Oct.92 to Dec.95</td>
<td>[-0.459]</td>
<td>[-0.625]</td>
<td>[0.785]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ten-Year</td>
<td>-0.1730</td>
<td>-0.3328</td>
<td>0.05705</td>
<td>11.206**</td>
<td>331</td>
</tr>
<tr>
<td>Jan.86 to Dec.95</td>
<td>[-0.784]</td>
<td>[-1.018]</td>
<td>[2.164]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biweekly</td>
<td>0.4645</td>
<td>-0.3382</td>
<td>0.1859</td>
<td>3.188</td>
<td>246</td>
</tr>
<tr>
<td>Jan.86 to Dec.95</td>
<td>[0.120]</td>
<td>[-0.832]</td>
<td>[0.468]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Based on the results from the univariate logit regressions, the alternative hypotheses are: \( \beta^H < 0 \) and \( \beta^S > 0 \) for the hedger and speculator, respectively. T-ratios are given in brackets.

* Significant at the 0.05 level. ** Significant at the 0.01 level.

For large hedgers will be negative and those for large speculators will be positive, and both will be statistically significant.

Consistent with the results obtained from the univariate regressions (tables 4.7 and 4.8), results in table 4.11 indicate not only that large speculators are superior forecasters of the direction of price changes but that their position is determined independent of the positions of other...
traders. Thus large speculators may have information superior to that of the other traders.

As anticipated, given the position of the large speculator, the position of the large hedger appears to be devoid of information. Though the large speculator's forecast ability is insignificant for two of four tranches, it is in the right direction in all four observation periods. In essence, the significance of the large speculator's position in the heating oil market appears to be highly dependent upon the time period observed. That is, the symmetrically informed large speculator's advantage seems to dissipate over time.

Of additional importance is the insignificance of the intercepts. In contrast to the crude oil market analysis (table 4.4) the probability of being on the correct side of the markets subsequent movement is only improved by observing the large speculator. At face value, this result supports the argument that nonreporting traders are simply free riders and, more important, that an asymmetric information backwardation equilibrium exists in the heating oil market.
Recall that in the crude oil market I suggested a market scenario that permitted the nonreporting trader to migrate across categories, thus implying that nonreporting traders were not necessarily small. In the case of heating oil no such machinations are necessary. This seems particularly important considering the results obtained from the multivariate OLS tests of forecast conviction, presented in table 4.12.

Table 4.12--Multivariate OLS Regression Results for Heating Oil

Model Form: \( \Delta R_{(t,T)} = \alpha_{(t)} + \beta_H^{H}(t)NETHEG_{(t)} + \beta_S^{S}(t)NETSPC_{(t)} + \varepsilon_{(t,t)} \). Null Hypothesis: \( \alpha, \beta^H, \beta^S \) Jointly = 0.

<table>
<thead>
<tr>
<th></th>
<th>( \alpha )</th>
<th>( \beta^H )</th>
<th>( \beta^S )</th>
<th>F-STAT.</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semimonthly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan.86 to Sept.92</td>
<td>-0.0008</td>
<td>-0.0122</td>
<td>0.0122</td>
<td>2.507</td>
<td>162</td>
</tr>
<tr>
<td></td>
<td>[-1.621]</td>
<td>[-1.521]</td>
<td>[0.984]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekly</td>
<td>-0.0015</td>
<td>-0.0119</td>
<td>-0.0073</td>
<td>2.323</td>
<td>169</td>
</tr>
<tr>
<td>Oct.92 to Dec.95</td>
<td>[-2.221]**</td>
<td>[-2.085]**</td>
<td>[-0.982]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ten-Year</td>
<td>-0.0011</td>
<td>-0.0110</td>
<td>0.00418</td>
<td>9.562**</td>
<td>331</td>
</tr>
<tr>
<td>Jan.86 to Dec.95</td>
<td>[-2.687]**</td>
<td>[-2.412]**</td>
<td>[0.633]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biweekly</td>
<td>-0.0003</td>
<td>-0.0217</td>
<td>-0.0208</td>
<td>4.759**</td>
<td>246</td>
</tr>
<tr>
<td>Jan.86 to Dec.95</td>
<td>[-1.059]</td>
<td>[-3.024]**</td>
<td>[-1.852]*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: By construction, the intercept (\( \alpha \)) represents nonreporting traders. Based on the results from the univariate OLS regressions, the alternative hypotheses are: \( \beta^H < 0, \beta^S > 0 \) and \( \alpha > 0 \) for the hedger, speculator and nonreporting traders, respectively. T-ratios are given in brackets. * Significant at the 0.05 level. ** Significant at the 0.01 level.
Immediately apparent is a wide discrepancy in the results reported in table 4.12 and those from multivariate logit and univariate OLS regressions. Whereas the large speculator appeared to have significant forecast conviction in three of four tranches in table 4.10, that position now does not appear to be independently determined. Moreover, with the exception of the biweekly tranche, the large speculator’s position, viewed simultaneously with other traders, appears to add nothing to the information set concerning market price movement.

The results for the large hedger and nonreporting trader are even more intriguing. Viewed independently of other traders the large hedger consistently produced a perverse forecast of the direction (tables 4.7 and 4.8) and magnitude (table 4.10) of subsequent price changes.

On the other hand, nonreporting traders independently appeared to have both forecast consistency and conviction. They generally took a position on the correct side of the market’s movement and adjusted the size of their commitment in consideration of the magnitude of the subsequent price change. However, when the positions of other traders are
held constant (table 4.11), the significance of the positions of the large hedger and nonreporting trader ($\alpha$), in either direction, appears to vanish.

Taking into account the magnitude as well as the direction of the price change and given the observation of other traders (table 4.12), the large hedger's position is once again an aberrant indicator of market movement. Note also that for the first time, the nonreporting trader's position is an aberrant indicator as well. On the plus side, even with results that are varied across the statistical tests performed and to a lesser degree across the four tranches, interpreting this result does not require an explanation accounting for known facts that are inconsistent with accepted theory, as was true in the crude oil analysis.

For example, nonreporting traders appear to be on the right side of the market's movement only when they are in league with other traders. Large speculators' forecast ability seems to be limited to large price movements and to the earlier years in the data set. Finally, large hedgers are systematically on the wrong side of heating oil market
price changes and to a greater degree as the price change increases in magnitude.

Two points that remain unclear are: (1) Why does the large hedger's position elicit a response mostly from the nonreporting trader with increasing significance over time?\(^{29}\) (2) Is the positive return awarded systematically to large speculators and nonreporting traders due to demand for risk premia, information assimilation inefficiency or some other form of trading anomaly?

Unfortunately, given the aforementioned data and methodological constraints, an answer to either question is little more than conjecture. Therefore, I will return to this discussion in chapter V. For now I move to the seasonality issues in the heating oil market.

Seasonality

Seasonal bias in the crude oil market was minimal due to the continuous and relatively constant-volume nature of the production process. Seasonal bias in the heating oil market, on the other hand, is anticipated, as the daily

\(^{29}\) See table 4.9.
production and usage levels vary greatly depending upon the
time of year.

The fall and early winter months of trading in the
heating oil market anticipate the shift in demand accompany-
ing unusually mild or harsh winters. Accordingly, the crude
oil refining process is reallocated from unleaded gasoline
to heating oil. If expectations are realized concerning the
demand for heating oil, the price is relatively stable. If
however, the quantity demanded moves up (down) unexpectedly
the short-run price may rise (fall) significantly. Thus ex
ante I anticipate that trading activity and returns to trad-
ers are concentrated in the corresponding months.

Tables 4.13A and 4.13B confirm the suspicion that
seasonal variance in the heating oil futures market is sig-
nificant and yet disclosed in the trader's position. Model
A is used to identify any months when the net open interest
position of the three traders is materially different from
others. That is, it addresses the question: Does the time
of the year explain the trader's commitment in the market?
Model B addresses the question of whether the trader's posi-
tion is sufficient to capture any seasonal component extant in the return series.\textsuperscript{30}

As expected model A identifies seven fall and winter months, August through March excluding December, as statistically significant at the 0.05 level or greater for at least two of the three trader classifications. August to October and February and March are significant for all three traders, and nonreporting traders appear to begin anticipating seasonal demand as early as July, with large speculators still on board as late as May.

Table 4.13A--Seasonal OLS Regression Results for Heating Oil From January to June, by Trader Type; Comparing Model A to Model B

<table>
<thead>
<tr>
<th>LARGE HEDGER</th>
<th>( N )</th>
<th>F-STAT(A)</th>
<th>( R^2(A) )</th>
<th>F-STAT(B)</th>
<th>( R^2(B) )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>331</td>
<td>31.237*</td>
<td>.1897</td>
<td>3.170*</td>
<td>.1146</td>
</tr>
<tr>
<td>DJAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DFEB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DMAR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAPR</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DMAY</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DJUN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \alpha_i^A )</td>
<td>-0.0749</td>
<td>-5.349*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \beta_m^A )</td>
<td>0.0539</td>
<td>0.0608</td>
<td>-0.0025</td>
<td>-0.0252</td>
<td>0.0270</td>
</tr>
<tr>
<td>( \beta_m^A )</td>
<td>[2.339]*</td>
<td>[2.725]*</td>
<td>[-0.110]</td>
<td>[-1.026]</td>
<td>[1.235]</td>
</tr>
<tr>
<td>( \alpha_i^B )</td>
<td>-0.0011</td>
<td>-1.615</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \beta_m^B )</td>
<td>-0.0009</td>
<td>0.0010</td>
<td>0.0012</td>
<td>-0.0001</td>
<td>-0.0007</td>
</tr>
<tr>
<td>( \beta_m^B )</td>
<td>[-0.832]</td>
<td>[0.961]</td>
<td>[1.276]</td>
<td>[-0.174]</td>
<td>[-0.738]</td>
</tr>
<tr>
<td>( \beta_m^B )</td>
<td>-0.0150</td>
<td>-5.977*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LARGE</th>
<th>( N )</th>
<th>F-STAT(A)</th>
<th>( R^2(A) )</th>
<th>F-STAT(B)</th>
<th>( R^2(B) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPECULATOR</td>
<td>331</td>
<td>6.973*</td>
<td>.1691</td>
<td>2.906*</td>
<td>.0988</td>
</tr>
</tbody>
</table>

\textsuperscript{30} See footnotes 17 and 18 for model details.
\[ \alpha_i^A = 0.0050 \quad [0.0644] \]
\[ \beta_i^A = -0.0234 \quad -0.0386 \quad 0.0226 \quad 0.0236 \quad -0.0260 \]
\[ \alpha_i^B = -0.0000 \quad [-0.145] \]
\[ \beta_i^B = -0.0012 \quad 0.0009 \quad 0.0007 \quad -0.0003 \quad -0.006 \]
\[ \beta_{\mu}^B = 0.0214 \quad [5.617]** \]

<table>
<thead>
<tr>
<th>NONREPORTING</th>
<th>( N )</th>
<th>( F)-STAT(A)</th>
<th>( R^2(A) )</th>
<th>( F)-STAT(B)</th>
<th>( R^2(B) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>LARGE HEDGER</td>
<td>331</td>
<td>55.959**</td>
<td>.1569</td>
<td>1.999</td>
<td>.0754</td>
</tr>
</tbody>
</table>

\[ \alpha_i^A = 0.0699 \quad [0.862]** \]
\[ \beta_i^A = -0.0304 \quad -0.0222 \quad -0.0200 \quad 0.0016 \quad -0.0010 \]
\[ \alpha_i^B = -0.0012 \quad [-1.725]** \]
\[ \beta_i^B = -0.0012 \quad 0.0005 \quad 0.0016 \quad 0.0001 \quad -0.0011 \]
\[ \beta_{\mu}^B = 0.0186 \quad [4.282]** \]

Note: T-ratios are given in brackets [ ]. See footnotes 17 and 18 for model specifications.
*Significant at the 0.05 level. **Significant at the 0.01 level.

Table 4.13B--Seasonal OLS Regression Results for Heating Oil from July to December, by Trader Type, Comparing Model A to Model B.
Model B, however, indicates as it did in the crude oil market that if a trader is able to observe the position of the large hedger or speculator or that of the nonreporting trader, the month of the year has no additional explanatory power. Therefore, I conclude that the annual calculation of dollar returns to a trading classification would, most likely, not be materially different from returns adjusted for seasonal variation in either the open interest position or the price series.

### Dollar Returns

The systematically perverse forecast of the large hedger implies that the heating oil market is bound by an
information irregularity, some form of trading constraint or possibly a risk premium enticement to trade. In other words, large hedgers may be slow to react to new information and thus the market is inefficient. A barrier to free trade may exist in the form of regulation or other such constraint. Or the large hedger may actually have superior information and agree by his/her position to pay a small risk premium.

Notably, some evidence resulting from the multivariate tests of forecast consistency supports the relative forecast power in the large speculator's ex ante position. However, large changes in the futures price do not appear to be matched by relatively larger positions taken by the large speculator. Thus forecast conviction in the large speculator's ex ante position is not indisputable. Yet the absolute power of the position, however determined, may hold valuable information for market timing purposes, based on the univariate tests. The empirical question emanating from these contradictory indications of forecast ability is: Can the casual investor profit from observing the position of
the large speculator? If so, what accounts for this market phenomenon?

As with the crude oil contract, I test the forecast power value of the large speculator's position by computing the dollar returns to a representative large speculator in the heating oil market in 1995. Recall that the representative trader is characterized as a trader who holds an equally weighted portfolio of all contract months trading on the NYMEX heating oil contract and does so throughout the entire year. The trader opens and closes his/her total position once each week, thus earning an average weekly return. Recall too, the univariate forecast conviction tests indicated large speculators take their largest positions when prices change by the greatest amount. Thus the representative speculator adjusts his/her total open interest position up 50 contracts for the first 1% increase (above 1%) and 100 contracts for each 1% thereafter, from a base of 250, in the net open interest of the large speculator category. Hence, if the total open interest in the large speculator category is long or short 5%, the repre-
sentative trader would hold a 500 contract position and so on up to a limit of 2,000 contracts.\textsuperscript{31}

Based on these qualifiers, the representative large speculator in 1995 held an average of 750 (rounded to the nearest 10) contracts per week,\textsuperscript{32} the maximum being 1,700 and the minimum zero. The average weekly return to this hypothetical trader was a positive $14,640. The maximum and minimum were positive $257,236 and negative $190,000, respectively. Given the initial margin requirements for heating oil (table 3.6) of $2,025 per contract, the representative trader would have been required to post an average of $1,519,000 and a maximum of $3,442,500 in risk-free interest-bearing securities. The maximum cash needed to cover margin calls would have been $0. (In fact from the beginning of 1995 the trader's credit balance would have never fallen below $7,600.) In summary, considering the position of the large speculator only, a representative trader having $3.5 million in treasuries, no transaction costs\textsuperscript{33} and no cash on

\textsuperscript{31} This limit was never reached.

\textsuperscript{32} The average of 750 contracts is not large, since it represents approximately 3.4% of the average net open interest of large speculators in 1995 and only .002% of the average total open interest during that year.

\textsuperscript{33} Footnote 21 applies here as well.
hand would have made in excess of $732,000 from the large hedger's position in 1995.\textsuperscript{34}

To see if opportunities for profit exist when a trader is subject to round-trip transaction costs, I again consider the nonreporting trader with 10\% of the weekly commitment of the large speculator above. This particular trader would have held an average of 75 contracts per week, a maximum of 170 and a minimum of zero. The weekly average profit, before round-trip dealer transaction costs, would have been $1,464, and the trader would have needed $151,900 and $0 to cover the initial and maintenance margins, respectively. Unfortunately, encumbered by retail-level weekly transaction costs, the trader would have paid more than $8,000 per week, resulting in an average weekly loss of $6,536. Again the reason that small investors are motivated to trade is unclear, since the only one profiting from a transaction seems to be the dealer:

In conclusion, I find little evidence in support of an asymmetrically informed heating oil futures market. The null hypothesis of the large speculator's having no fore-

\textsuperscript{34} Dollar returns were again calculated for the entire ten-year period under investigation with similar results.
casting ability is rejected by the univariate logit and OLS tests, though the degree and significance vary across the tranches examined. On the other hand, multivariate tests allow only a weak rejection of the null. More important, the evidence suggests the large hedger's demand for speculative services is met by the nonreporting trader rather than the large speculator. This last observation may be a function of the highly publicized opportunities touted by dealers during the fall and winter months.

What is again clear in the heating oil market is that large hedgers are net losers, thus motivating the supply of speculative services.

Unleaded Gasoline

Unleaded gasoline, like heating oil, is a crude oil derivative that is consumed throughout the United States. Demand for unleaded gasoline is also seasonal and relatively inelastic. But a futures contract written on unleaded gasoline is not considered to be as highly speculative as a futures contract written on heating oil.

In this section, as in the previous analyses, I test for evidence of the market timing information extant in the
net open interest positions of large hedgers and speculators and nonreporting traders. Again, tests for consistency, conviction and seasonality follow in turn, and dollar-return potential concludes the analysis.

Recalling the previously mentioned theoretical arguments of Keynes (1930), Houthakker (1957), Telser (1958), and Danthine (1978), the first step is to test empirically for evidence supporting the notion that large speculators have consistent forecast ability when predicting the direction of ensuing price changes.

Forecast Consistency

Again I rely on the Henrikkson-Merton (1981) and Cumby-Modest (1987) tests to identify any consistent forecast ability possessed by a trader to predict the direction of a price change, where prediction is indicated by the trader's net open interest position in the market. Results for both the conditional probability and logit regression estimates of the semimonthly and weekly observation periods are presented in table 4.14, along with coefficients, significance tests and the number of observations in each tranche.

<table>
<thead>
<tr>
<th></th>
<th>Conditional Probability Estimates</th>
<th>Logistical Regression Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Null Hypothesis: $\Pi_0 + \Pi_0 = 1$</td>
<td>Null Hypothesis: $\beta_{(1, k)} = 0$</td>
</tr>
<tr>
<td>Semimonthly Jan. 86-Sept. 92</td>
<td>$\Pi_0$  $\Pi_0$  $\Pi_0 + \Pi_0$</td>
<td>$\alpha_i$  $\beta_i$  $\chi^2$ STAT  $N$</td>
</tr>
<tr>
<td>LARGE HEDGER</td>
<td>0.391  0.447  0.838</td>
<td>0.4418  -0.6554  (-2.657)**  162</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[2.312]* [-1.871]* 3.535</td>
</tr>
<tr>
<td>LARGE SPECULATOR</td>
<td>0.509  0.600  1.109</td>
<td>-0.0350  0.4405  (-0.132) [1.329]  1.770</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[-1.062] [2.183]* 4.848</td>
</tr>
<tr>
<td>NONREPORTING TRADER</td>
<td>0.581  0.613  1.195</td>
<td>-0.3285  0.0790  (3.111)**  162</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[-1.602] [2.183]* 4.848</td>
</tr>
<tr>
<td>Weekly Oct. 92-Dec. 95</td>
<td>$\Pi_0$  $\Pi_0$  $\Pi_0 + \Pi_0$</td>
<td>$\alpha_i$  $\beta_i$  $\chi^2$ STAT  $N$</td>
</tr>
<tr>
<td>LARGE HEDGER</td>
<td>0.463  0.377  0.840</td>
<td>0.1484  -0.6505  (-2.819)**  169</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.769] [-1.988]* 4.029</td>
</tr>
<tr>
<td>LARGE SPECULATOR</td>
<td>0.611  0.522  1.133</td>
<td>-0.4519  0.5390  (2.273)*  169</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[-1.619] [1.605] 2.616</td>
</tr>
<tr>
<td>NONREPORTING TRADER</td>
<td>0.653  0.585  1.238</td>
<td>-0.6337  0.9775  (4.347)**  169</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[-2.611] [3.050]** 9.614**</td>
</tr>
</tbody>
</table>

Note: T-ratios are given in brackets [ ]. Z-scores are given in parentheses ( ). See footnotes 3 and 5 for details on the models and hypotheses tests.
*Significant at the 0.05 level. **Significant at the 0.01 level.

In contrast to the analysis of both the crude oil and heating oil markets, the large speculator’s statistic on the sum of the conditional probability estimates indicates no asymmetric information advantage during the semimonthly tranche.
Thus although large speculators appear to be correctly forecasting the direction of price changes (based on the sum of $\Pi_u + \Pi_d > 1$), they do so insignificantly. The nonreporting trader, however, once again curiously appears to be the better informed trader. That is, nonreporting traders appear to be better informed than either large hedgers or speculators on subsequent changes in the futures price.

Large hedgers in the semimonthly tranche are, as they were in the crude oil and heating oil markets, consistent losers. Large hedgers predicted correctly approximately 40% ($\Pi_u + \Pi_d = 0.83, Z = -2.65$) of subsequent price changes.

Consistent with the crude oil results in table 4.1, the weekly tranche indicates the large speculator and nonreporting trader enjoy an informational advantage over their large hedger counterpart. The sums of the conditional probability estimates are significantly different from 1 and in the anticipated direction (given previous results) for all three traders.

Logistical regression results, on the right-hand side of table 4.14, for the semimonthly and weekly observation periods are consistent with their conditional probability
estimate counterparts. However, the signs on the univariate regression coefficients and the test statistics appear to confirm that if an asymmetrically informed unleaded gasoline market exists, it must exist between the large hedgers and nonreporting traders only.

Statistical tests, including the model chi-square, are much less significant than in the previous two analyses. Only during the weekly period and for the nonreporting trader's regression is the chi-square statistic significant at the 0.01 level.

The results of the same tests applied to the ten-year and biweekly observation periods are reported in table 4.15. In contrast to the semimonthly and weekly tranches, conditional probability estimates for both the ten-year and biweekly tranches strongly support an asymmetrically informed unleaded gasoline market. Thus large speculators and nonreporting traders appear to have a significant informational advantage over the large hedger. Z-scores reported indicate significance at the 0.01 level for all traders in both the ten-year and biweekly tranches.
Results from the logistical regressions alternative, reported coincidentally, also support the asymmetric information hypothesis. Statistical significance is at the 0.01 level or greater for all but the large speculator in the

Table 4.15--Estimating Forecast Consistency for Unleaded Gasoline: Comparing Conditional Probability Estimates and Logit Regressions for Ten-Year and Biweekly Tranches

<table>
<thead>
<tr>
<th></th>
<th>Conditional Probability Estimates</th>
<th>Logistical Regression Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Null Hypothesis: $P_0 + P_0 = 1$</td>
<td>Null Hypothesis: $\beta_{i,t} = 0$</td>
</tr>
<tr>
<td></td>
<td>$\alpha_1$ $\beta_1$ $\chi^2$ STAT</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$P_0$ $P_0$ $P_0 + P_0$</td>
<td>$a_1$ $b_1$ $\chi^2$ STAT</td>
</tr>
<tr>
<td>Ten-Year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan.86-Dec.95</td>
<td>N = 331</td>
<td></td>
</tr>
<tr>
<td>LARGE HEDGER</td>
<td>0.426 0.407 0.833</td>
<td>0.2981 -0.6728</td>
</tr>
<tr>
<td></td>
<td>(-4.016)**</td>
<td>[2.201]* [-2.825]** 8.115*</td>
</tr>
<tr>
<td>LARGE SPECULATOR</td>
<td>0.559 0.559 1.118</td>
<td>-0.2353 0.4727</td>
</tr>
<tr>
<td></td>
<td>(2.856)**</td>
<td>[-1.231] [2.016]* 4.095</td>
</tr>
<tr>
<td>NONREPORTING TRADER</td>
<td>0.627 0.601 1.228</td>
<td>-0.5198 0.09292</td>
</tr>
<tr>
<td></td>
<td>(5.617)**</td>
<td>[-2.730]** [3.933]** 15.941**</td>
</tr>
<tr>
<td>Biweekly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan.86-Dec.95</td>
<td>N = 246</td>
<td></td>
</tr>
<tr>
<td>LARGE HEDGER</td>
<td>0.394 0.395 0.789</td>
<td>0.4300 -0.8574</td>
</tr>
<tr>
<td></td>
<td>(-4.334)**</td>
<td>[2.739]** [-3.037]** 9.447**</td>
</tr>
<tr>
<td>LARGE SPECULATOR</td>
<td>0.578 0.601 1.180</td>
<td>-0.3158 0.7264</td>
</tr>
<tr>
<td></td>
<td>(3.771)**</td>
<td>[-1.421] [2.652]** 7.144*</td>
</tr>
<tr>
<td>NONREPORTING TRADER</td>
<td>0.617 0.618 1.235</td>
<td>-0.4780 0.9598</td>
</tr>
<tr>
<td></td>
<td>(4.915)**</td>
<td>[-2.091]* [3.438]** 12.176**</td>
</tr>
</tbody>
</table>

Note: T-ratios are given in brackets [ ]. Z-scores are given in parentheses (). See footnotes 3 and 5 for details on the models and hypotheses tests.

*Significant at the 0.05 level. **Significant at the 0.01 level.
ten-year tranche (significant at the 0.05 level), and the $\chi^2$ statistics are improved as well. Two additional facts are of some significance: The positions of the large speculator and large hedger appear to be the most sensitive to the method of data aggregation. The nonreporting trader is significant in all tranches.

The first result is illustrated by the insignificant position of the large speculator in the semimonthly and weekly tranches becoming significant in the ten-year and biweekly tranches. In addition, the significance of the large hedger's position increases from the earlier time period to the later. The second result, in keeping with previous findings, depicts the nonreporting traders as having an apparent advantage in the unleaded gasoline market.

Once again, comparable to crude oil, a longer estimation interval for the unleaded gasoline trader materially improves the power of the tests. Therefore, evidence appears to support the notion that either a longer time interval (Leuthold et al. 1994) or an increase in the number of observations (Cumby and Modest 1987) improves the results. In either case, this implies that results from
tranches that include more observations should be relied upon more heavily.\footnote{My suspicion in this case is that the semimonthly and weekly tranches are prone to type II error. Recall in the crude oil analysis that the number of up and down markets was approximately the same, thus reducing this possibility. In the unleaded gasoline market the number of up and down markets is less symmetric (semimonthly 91 up, 71 down and weekly 81 up, 88 down), and the significance of the tranches with more observations is not materially different from the significance in the tranches with fewer observations. Consequently the possibility of failing to reject a false null appears to have increased markedly.}

As noted in the crude oil and heating oil analyses, seeming variation in trader advantage may be due to a variety of factors. For unleaded gasoline, the most plausible explanation may stem from the statistical limitations associated with the relatively small sample sizes. However, before discounting the possibility of a major shift in the market paradigm or an increase or decrease in the efficiency of information transmission over the years of market operation, I again conduct a crude test applied to the two other markets.

Recall I contend that if information asymmetry is reduced (increased) over time, the significance of the forecast power in tranches containing data from the later time period will be systematically lower (higher) than those from
the earlier period. While this is somewhat true for the semimonthly versus weekly results, the actual difference appears to be small. Thus diminishing or increasing intertemporal forecast ability is not likely to explain much of the variation.

As a follow-up examination I determine whether a structural change may have occurred in the unleaded gasoline market over the ten years examined. Due to constraints in the data set, discussed earlier, the analysis is limited to identifying any significant shifts in the net open interest positions of traders. Hence, the market paradigm shift explanation is weakly tested by calculating the within-sample means of the net open interest of the three traders and noting whether the means appear to be consistent across both intervals.

Results from the analysis, shown in table 4.16, portray the unleaded gasoline market as having little if any shift in market structure over time. Unlike the heating oil market, large hedgers are chiefly dependent on the large speculator to meet their demand for speculative services.
Taken together, the results in table 4.15 and table 4.16 provide substantial support for the alternative hypothesis that large speculators and nonreporting traders are better informed. Results from table 4.14 are not sufficient to reject the null hypothesis of no market forecast ability. However, this may be a statistical artifact of the asymmetric distribution of price changes, as pointed out earlier.

Table 4.16--Average Percentage Net Open Interest of the Three Trader Types in the Unleaded Gasoline Market, Jan.86 to Sept.92 and Oct.92 to Dec.95.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>LARGE SPECULATOR</th>
<th>NONREPORTING TRADER</th>
<th>LARGE HEDGER</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEMIMONTHLY</td>
<td>162</td>
<td>0.019</td>
<td>0.020</td>
<td>-0.039</td>
</tr>
<tr>
<td>WEEKLY</td>
<td>169</td>
<td>0.038</td>
<td>0.014</td>
<td>-0.053</td>
</tr>
</tbody>
</table>

Notwithstanding the above conclusion, Cumby and Modest (1985) point out that tests of a trader's ability to consistently forecast the direction of price are not sufficient to demonstrate that a trader possesses market timing ability.
Forecast Conviction

Following Cumby and Modest's recommendation, I again test whether large speculators take their largest positions at the time market prices change by the greatest amount. Empirical evidence supporting the notion that large speculators have conviction about their forecasts in the unleaded gasoline market is presented in table 4.17.

Consistent with results from the crude oil market, the results shown in table 4.17 depict the net open interest position of large hedgers as a significant, perverse forecast of direction and magnitude of subsequent price changes. That is, hedgers' largest short (long) position occurs most often when the price increases (decreases) by the greatest amount. Furthermore, the large hedger's inferior forecast ability is again consistent across all four tranches.

Large speculator results in the unleaded gasoline market systematically reject the null hypothesis of no market timing ability. Of particular interest is the finding that the only tranche without statistical significance is the one with the greatest likelihood of type II error effect.
Table 4.17--Forecast Conviction For Unleaded Gasoline Using OLS regressions, by Observation Period.

Model Form: $\Delta R_{t,t-1} = \alpha_t + \beta_t \cdot NETPOS_{t,t} + \varepsilon_{t,t}$.
Null Hypothesis: $\beta_{t,t} = 0$.

<table>
<thead>
<tr>
<th></th>
<th>TRADER$_{t,t}$</th>
<th>$\alpha_t$</th>
<th>$\beta_t$</th>
<th>P-value</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semimonthly</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan.86 to Sept.92</td>
<td>LARGE</td>
<td>-0.0001</td>
<td>-0.0142</td>
<td>0.032</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>HEDGER</td>
<td>[-0.364]</td>
<td>[-2.568]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LARGE</td>
<td>0.0017</td>
<td>0.00986</td>
<td>0.374</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>SPECULATOR</td>
<td>0.0320</td>
<td>0.972</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NONREPORTING</td>
<td>-0.0001</td>
<td>0.2516</td>
<td>0.016</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>TRADER</td>
<td>[-0.284]</td>
<td>[2.451]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Weekly</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct.92 to Dec.95</td>
<td>LARGE</td>
<td>-0.0007</td>
<td>-0.0107</td>
<td>0.000</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>HEDGER</td>
<td>[-1.825]</td>
<td>[-3.562]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LARGE</td>
<td>-0.0007</td>
<td>0.0144</td>
<td>0.000</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>SPECULATOR</td>
<td>[-1.767]</td>
<td>[3.389]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NONREPORTING</td>
<td>-0.0004</td>
<td>0.0199</td>
<td>0.018</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>TRADER</td>
<td>[-1.258]</td>
<td>[2.623]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ten-Year</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan.86 to Dec.95</td>
<td>LARGE</td>
<td>-0.0004</td>
<td>-0.0114</td>
<td>0.000</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>HEDGER</td>
<td>[-1.374]</td>
<td>[-4.289]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LARGE</td>
<td>-0.0002</td>
<td>0.0124</td>
<td>0.011</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>SPECULATOR</td>
<td>[-0.838]</td>
<td>[2.975]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NONREPORTING</td>
<td>-0.0003</td>
<td>0.0224</td>
<td>0.000</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>TRADER</td>
<td>[-1.020]</td>
<td>[3.751]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Biweekly</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan.86 to Dec.95</td>
<td>LARGE</td>
<td>-0.0004</td>
<td>-0.0134</td>
<td>0.000</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>HEDGER</td>
<td>[-1.117]</td>
<td>[-4.666]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LARGE</td>
<td>-0.0001</td>
<td>0.0132</td>
<td>0.025</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>SPECULATOR</td>
<td>[-0.424]</td>
<td>[2.637]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NONREPORTING</td>
<td>-0.0002</td>
<td>0.0254</td>
<td>0.000</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>TRADER</td>
<td>[-0.817]</td>
<td>[3.792]**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: T-ratios are given in brackets [ ].
*Significant at the 0.05 level. **Significant at the 0.01 level.
Recall in the crude oil and heating oil markets a forecast interval explanation was examined because results for tranches aggregating data over a longer period were inferior to results for the weekly tranches. Though no such evidence appears in the unleaded gasoline market, a comparison of Chow tests for the ten-year and biweekly data series lends additional support to the conclusions reached for the previous contracts.

The first Chow test split the ten-year sample at the changeover point (semimonthly to weekly) to test for stationarity. Results for unleaded gasoline \( (F_{(160,167)} = 1.099) \) reject the notion of nonstationarity and suggest instead that the data series remained relatively constant over the ten-year period. A second Chow test was conducted on the biweekly data set to see whether the stationarity would remain if no measurement interval change occurred. Recall that evidence supporting the time-period hypothesis requires the Chow tests have similar statistics; that is, both must be significant. Evidence supporting the measurement interval hypothesis requires the biweekly Chow tests, contrary to the ten-year Chow tests, be insignificant.
Comparing results from the two tests I find even greater support for the measurement interval hypothesis proposed for the crude oil and heating oil markets, as forecast power appears to be relatively constant over time in the unleaded gasoline market. The null hypothesis of stationarity over the biweekly measurement interval cannot be rejected \( F_{(160, 84)} = 0.994 \).

Taken together, the results presented in table 4.17 coupled with the Chow tests are consistent with the notion that large speculators, compared to large hedgers, have superior forecasting skills. Again this observation is generally consistent with results appearing in tables 4.14 and 4.15.

Interestingly, the nonreporting trader’s position appears to be the most uniform and significant, as it was in both the crude oil and heating oil futures markets. Note the model and coefficient tests are significant at the 0.01 level or better for all four tranches.

However, also similar to the crude oil and heating oil analyses, this observation is inconsistent with economic theory. No empirical or theoretical examinations to date
have cast the nonreporting traders as having a market advantage compatible with the large speculators. On the contrary, the conventional notion is that they are simply following the advice of dealers or observing the position of the large speculator and adjusting their position accordingly.

To address this issue for the unleaded gasoline market, I once again determine whether the positions of the three traders are independent. That is, given that the large speculator's position is observed, what if any additional information can be extracted from the positions of the large hedger and the nonreporting trader?

Multivariate Tests

A priori, based on the results contained in tables 4.14 and 4.15, I expect to find evidence supporting the existence of asymmetrically informed traders in the unleaded gasoline market. I expect the evidence to demonstrate, with respect to the direction of price movement, that the motivation for trade by large speculators is determined independent of other traders. I therefore expect negative
coefficients for large hedgers and positive coefficients for large speculators, both statistically significant.

Again, multivariate logistical regression results are compared to those from their univariate counterparts. That is, the fine points in tables 4.14 and 4.15 are contrasted with those in table 4.18. The interpretation of the coefficients from the logistical regressions in tables 4.14 and 4.15 and the corresponding coefficients in table 4.18 are similar. Consequently, they indicate the increase or decrease in the odds ratio given that each trader's position is determined independent of the position of other traders.

Consistent with crude and heating oil, results from multivariate logit regressions (table 4.18) are contrary to those from the univariate logit regressions (tables 4.14 and 4.15). The large speculator's position, viewed together with other traders, appears not only to add nothing to the forecast of the direction of subsequent price changes but in fact to reduce the likelihood of an accurate forecast. Thus large speculators may be seen as traders who, acting on their information set alone, also generate a perverse forecast, though not to the extent of the large hedgers.
### Table 4.18--Multivariate Logit Regressions For Unleaded Gasoline

Model Form: $RET_{t,T} = \alpha_t + \beta_H^H HE_{t,T} + \beta_S^S SP_{t,T} + \epsilon_{t,T}$.  
Null Hypothesis: $\alpha, \beta^H$ and $\beta^S$ Jointly = 0.

<table>
<thead>
<tr>
<th></th>
<th>$\alpha_t$</th>
<th>$\beta_H^H$</th>
<th>$\beta_S^S$</th>
<th>$\chi^2$ STAT</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semimonthly</td>
<td>0.4039</td>
<td>-0.6240</td>
<td>0.0445</td>
<td>3.545</td>
<td>162</td>
</tr>
<tr>
<td>Jan.86 to Sept.92</td>
<td>[0.944]</td>
<td>[-1.324]</td>
<td>[0.099]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekly</td>
<td>0.2869</td>
<td>-0.7685</td>
<td>-0.1411</td>
<td>4.074</td>
<td>169</td>
</tr>
<tr>
<td>Oct.92 to Dec.95</td>
<td>[0.419]</td>
<td>[-1.182]</td>
<td>[-0.2109]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ten-Year</td>
<td>0.3729</td>
<td>-0.7356</td>
<td>-0.0817</td>
<td>8.165*</td>
<td>331</td>
</tr>
<tr>
<td>Jan.86 to Dec.95</td>
<td>[1.031]</td>
<td>[-1.993]*</td>
<td>[-0.223]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biweekly</td>
<td>0.2048</td>
<td>-0.6695</td>
<td>0.2524</td>
<td>8.844*</td>
<td>246</td>
</tr>
<tr>
<td>Jan.86 to Dec.95</td>
<td>[0.527]</td>
<td>[-1.637]</td>
<td>[0.632]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Based on results from the univariate logit regressions, the alternative hypotheses are: $\beta_H^H < 0$ and $\beta_S^S > 0$ for the hedger and speculator, respectively. T-ratios are given in brackets [ ].

*Significant at the 0.05 level. **Significant at the 0.01 level.

Again the importance of the insignificant intercepts is noted and thus, the argument that nonreporting traders are simply free riders seems to have strong support in the unleaded gasoline market.

Generally, the results for the unleaded gasoline market are inconsistent with any form of backwardation equilibrium process. Again, as with the crude oil findings, no explanation of the superior performance of the nonreporting...
trader is satisfying or consistent with the standard statistical and theoretical arguments. Moreover, based on the multivariate logit the nonreporting trader's position is most certainly inconsequential. Discussion of this and other issues will be postponed until Chapter V. For now, the reader is again directed to the results obtained from the multivariate OLS tests of forecast conviction, presented in table 4.19.

Immediately apparent is some discrepancy in the results reported in table 4.19 and those from multivariate logit and univariate OLS regressions. Whereas the large speculator appeared to have significant forecast conviction in three of four tranches in table 4.16, that position now appears to be neither independently determined nor a significant a priori forecast variable. That is, the large speculator's position, viewed simultaneously with those of other traders, appears to add nothing to the information set concerning the magnitude of price movement.

Even more intriguing are the results for the large hedger and nonreporting trader. Measured independently of other traders, the large hedger consistently produced a
Table 4.19--Multivariate OLS Regression Results for Unleaded Gasoline

<table>
<thead>
<tr>
<th></th>
<th>( \alpha )</th>
<th>( \beta^h )</th>
<th>( \beta^s )</th>
<th>F-STAT.</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semimonthly</td>
<td>-0.0002</td>
<td>-0.0240</td>
<td>-0.0185</td>
<td>2.947</td>
<td>162</td>
</tr>
<tr>
<td>Jan.86 to Sept.92</td>
<td>[-0.417]</td>
<td>[-2.151]*</td>
<td>[-0.981]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekly</td>
<td>-0.0007</td>
<td>-0.0109</td>
<td>-0.0003</td>
<td>4.075*</td>
<td>169</td>
</tr>
<tr>
<td>Oct.92 to Dec.95</td>
<td>[-1.791]*</td>
<td>[-1.331]</td>
<td>[-0.028]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ten Year</td>
<td>-0.0004</td>
<td>-0.0185</td>
<td>-0.0116</td>
<td>6.156**</td>
<td>331</td>
</tr>
<tr>
<td>Jan.86 to Dec.95</td>
<td>[-1.340]</td>
<td>[-2.503]**</td>
<td>[-1.083]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biweekly</td>
<td>-0.0004</td>
<td>-0.0222</td>
<td>-0.0150</td>
<td>6.453**</td>
<td>246</td>
</tr>
<tr>
<td>Jan.86 to Dec.95</td>
<td>[-1.110]</td>
<td>[-2.747]**</td>
<td>[-1.174]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The net open interest positions of the three trader types always sum to zero. Therefore, by construction, the intercept (\( \alpha \)) represents nonreporting traders. Based on results from univariate OLS regressions, the alternative hypotheses are: \( \beta^h < 0 \), \( \beta^s > 0 \) and \( \alpha > 0 \) for the hedger, speculator and nonreporting traders, respectively. * and ** denote significance at the .05 and .01 levels, respectively. T-ratios in [ ].

perverse forecast of the direction (tables 4.14 and 4.15) and magnitude (table 4.17) of the price change. Nonreporting traders, on the other hand, demonstrated both forecast consistency and conviction, systematically taking a position on the correct side of the market's movement and adjusting the size of their commitment in keeping with the magnitude of the subsequent price change.
However, when the positions of other traders are held constant (table 4.19), the significance of the position of the nonreporting trader (α) nearly vanishes. In the only instance (the weekly tranche) the nonreporting trader’s position is significant, the forecast coefficient’s sign indicates the position taken is generally on the wrong side of the ensuing price change. Consistent with the previous two contracts examined, the large hedger’s position, once again represents a significantly perverse forecast.

Therefore, considering the magnitude as well as the direction of the price change and given all traders are viewed simultaneously, the large hedger’s position seems to be the only consistently significant indicator of the market’s movement, and as before, it is a severely flawed indicator. Unexpected as this is, as in the heating oil market, the varied results across the statistical tests performed and to a lesser degree across the four tranches may be explained without violating the conventions of accepted theory.

Nonreporting traders appear to be free riders, as they are on right side of an impending market movement only
when information on other traders' positions is available. Large speculators' forecast ability seems to be most significant for large price movements, though admittedly sample sizes may reduce the significance of the semimonthly and weekly tranches. Finally, as in the heating oil market, large hedgers are systematically on the wrong side of unleaded gasoline market price changes and to a greater degree as the price change increases in magnitude.

Two facts mentioned in the heating oil analysis are still unclear. That is, why do large hedgers and nonreporting traders continue to have the most significant forecast coefficients? Is the positive return awarded systematically to large speculators and nonreporting traders due to demand for risk premia, information assimilation inefficiency or some other form of trading anomaly? Unfortunately, as before, satisfactory answers to either question will require additional research. Therefore, I will comment on these extensions in chapter V. For now I examine the potential effects of seasonal demand fluctuations in the unleaded gasoline market.
Seasonality

Seasonal bias in the crude oil market was minimal due to the continuous and relatively constant-volume nature of the production process. Seasonal bias in the heating oil market, on the other hand, was anticipated in the monthly production levels but was found to be fully anticipated by the participants in the market. To see whether participants in the unleaded gasoline market anticipate seasonal demand shifts, I extend the crude and heating oil seasonal analyses to unleaded gasoline futures traders.

Spring and early summer months foresee a potential shift in demand accompanying unusually low or high demand for unleaded gasoline during the vacation months. Accordingly, the crude oil refining process is again altered, as reallocation occurs from heating oil to unleaded gasoline. If expectations are realized concerning the demand for unleaded gasoline, the price is relatively stable. If, however, the quantity demanded moves up (down) unexpectedly the short-run price may rise (fall) significantly, thus producing a reaction in the futures market. Therefore, ex ante, I anticipate that trading activity and returns to
traders are concentrated in the months from March through July.

The details reported in tables 4.20A and 4.20B confirm the suspicion that seasonal variance in the unleaded gasoline futures market is significant and yet fully anticipated in the traders' positions in the market. Model A is used to identify any months when the net open interest position of the three traders is materially different from others. That is, model A addresses the question: Does the time of the year explain the trader's commitment in the market? Model B addresses the question of whether the trader's position is sufficient to capture any seasonal component extant in the return series.

In contrast to the heating oil market, the results from model A suggest that seasonal patterns in the unleaded gasoline market are limited to the large hedger and speculator. That is, the nonreporting trader's position appears to vary over the entire year. Even though the large hedger's position appears to be sensitive to increased summer demand, the large hedger has a significantly short January position.
Table 4.20A--Seasonal OLS Regression Results for Unleaded Gasoline from January to June, by Trader Type, Comparing Model A to Model B

<table>
<thead>
<tr>
<th></th>
<th>LARGE HEDGER</th>
<th></th>
<th>SPECULATOR</th>
<th></th>
<th>TRADER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>F-STAT(A)</td>
<td>R^2(A)</td>
<td>F-STAT(B)</td>
<td>R^2(B)</td>
</tr>
<tr>
<td>DJAN</td>
<td>331</td>
<td>8.117**</td>
<td>.2210</td>
<td>2.267**</td>
<td>.0847</td>
</tr>
<tr>
<td>DFEB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DMAR</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DAPR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DMAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DJUN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \alpha_1^A = -0.0541 \quad [-4.364]^* \]
\[ \beta_1^A = -0.0350 \quad -0.0451 \quad -0.0798 \quad -0.0759 \quad 0.0411 \]
\[ \alpha_1^B = -0.0001 \quad [-0.232] \]
\[ \beta_1^B = -0.0029 \quad -0.0005 \quad 0.0003 \quad -0.0009 \quad -0.0015 \]
\[ \beta_1^B = -0.0129 \quad [-4.504]^* \]

\[ \alpha_1^A = 0.0362 \quad [3.601]^{**} \]
\[ \beta_1^A = 0.0063 \quad 0.0045 \quad 0.0325 \quad 0.0396 \quad -0.0294 \]
\[ \alpha_1^B = 0.0000 \quad [0.115] \]
\[ \beta_1^B = -0.0025 \quad -0.0000 \quad 0.0010 \quad -0.0004 \quad -0.0017 \]
\[ \beta_1^B = 0.0122 \quad [2.964]^{**} \]

\[ \alpha_1^A = 0.0178 \quad [2.794]^{**} \]
\[ \beta_1^A = 0.0286 \quad 0.0406 \quad 0.0473 \quad 0.0363 \quad -0.0117 \]
\[ \alpha_1^B = 0.0000 \quad [0.031] \]
\[ \beta_1^B = -0.0033 \quad -0.0011 \quad 0.0000 \quad -0.0010 \quad -0.0017 \]
\[ \beta_1^B = 0.0283 \quad [3.620]^{**} \]

Note: T-ratios are given in brackets [ ]. See footnotes 17 and 18 for model specifications.
*Significant at the 0.05 level. **Significant at the 0.01 level.
Table 4.20B--Seasonal OLS Regression Results for Unleaded Gasoline from July to December, by Trader Type, Comparing Model A to Model B.

<table>
<thead>
<tr>
<th>LARGE HEDGER</th>
<th>N</th>
<th>F-STAT(A)</th>
<th>R' (A)</th>
<th>F-STAT(B)</th>
<th>R' (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DJUL</td>
<td>331</td>
<td>8.117**</td>
<td>.2210</td>
<td>2.267**</td>
<td>.0847</td>
</tr>
<tr>
<td>DAUG</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DSEP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOCT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DNOV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DDEC</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

\[ \beta_h^A \]

<table>
<thead>
<tr>
<th>SPECULATOR</th>
<th>N</th>
<th>F-STAT(A)</th>
<th>R' (A)</th>
<th>F-STAT(B)</th>
<th>R' (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DJUL</td>
<td>331</td>
<td>8.319**</td>
<td>.1080</td>
<td>1.559</td>
<td>.0597</td>
</tr>
<tr>
<td>DAUG</td>
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<td>DSEP</td>
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</tr>
<tr>
<td>DOCT</td>
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</tr>
<tr>
<td>DNOV</td>
<td></td>
<td></td>
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<tr>
<td>DDEC</td>
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</table>

\[ \beta_h^B \]

<table>
<thead>
<tr>
<th>NONREPORTING</th>
<th>N</th>
<th>F-STAT(A)</th>
<th>R' (A)</th>
<th>F-STAT(B)</th>
<th>R' (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DJUL</td>
<td>331</td>
<td>15.808**</td>
<td>.3022</td>
<td>2.372**</td>
<td>.0882</td>
</tr>
<tr>
<td>DAUG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DSEP</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>DOCT</td>
<td></td>
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<tr>
<td>DNOV</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>DDEC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \beta_h^B \]

Note: T-ratios are given in brackets [ ]. See footnotes 17 and 18 for model specifications.

*Significant at the 0.05 level. **Significant at the 0.01 level.

Large speculators also seem to conform to the summer demand notion, concentrating their seasonal activity in four months from May to August. Interestingly they appear to take a position, in June through August, indicative of falling prices. However, the nonreporting trader continues to defy conventional explanation.
Statistically significant at the 0.05 level or greater for nine of twelve months, nonreporting traders are immaterial only during the months of June, July and August. The question emanating from this finding is: With whom are the nonreporting traders dealing during the months of October through December and February, since neither large hedgers nor large speculators appear to modify their positions significantly during those months? Happily however, concerns about the significance of these facts are mitigated by the results from model B.

Taking into account the net open interest position of the three traders, Model B indicates, as it did in the crude and heating oil markets, that if a trader is able to observe the position of the large hedger or speculator or that of the nonreporting trader, the month of the year has no additional explanatory power. Therefore, I conclude again that the annual calculation of dollar returns to a trading classification would, most likely, not be materially different from returns adjusted for seasonal variation in either the open interest position or the price series.
Dollar Returns

The systematically perverse forecast of the large hedger implies that the unleaded gasoline market, like the crude oil and heating oil markets, is bound by an information irregularity, some form of trading constraint or possibly a risk premium enticement to trade. Therefore, large hedgers are slow to react to new information and the market is inefficient, a regulatory barrier to free trade or other such constraint exists or the large hedger has superior information and agrees, by his/her position, to pay a small risk premium.

Importantly, unlike the results from the heating oil market analysis, the results from the multivariate tests did not support the notion of market timing ability in the large speculator's ex ante position in the unleaded gasoline market. Thus I cannot conclude that forecast power resides in an independently generated position taken by the large speculator.

However, consistent with the previous two analyses, the absolute power of the large speculator's position, based on the univariate tests, may contain valuable information.
The empirical question is again addressed: Can the uninformed investor profit from observing the position of the large speculator? If so, to what degree?

As with the crude oil and heating oil contracts, I test the information value of the large speculator's position by computing the dollar returns to a representative large speculator in the unleaded gasoline market in 1995. Recall that the representative trader is characterized as a trader who holds an equally weighted portfolio of all contract months trading on the NYMEX unleaded gasoline contract and does so throughout the entire year. The trader opens and closes his/her total position once each week, thus earning an average weekly dollar return.

Recall the univariate forecast conviction tests indicated large speculators take their largest positions when prices change by the greatest amount. Thus the representative speculator adjusts his/her total open interest position up 50 contracts for the first 1% increase (above 1%) and 100 contracts for each 1% thereafter, from a base of 150, in the net open interest of the large speculator category. Hence, if the total open interest in the large
speculator category is long 5%, the representative trader
would hold a 500-contract position, and so on.

Based on the above characteristics, the representa-
tive large speculator in 1995 held an average of 860
(rounded to the nearest 10) contracts per week, the maxi-
mum being 2,000 and the minimum zero. The average weekly
return to this hypothetical trader was a positive $25,170, a
much larger return than the hypothetical traders earned from
crude or heating oil. The maximum and minimum returns were
positive $377,790 and negative $190,000, respectively.

Given the initial margin requirements for unleaded gasoline
(table 3.6) of $2,025 per contract, the representative
trader would have been required to post an average of
$1,741,500 per week and a maximum of $4,050,000 in risk-free
interest-bearing securities. The maximum cash needed to
cover margin calls would have been $0. (As in the heating
oil market, from the beginning of 1995 the trader's credit
balance would have never fallen below $15,700.) In summary,
considering the position of the large speculator only, a

36 The average of 860 contracts is not large, since it rep-
resents approximately 3.7% of the average net open
interest of large speculators in 1995 and only .002% of
the average total open interest during that year.
A representative trader having $4.05 million dollars in treasuries, no transaction costs and no cash on hand would have made in excess of $1,283,670 from the large hedger's position in 1995.

To see if opportunities for profit exist when a trader is subject to round-trip transaction costs, consider the nonreporting trader with 5% of the weekly commitment of the large speculator above. This particular trader would have held an average of 43 contracts per week, with a maximum of 100 and a minimum of zero. The weekly average profit, before round-trip dealer transaction costs, would have been $1,258, and the trader would have needed $87,075 and $0 to cover the average initial and maintenance margins, respectively.

Unfortunately, encumbered by retail-level weekly transaction costs, the trader would have again paid in excess of $4,300 per week in round-trip trading costs.

---

37 Again footnote 21 applies if transaction costs are increased by as little as $8 per contract i.e. $30.

38 Again, dollar returns were calculated for the entire ten-year period under investigation with similar results.

39 It was not possible to use the 10% position adopted for crude oil and heating oil because the nonreporting trader's position would have exceeded the reporting limit of 150 contracts on several occasions in 1995.
resulting in an average weekly loss of $3,042. On a con-
tinuous trading basis, why small investors are motivated to 
trade is again unclear. However, if participation in the 
market is frequent enough and timed correctly, significant 
reductions in transaction costs may result, thus allowing 
limited opportunities for positive returns. Absent the cost 
breaks, profit potential for the nonreporting trader seems 
to be passed along to the promoting dealer!

In conclusion, I find no evidence in support of an 
asymmetrically informed unleaded gasoline futures market. 
Again, although the null hypothesis of the large speculator 
having no market timing ability is rejected by the univari-
ate logit and OLS tests, multivariate tests do not permit 
rejection of the null hypothesis but rather suggest that the 
unleaded gasoline market is informationally efficient and 
seldom rewards a large speculator or nonreporting trader for 
supplying speculative services.

More important, unlike the heating oil market the 
unleaded gasoline market yields evidence that the large 
hedgers' demand for speculative services is provided by
large speculators. This observation does conform to generally excepted theories of market organization.

Whether or not market efficiency or information symmetry exists, the inability to separate the effects remains an obstacle. Two observations that seem clear are: (1) Some form of motivation for the supply of speculative services is extant in the results, since large hedgers are net losers in the unleaded gasoline market. (2) The unleaded gasoline market appears to be more speculative than the heating oil market, owing to the higher degree of volatility evident in the price series.
CHAPTER V

CONCLUSIONS AND OPPORTUNITIES
FOR FURTHER RESEARCH

Chapter V has a twofold purpose. First, the chapter serves to summarize and conclude this investigation of the crude oil, heating oil and unleaded gasoline futures markets. Second, it serves to identify several unanswered questions that provide opportunities for extending or improving the research conducted herein.

The summarization process pulls together the varied findings for all three contracts and presents a coherent picture of the conclusions that are supported by the hypotheses tested. Thus conclusions are linked directly to the testable hypotheses identified in chapter III and follow, in like manner, the order of examination conducted for the separate commodities. Questions emanating from this research and remaining unanswered are then linked to proposed modifications in both the data set and the research design,
thus highlighting extensions that may result in some resolution of these important issues.

Forecast Consistency

I began the analysis of each futures contract by examining the a priori positions taken by large hedgers and speculators and nonreporting traders to see if any of their respective forecasts was consistently on the correct side of the subsequent change in market price. Two alternative tests, proposed by Henriksson and Merton (1981) and extended by Cumby and Modest (1987), were conducted for each trader, in each contract and across four tranches of the data set.

The tests of forecast consistency incorporated three testable hypotheses. $H_1$: Speculators, on average, have no greater ability to forecast the direction of price changes than hedgers. $H_2$: Forecast consistency did not change over the ten-year period examined. $H_3$: Model robustness is insensitive to measurement interval (i.e., semimonthly, weekly, combined or biweekly).

Considering the results for crude oil, given in tables 4.1 and 4.2, I am able to strongly reject the null
hypothesis of no market forecast ability and fail to reject both $H_2$ and $H_3$. Therefore, I conclude, based upon the Cumby-Modest (1985) paradigm alone, that large speculators appear to be superior forecasters. They were superior for the entire period under examination and their forecast power was not effected by subperiod analysis or the method of data aggregation.

The heating oil contract results are not as convincing. Tables 4.7 and 4.8 seem to be depicting a market whose evolutionary process has diminished the significance of the large speculator over time. Evidence of large speculator forecast consistency is far greater in the three tranches containing data from January 1986 to September 1992 than in the one remaining tranche. In addition, some evidence may indicate that increasing the holding period from weekly to biweekly reduces the significance of any a priori forecast.

Accordingly, the evidence shows a weak rejection of $H_1$ (no forecast ability) and stronger evidence supporting the rejection of $H_2$ (consistent intertemporal forecast ability) and $H_3$ (robust forecast consistency over various
methods of data aggregation). Therefore, I conclude, again based upon the Cumby-Modest (1985) paradigm alone, that evidence of an asymmetrically informed large speculator in the heating oil market was strong in the early years of trading, diminished over time and may be sensitive to holding period length.

Evidence that large speculators have consistent forecast ability in the unleaded gasoline market is on a par with that in the crude oil market. Although tables 4.13 and 4.14 indicate the results are mixed, I believe the reliability of the evidence in table 4.13 is suspect, given the probability of type II error in the estimations. Thus, on balance, the evidence seems sufficient to reject $H_1$ (large speculators are no better informed than other traders) and $H_3$ (forecast consistency is robust over various methods of data aggregation) and insufficient to reject $H_2$ (large speculators have constant intertemporal forecast ability). I conclude, therefore, that the preponderance of evidence, based upon the Cumby-Modest (1985) paradigm alone, supports the notion that large speculators in the unleaded gasoline
market are asymmetrically informed and thus consistently predict the direction of subsequent price changes.

Thus far, evidence of the large speculator's market direction forecast power seems compelling for all three contracts. However, the significance of the large speculator's position is also the most unstable of the three trader types. For the three contracts and four tranches of each tested, the large hedger's net open interest position is a systematically perverse forecast of subsequent price changes, statistically significant at the 0.01 level in 17 of 24 tests and at the 0.05 level for the other seven. Moreover, in all but one case the nonreporting trader's position is statistically significant at a level equal to or greater than that of the large hedger, although on the correct side of the subsequent price change.

Taken together, the findings suggest that the net open interest position of large hedgers is offset to their detriment by large speculators and nonreporting traders. Thus large hedgers may be paying a fee to procure a supply of speculative services, though there is no way to prove this with the data used for this study. However, among
competing probable explanations, this seems a particularly plausible conclusion considering the results from the forecast conviction (magnitude) tests summarized next.

Forecast Conviction

As pointed out in an earlier discussion\(^1\) any true test of superior forecast ability must include consideration of the magnitude of the subsequent price change. To facilitate the interpretation of tests designed to include magnitude considerations, three testable hypotheses are employed. \(H_3\): Model robustness is insensitive to measurement interval (i.e. semimonthly, weekly, combined or biweekly). \(H_4\): Forecast conviction did not change over the ten-year period examined. \(H_5\): The magnitude of a trader's position and the size of the ex post returns are independent.

Tables 4.3, 4.9 and 4.15 depict the results from incorporating the magnitude issue into forecast power tests for crude oil, heating oil and unleaded gasoline, respectively. In the main, evidence is pervasive across the three

\(^{1}\) See footnote 9 in chapter II.
contracts that large speculators exhibited forecast conviction; that is, they took their largest positions at times when prices changed by the greatest amount.

However, each contract contained one tranche (semimonthly for crude oil, biweekly for heating oil and semimonthly for unleaded gasoline) that portrayed the large speculator as insignificant. Sorting out this discrepancy in the findings is, conveniently, limited to the large speculator, since the large hedger and nonreporting trader positions were systematically significant for the four tranches of the three contracts tested.

Considering the results and hypotheses tests individually, I find sufficient evidence to conclude that large speculators in the crude oil market are indeed superior forecasters only marginally affected by increases in the holding period over which return is measured. I consequently find strong evidence rejecting $H_5$, and to a lesser degree, $H_3$. However, evidence is insufficient to reject $H_4$, since as measured by comparative Chow tests, no paradigm shift is apparent.
Results from the heating oil market were more consistent than those from the crude oil market. In point of fact the heating oil results supported the rejection of all three hypotheses. Specifically, large speculators appear to have significant forecast conviction, which decays both over time and as the return aggregation period increases.

Large speculators in the unleaded gasoline market also appear to have conviction concerning the magnitude of subsequent price changes. However, in this case, the significance of their forecast conviction actually appears to increase over time\(^2\) and is consistent whether the holding period return is calculated weekly or biweekly. Therefore, the evidence supports the rejection of \(H_4\) and \(H_5\) and fails to support the rejection of \(H_3\).

Aggregating the results, I conclude, again based upon the Cumby-Modest (1985) paradigm alone, that the net open interest position of large speculators in the three markets is a significant a priori forecast of not only the direction

\(^2\) Recall from chapter IV that Chow tests seemed to indicate that some form of paradigm shift may have occurred as the market matured, although no attempt was made to identify the specific source of the shift.
but the magnitude of subsequent price changes. Therefore, the petroleum futures markets appear, to this point, to be asymmetrically informed. Moreover, the significance of the net open interest positions of large hedgers and nonreporting traders provides further support of this conclusion, particularly given the systematic nature of the hedger and small trader results.

Giving due consideration to the importance of the large hedger and speculator in futures market efficiency, the role of the nonreporting trader may deserve special attention. Several unresolved issues have emanated from the tests thus far. For example, a satisfactory explanation of the large speculator's idiosyncratic behavior across contracts and tranches tested will require additional data. The same is true for the large hedger's systematically perverse forecast of the direction and magnitude of subsequent price movement.

These results, as pointed out in chapter IV, are subject to a variety of explanations, including but not limited to information inefficiency, a risk premium backwardation equilibrium or some form of trading constraint.
However, the nonreporting trader's position still presents a real enigma.

The puzzling issue is this: How does the nonreporting trader's net open interest position yield the most significant a priori forecast of the direction and magnitude of ensuing price changes? Though the nonreporting position has not been addressed directly in theory or previous empirical research, I believe three possible explanations exist for nonreporting traders' seemingly remarkable performance in the petroleum futures markets. First, nonreporting traders are simply free riders, observing the positions of other traders (the large speculator) and adopting a position in kind. Second, they are not speculators at all but rather a collection of small hedgers offsetting large hedgers and reducing the true demand for speculative services. Third, they may possibly be trading on the advice of dealers, who may be endowed with superior information themselves.

Though these competing, yet not mutually exclusive, notions may be impossible to unravel, the multivariate analyses of the three contracts hint at the more credible
explanations. More importantly, the multivariate tests illustrate the limitations of relying solely on the Cumby-Modest (1985) market timing paradigm when the number of a priori forecast variables exceed one (1).

Multivariate Analysis

Inferences drawn from results obtained employing univariate models are subject to what I have termed the independent forecast assumption and thus, may lead to spurious interpretations. Therefore, I employ a multivariate extension of both the logit and OLS regression models to test null hypothesis \( H_6 \): The large speculator's position, viewed simultaneously with other traders, does not provide a superior forecast. That is, I test against the alternative hypothesis that the net open interest position of speculators contains information not available in the positions held by hedgers or nonreporting traders.

Collectively, the results from multivariate logistical analysis of the three commodities (shown in tables 4.4, 4.10 and 4.16) indicate that the previously heralded forecast power significance of not only the nonreporting trader
but also the large speculator is nonexistent. Specifically, the large speculator’s information set appears to be no better than that of a trader whose choice of position is randomly determined.

This is clearly true in the crude oil and unleaded gasoline markets, though some evidence of direction forecast ability remains in the heating oil market. The position of the large hedger is consistently a significantly aberrant forecast in the crude oil market. However, in the heating oil and unleaded gasoline markets that forecast power appears to be indistinguishably different from zero.

As for the nonreporting trader, the notion of a collection of small hedgers and/or dealer advice may be prevalent, since the perverse forecast of the large speculator appears to lack information available to the nonreporting trader. In the heating oil and unleaded gasoline markets the most likely explanation of the insignificant result is that of the free rider. That is, when nonreporting traders take a position in either of these two markets without the signal provided by the large specu-
lator or hedger's position, they do so with no hope of prof-
iting, or of losing, for that matter.

To make matters worse, consolidated results from the
multivariate OLS magnitude tests (shown in tables 4.5, 4.11
and 4.17) suggest that large speculators and nonreporting
traders proffer an independently determined forecast of the
direction and magnitude of an ensuing price change that,
when significant, is as perverse a forecast as that of the
large hedger. Thus, the multivariate evidence mitigates any
possibility that the petroleum futures markets are asymmet-
rically informed, inefficient and/or composed of irrational,
risk-neutral investors. The one unwavering factor in all
three markets is the statistically significant errant net
open interest position of the large hedger.

Relying solely on tranches with sufficient observa-
tions (i.e. ten-year and biweekly) to minimize possible data
constraints, large speculators and nonreporting traders
observing the long or short position and relative size of
the large hedger's position would appear to have the ability
to earn a positive return. However, this is only the case
when large speculators and nonreporting traders pay no round
trip transaction costs. Therefore, I conclude that, the multivariate results have uncovered an entirely unexpected and unresolved set of issues and the preponderance of evidence supports a symmetrically informed petroleum futures market. That is, the evidence supports the notion that the large speculator's a priori net open interest position provides no forecast of the direction and magnitude of subsequent price changes. This notion is further tested by adopting a dollar return trading rule. However, before the dollar return potential of a trading strategy based on the large speculator's position is examined, the informational significance of seasonal variation is discussed.

Seasonal Analysis

To capture potential seasonal variance in the net open interest positions of traders in crude oil, heating oil and unleaded gasoline, two hypotheses are examined individually and then compared. The first null hypothesis tested is $H_7$: The trader's position in the market is invariant to the time of year. Seasonal patterns observed in the results from the first test are then compared to regressions employ-
ing the a priori position of each trader to determine whether traders have already considered the seasonal patterns in their respective net positions, long or short, in the market. This leads to the second hypothesis examined in a follow-up test, $H_8$: The trader's ability of forecast the direction and magnitude of future price changes is unaffected by seasonal shifts in demand.

For all three markets and traders the results confirmed prior expectations. Crude oil results from the first test indicated minimal seasonal variation to be dealt with by traders. Unleaded gasoline results identified spring, summer and some winter variation in trader positions. Heating oil results corroborated variation during the fall and winter months with some significance in late summer and late spring. Therefore, sufficient evidence was found to reject $H_7$ for heating oil and unleaded gasoline but insufficient evidence caused a failure to reject $H_7$ for the crude oil market.

Incorporating the net open interest of the respective traders in the second test limited the significance of the time of year in the heating oil market to January and Febru-
ary and in the unleaded gasoline market to February only. Crude oil seasonality issues disappeared entirely when the traders' positions were taken into account. I, therefore, conclude that insufficient evidence exists to reject $H_8$ and accordingly find no need to consider seasonality in the computation of dollar returns to large speculators.

Transaction Costs and Dollar Returns

Based on the direction and magnitude results, both univariate and multivariate, a simple trading rule strategy was proposed: Do as the large speculator does. Two conclusions emanate from this test: (1) The dollar-return potential for small traders, constrained by transaction costs, is substantially below zero. (2) The excess value of a publicly available information set is less than or equal to zero, supporting the notion that the petroleum futures market is efficiency. Two testable hypotheses that arise for this examination are: $H_9$: Transaction costs are an insignificant component in petroleum futures market trading activity. $H_{10}$: Large speculators are net losers in the petroleum futures market.
In light of the results from the individual market analyses, \( H_9 \) is out-and-out rejected and \( H_{10} \) is not. The representative large speculator appeared to profit significantly from this strategy in all three markets but did so without transaction cost requirements. Once encumbered by wholesale level transaction costs, the large speculator, trading continuously, would have no incentive to supply speculative services to the petroleum futures market. In addition, true small traders were also systematically unable to generate a positive return net of transaction costs.

**Summary Remarks**

A review of the empirical results obtained from this investigation have painted a consistent picture of traders and trading motivations in three petroleum futures markets. Though positive returns appear to be awarded, they are apparently significant only in the absence round-trip transaction costs. Moreover, the nonreporting trader's position in the market seems for the most part to be determined either as a result of an advisor's (dealer's) forecast or as a free rider.
Of particular importance is that the trader appearing to pay the highest premium for participation in the three markets is the large hedger. This observation is in stark contrast to the results obtained by Hartzmark (1991). Moreover, the exact explanation of this finding remains an open question.

Four plausible explanations of systematic returns to large speculators have been discussed previously in this paper. The first two, risk premiums and asymmetric information, have been tested and reviewed widely in the literature, the latter being the focus of this investigation. However, market inefficiency and regulatory or other trading constraints may also offer valid explanations. Regardless of which of the four explanations seems most plausible, the evidence presented in this investigation suggests additional research is warranted on all four fronts.

For example, that large speculators are motivated to trade because of their superior forecasting skills, a function of an extraordinary information set, seems unlikely. Multivariate direction and magnitude tests characterize the
large speculator, at best, as symmetrically informed with other traders. On the other hand, market inefficiency and regulatory or other barriers to trade are equally difficult tenets to support.

In the first place, I know of no regulation or other barrier to trade that would cause the large hedger to more often than not take a position on the wrong side of subsequent price movement and to do so with a commitment that increases with the size of the subsequent change. Second, if the petroleum futures market is informationally efficient, the large hedger is in possession of the same information as the large speculator and fails to react quickly enough to avoid a loss or large hedgers in the petroleum futures markets are irrational.

Embracing the notion that large speculators are invariably able to discern the economic impact of new information faster than large hedgers has serious implications for proponents of efficient markets. On the other hand, if the irrationality supposition has merit, then I would expect from time to time in the three markets that large hedgers would have been on the correct side of market
drift, thus causing the results to vary, at least slightly. This was never the case. One explanation, however, conforms with theory and the results, and though it is unverifiable with the data available for this study, it seems to have the greatest merit.

It may be that the petroleum futures market is dominated by a superiorly informed large hedger who is willing to advance a premium to motivate the supply for speculative services. This is not to say that a backwardation equilibrium exists, for if the large speculator and nonreporting trader pay transaction costs the premium disappears. The rationale for such a scenario is that leverage risk, extant in the large hedger's income statement, is reduced, and balance sheet estimates of reserves are stabilized. Moreover, this may be a zero-sum game for the large hedger, since spot market gains may equal or exceed risk premiums paid in the futures market. Of course additional research is needed to verify or condemn the aforementioned hypothesis and to address the host of other questions emanating from this study.

\(^3\) Recall this was the case for both the large speculator and the nonreporting trader.
Research Limitations and Extensions

Most, if not all, of the discontinuities and complexities identified previously in this research are likely to be attributable to data constraints. But the accuracy and robustness of the data analyzed also resulted in significant findings and provided a valuable collection of issues and insights requiring further investigation.

Additional data that would strengthen and refine the analysis of the information content impounded in the net open interest positions of traders includes contemporaneous spot price data for all contracts, the contents of the confidential files of the Commodity Futures Trading Commission on individual trader commitments and detailed actual round-trip transaction cost data identified by trader. In addition, daily commitment of trade information would permit finer aggregations of the intertemporal return series. Though the possibility of obtaining even part of this laundry list of data may be slight, owing to issues of accuracy, access and cost, in each instance the additional data could be used to address the larger issues left unresolved in this study.
For example, accurate spot price data would permit an examination of the true cost to large hedgers\(^4\) in the futures market and allow the fees paid in the futures market to be divided into forecast power and risk premium components.\(^5\) Moreover, coupled with the confidential files of the CFTC, spot price data would help explain the paradigm shifts that seem to have occurred in the heating oil and unleaded gasoline markets and, further, explain why the large speculator in the heating oil market is relatively immaterial in meeting an apparently growing demand for speculative services in that market. In addition, the CFTC files alone would aid in discriminating between the free rider and the migration hypotheses proposed for the non-reporting trader, permit an extensive investigation of the idiosyncratic issues identified across markets and empower tests utilizing shorter return horizons.

Finally, transaction cost data, whether obtained by survey, examination of dealer documentation or some other source, are sure to modify the small trader's return poten-

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\(^4\) Net of contemporaneous gains in the spot market.

\(^5\) Specifically, I envision a comparison of results from the methodologies employed in this investigation with those
tial and, therefore, motivation to trade. Heretofore ig-
nored, round-trip transaction costs appear to be an
important component in any true test of an efficiently oper-
ating futures market.

utilizing Fama and French's (1987) dissection of the basis
into forecast power versus risk reduction premiums.
REFERENCES


