Future Spreads: Theory and Praxis

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Abstract

Many professional traders, hedgers, and institutional investors utilise spread trading to engage in the futures market. Most of the literature dedicated to futures spreads was published between the late 1970s and early 1990s, and has partly lost its relevance. This is because of the emergence of new financial instruments, changed relationships and regulations within the financial industry and, furthermore, the advent of round-the-clock electronic trading which has increased the number of players and liquidity of futures markets many times over (Hull, 2006). Hence, there is a need to explore futures spreads from a contemporary perspective.

The six publications which form the basis of this PhD examine futures spreads from different perspectives. They address questions surrounding spreads systematisation, classification and analysis. The thesis develops a new framework for futures spreads analysis which has practical application as an investment tool.

This thesis makes a contribution to theory and practice in the area of futures spreads. The research results could find wide application in the futures industry and of interest to the research community.

Acknowledgments

I would like to thank Professor Nada Kakabadse, who supervised the process of writing this PhD by publication integration document. The help and guidance I received during the writing process is much appreciated and gratefully acknowledged. Her contribution to Chapters Three and Four in the form of very valuable thoughts, advice and insights deserves special mentioning.

I am very thankful to my wife Irina. She supported me at all stages of this difficult and demanding research and writing process. Her encouragement helped me to withstand all the challenges on this path.

I am also thankful to my parents and especially my mother who always wanted me to become a highly educated person.

I would like to thank my grandmother for being a live example of human spiritual strength and readiness to help other people.

Outputs and Dissemination from this Thesis

Refereed Articles

Perchanok, K. and Kakabadse, N. (2012) Causes of Market Anomalies of Crude Oil Calendar Spreads: Does Theory of Storage Address the Issue? *Journal of Futures Markets* (under review).

Perchanok, K. and Kakabadse, N. (2012) Futures Spreads Trading: A Framework for Effective Analysis. *The Journal of Derivatives* (under review).

Contents

Chapter One: Introduction

1.1 Introduction

The research presented here was conducted between 2008 and 2012. This thesis is based on two published books and four published articles dated between 2011 and 2012. The introductory chapter presents the research aims, delineates the scope of this research, establishes its prime objectives and outlines the structure of this document.

1.2 Study Justification

After I became interested in this subject of futures spreads, I tried to find all available literature in this regard. To my surprise, only a few books and articles were available that were devoted to this topic, as compared to the thousands of books that are dedicated to the stock market. It is a negligibly small number for such a broad subject. Most of the literature on futures spreads was published during the period extending from the late 1970s to the early 1990s and are partially no longer relevant today. This is because many new futures contracts have appeared, which had not existed at that time, and many of the fundamental factors and interrelations have changed. Moreover, round-the-clock electronic trading has appeared, as a result of which the number of participants has grown and the futures market liquidity has repeatedly increased (Hull, 2006). It became clear to me that a need existed for taking a look at the subject of futures spreads from a modern point of view.

There are several publications dedicated exclusively to the seasonal analysis of spread behaviour and its use in formulating trading strategies, which does not constitute the full investigation of the topic as I saw it. In my view, it was necessary to explore a more comprehensive approach to the question of using spreads as an investment tool.

Ultimately, it became clear that even simple tasks such as structuring and plotting graphs are not so easy in the case of spreads. Awareness of the problems described above served as the principal motive for undertaking the research.

1.3 Study Context

There are various financial market segments. The derivatives market is one of these segments, and a very large one. The futures market is a part of the derivatives market. There are many futures, which have different underlying asset classes (Moles, 2004). I concentrated on the study of futures spreads based on various types of commodities and equity indices. There is a wide variety of different commodities that are traded in futures markets. By the volume of transactions, oil and gold futures are principals in these groups. However, I focused my study mainly on oil and metal futures. The main difference between these two markets and the stock market is that the price is formed as a result of supply and demand balancing and not by an investor's assessment of the company's performance. Given the huge turnover volume of the petroleum and precious metals markets, the price manipulation using insider information is almost not possible. However, these markets are the subject to the application of large speculative capital, which also has notable impact on the outright prices. At the same time, a significant number of speculators utilise in their work futures spreads (Schap, 2005). This has greatly increased spreads volatility in recent years, increasing both the potential risks and opportunities, offered by this tool. This makes, in my opinion, futures spreads an interesting and important subject to research.

1.4 Theoretical Foundation and Research Relevance

The work involved reviewing a wide variety of literature dedicated not only to futures spreads, but also to futures pricing, fundamental and technical analyses, and capital management.

Traders deal in futures contracts on a futures exchange. The exchange offers traders, and via them, the public, a place to buy and sell contracts. Working (1962) identified three "chief merits" of futures markets which are in the public interest on three accounts. First, futures markets reduce price variability in cash markets. Second, futures markets provide "usefulness to handlers of the commodity". Third, futures markets provide market information concerning prices to the public (Working, 1953).

Fama and French (1988) used the theory of storage model to explain the behaviour of futures prices in industrial commodities such as steel, copper and zinc. They showed that the model can predict the behaviour of metal prices, including normal backwardation. However, this theory did not allow the assessment of the futures which are based on various financial assets including stocks, stock indexes and bonds. Numerous authors (Duffie, 1989; Hull, 2006) have discussed financial futures pricing models. Pricing of futures based on fixed income securities is an even more complex question which Fabozzi (2005) addresses.

Practical application of spreads assumes understanding of the mechanics of their functioning which is based on such concepts as relative price change of one future contract in relation to another. Works of authors such as Schap (2005), Smith (2000) and Ross (2006) have contributed to it. Using futures spreads in practice raises a number of issues related to the structuring of spreads to the investor. Schap (2005) addressed these issues.

Working with spreads requires evaluation of mechanisms that cause the value of the spread to change. We can analyse these mechanisms by utilising three main types of analysis: fundamental, technical and seasonal. The research pays close attention to fundamental analysis based on concepts such as supply and demand, balance between supply and demand, and supply and demand elasticity. Fundamental analysis examines changes in fundamental factors that affect the underlying assets. The following authors explored these issues: Parkin *et al*. (2005), McConnell *et al*. (2008). Seasonal analysis is based on a cyclic nature of temperature, weather, production, and life processes. Many seasonal patterns are formed by human behaviour. Moore *et al*. (2006), Ross (2006) and Bernstein (1990) undertake the study of these patterns in relation to futures spreads. Technical analysis is one of the most used tools to prognose price movements. This analysis concentrates on the behavior of price itself, studying primarily historical data and charts configuration. Murphy (1999), Schwager (1995) and DeMark (1994) cover the technical analysis of futures markets in their work. Many indicators were developed for the purposes of technical analysis. One of the most popular is the RSI which Wilder (1978) developed and described.

1.5 Research Aim and Objectives

Eight years of independent studies reported in six publications (two books and four articles) underpin this study that proposes new approaches to the work with futures spreads. The study aims to build and develop a coherent framework for identifying key factors affecting futures spreads behaviour, which in turn will provide the possibility for spreads effective use as an investment tool.

Specifically, the thesis objectives are to:

1. Systematise, classify and describe spreads based on the most liquid metal, energy and index futures contracts.
2. Develop a spread analysis methodology using technical, fundamental, seasonal and historical comparison analyses.
3. Develop approaches to designing trading strategies based on the use of spreads as an investment tool.
4. Develop a framework for implementing a practical task of using futures spreads as an investment tool.

The author based both the thesis' aims and objectives on his current research and his published research in two books and four peer reviewed journal articles. The overall research theme in these separate, but linked studies, is exploratory in nature (see Chapter Two, Table l). The primary purpose was to gain a deeper understanding of spreads behaviour in order to apply this theoretical knowledge for practical purposes. The author achieved this through an investigation of the key factors influencing them.

The first objective focused on systematisation, classification and description of futures spreads. There are many different spreads, and in order to explore them further it was necessary to form the groups.

Four major spreads types can be identified:

- Intramarket (Working, 1933; Kawaller et al., 2002; Schap, 2005). A spread involving simultaneous futures contracts buying and selling for the same

commodity, but with different delivery months is called an intramarket spread (Working, 1933; Kawaller et al., 2002; Schap, 2005). Probably the most common spread type, we often call this a calendar spread (Schap, 2005).

– Intermarket (Elfakhani and Wionzak, 1997; Butterworth and Holmes, 2002). Intermarket spreads are comprised of futures that, whilst having the same underlying commodity, dealers quote and trade on different exchanges (Butterworth and Holmes, 2002).

– Intercommodity (Wahab *et al.,* 1994; Schap, 2005) spreads. A spread involving the simultaneous purchase and sale of futures contracts for different, but related commodities is called an intercommodity spread (Wahab et al., 1994; Schap, 2005). Thus, it represents a structure consisting of futures contracts based on different, although more or less economically related commodities, whose pricing positively correlates. Futures for the same delivery months typically comprise these spreads which traders quote on the same exchange, even though other, more complex options are also possible.

– Processing spreads. This is a more complex spread category that represents a sort of "paper" replication of the production process and comprises of:

  - Crack spreads (Haigh and Holt, 2002; Schap, 2005);
  - Crush spreads (Rechner and Poitras, 1993; Simon, 1999; Schap, 2005);
  - Spark spreads (Errera and Brown, 1999).

The empirical evaluation of the different spread classes (types) by trade volume and variety is graphically represented on a Diagram 1.

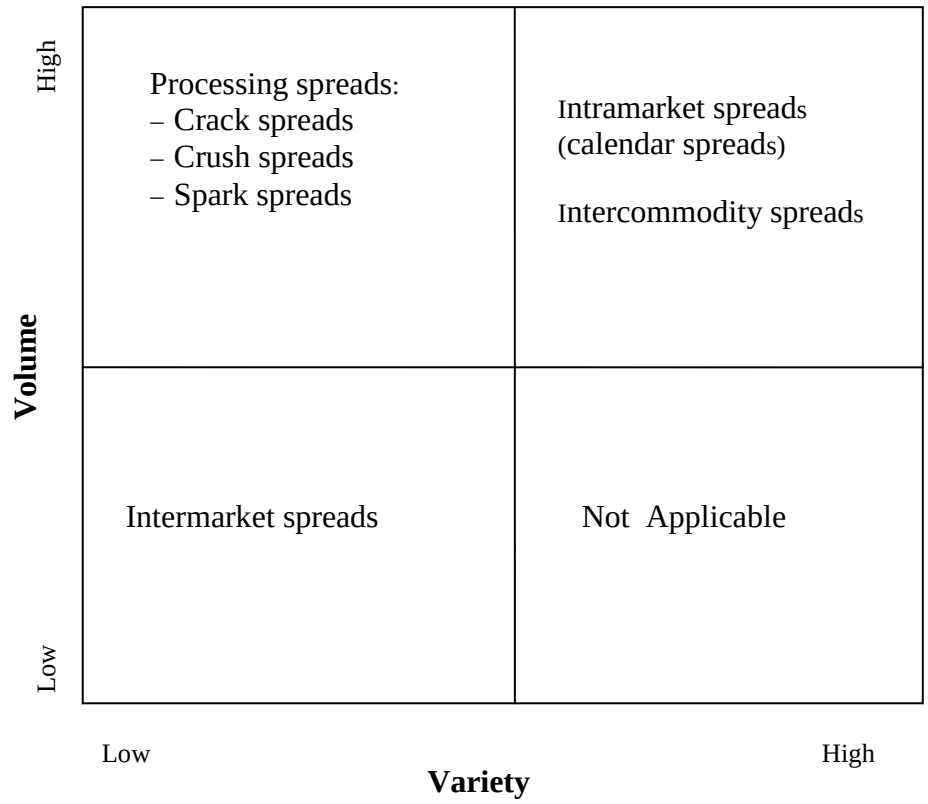


Diagram 1: Empirical evaluation of the different spread classes (types) by trade volume and variety.

The above-mentioned spread types are large classes. Within these classes (types), spreads can be divided into different groups based on the underlying futures. This division into classes and groups allows us to create a coherent system of analysis of key factors influencing both the class and the group as a whole and each individual spread within the group.

For example, there is the class - calendar spreads and the group - financial and energy spreads. The influence of supply and demand balance, as the determining factor is the key to energy spreads and practically irrelevant to the financial spreads. Thus, such a classification best allows us to develop a methodology for spread analysis, which is the next research objective.

Publications 1, 3, 4 and 6 address this objective.

The second objective pays close attention to methods of spread analysis. Spread analysis is a key to understanding their behaviour and the basis, which allows practical use of different spread types. There are different spread analysis types, but research findings (Publications 1, 2) concluded that the most effective for this purpose are the following four types: fundamental, seasonal, technical and comparative-historical.

Fundamental analysis is based on the following principle: any economic factor which reduces the supply or increases the demand will increase the price. Vice versa, we see that any factor which increases the supply or reduces the demand usually leads to stock accumulation and a fall in prices (Schwager and Turner, 1995; Thomsett, 2006). Fundamental factors play an important role not only in the case of spreads, but also in the case of outright futures positions, currencies and shares. Whatever segment of the market that we may mention, in the long run, these fundamental factors will play a determining role. However, there is certain difference between spreads and other investment instruments. In fact, fundamental factors impact spreads much more strongly than other instruments. Furthermore, fundamental factors also affect spreads much more quickly.

Seasonal analysis is based on life processes and on methods which statistical analysis employs (Bernstein, 1990; Moore *et al.*, 2006). Essentially, when analysing analogous historical periods, investors attempt to find recurring patterns, and if they identify the high recurrence of certain behaviour which prices previously prices exhibited, they assume that such behaviour is likely to occur in the future. Hence, the longer the selected time span for analysis, the more credible the analysis pattern and, consequently, the more reasons to expect that this pattern will repeat itself in the future.

Technical analysis is the study of market dynamics with the purpose of forecasting future price trends, focused on investment decision-making. (Murphy, 1999) As applied to the futures market, the term “market dynamics” captures two information sources available to a technical analyst, namely, transaction prices and transaction volumes. In investigating price movement and trade volume dynamics, technical analysis puts aside the issuer and the environment where it operates, that is, knowing the reasons behind price movements is

not absolutely necessary in a technical analysis.

Comparative historical analysis is based on the assumption that under similar circumstances (fundamental factors) futures prices or spreads should behave in a similar way (Smith, 2000). It suggests searching for situations in the past that would be similar to the current one, tracing price behaviour in that historical period, and predicting the development of the current situation on this basis. Comparative historical analysis combines fundamental, technical and seasonal analyses.

Publications 1 and 2 address this objective.

The third objective concentrates on the fairly complicated process of designing trading strategies. Furthermore, this process requires a considerable creative effort, as well as patience for strategy testing. Once one has tested the designed strategy, one must analyse the obtained results and optimise the strategy, if necessary. The above considerations also hold true for designing trading strategies that use spreads as an instrument. However, dealing with spreads requires a somewhat more profound approach than dealing with outright positions. The basic difference is that in the former case it is necessary to evaluate the price behaviour of several positions rather than one. Since the spread is a more complex instrument, it is much harder to analyse and create trading strategies based on spread. It is very hard to perform strategy backtesting for spreads using software applications, such as Tradestation, Amibroker and others. Whilst many of these applications provide the ability to manage a set of several financial instruments, the backtesting of spreads, due to their nature, is almost impossible. So, dealing with spreads will inevitably require the use of other analysis types and has its inherent limitations.

Publications 1 and 2 address the third objective.

Despite the fact that there is some literature dedicated to spreads, most of it focuses on the practical side of working with them (notable exceptions include Billingsley and Chance, 1988; Board and Sutcliffe, 1996; Butterworth and Holmes, 2002; Kawaller *et al.,* 2002). There is almost no literature that examines the theoretical aspect of spread functioning which builds a theoretical framework for implementing a practical task of using spreads as

an investment vehicle. The research's **final objective** was to develop such a framework, which based on the findings of various types of analysis, will identify the main factors that lead to spreads movement, as well as using this framework to prognose in practice future spread value changes.

1.6 Research Aims and Objectives of the Original Studies that Underpin the Thesis

Now, as I have explained in detail the general thesis objectives, it is meaningful to mention the study objectives of each individual publication that constitute this thesis.

Publication 1 aimed to:

- Systematise, classify and describe spreads based on the most liquid metal, energy and index futures contracts;
- Develop a spread analysis methodology using technical, fundamental, seasonal and historical comparison analyses; and
- Develop approaches to designing trading strategies based on the use of spreads as an investment tool.

Publication 2 intended to:

- Investigate the possibility of applying the RSI indicator to futures spreads.

Publication 3 attempted to:

- Provide an in-depth investigation of the platinum/gold spread; and
- Understand fundamental factors affecting this spread.

Publication 4 endeavoured to:

- Conduct an in-depth investigation of the crude oil calendar spread; and
- Understand fundamental factors affecting this spread.

Publication 5 ventured to:

- Understand the causes of abnormal contango on the WTI crude oil market; and
- Test the theory of storage and cost of carry model as the tool to explain enormous contangos.

Publication 6 undertook to:

– Provide an in-depth investigation of the spark spread; and
– Understand fundamental factors affecting this spread.

1.7 Thesis Structure

An integration document accompanies the six publications within the final thesis. The integration document comprises five chapters, references and four appendices.

- Chapter One establishes the aims, objectives and research themes.

- Chapter Two lists the refereed publications and gives a brief summary of each, cross-referencing them to other closely related publications.

- Chapter Three explores the causes of market anomalies of crude oil calendar spreads, discusses the theory of storage and provides a literature review.

- Chapter Four discusses different types of spreads analysis. It develops a framework for effective analysis for future spreads trading and provides a literature review.

- Chapter Five explores whether the research met the original aims and objectives, and its contribution to knowledge and understanding of questions surrounding futures spreads. It sets out implications for practitioners, together with both the research limitations and the opportunities for further research in the field.

- The thesis lists full references to all cited works.

- Appendix I comprises the six publications.

- Appendix II presents co-author affirmations of the author's contribution.

- Appendix III demonstrates the standing of the journals in which this research is

published, showing the relevant editorial review policy.

- Appendix IV contains assessments of the publications' impact.

1.8 Summary of Chapter One

This chapter has identified the research aims that informed the six submitted publications and the development of this thesis. It sets outs the underlying research themes which informed the various studies and which appear in the final framework. In doing so, it demonstrates the coherence and consistency between research aims and the development of the thesis.

The next chapter summaries each of the six publications and demonstrates the extent of their inter-relatedness. In the interests of readability, the thesis adopts a similar format to this chapter whereby each chapter opens with an introductory statement and closes with a chapter summary.

Chapter Two: List of Publications with Paper Summaries

2.1 Introduction

This chapter identifies the six publications submitted for the thesis (see Table 1 below). Of the six publications, two are critically peer-reviewed books and four are articles in critically peer-reviewed journals. All articles and one book are sole-authored and one book is co-authored. The current author was the sole or joint initiator of all of the related research projects, making a contribution, as certified by the co-author, of 70%. Appendix I contains the complete transcripts of each publication. A summary of all publications is provided in this chapter, followed by a discussion of the inter-relatedness of the publications, and a chapter summary.

2.2 Publications and Summaries

As Table 1 indicates, this thesis comprises six submitted publications for assessment. They all represent detailed research works dedicated to the different aspects related to futures spreads. These works explore such issues as spreads description, development of spread analysis methodology and approaches to practical application of spreads as an investment tool.

Table 1: Publications that form the basis for this thesis

No	Publications	Appendix
1	Perchanok, K. (2011) *Futures Spreads: Classification, Analysis, and Trading (Russian)*. Moskow: Dashkov & Co (Russia), ISBN: 978-5-394-01316-4 English version, *Futures Spreads: Classification, Analysis, and Trading*. Charleston: CreateSpace, ISBN: 978-1-466-29016-7	I.1
2	Perchanok, K. and Hrytsyuk, I. (2011) *The Encyclopedia of the Indicator RSI (Relative Strength Index)*. Charleston: CreateSpace, ISBN: 978-1-466-29030-3	I.2
3	Perchanok, K. (2011) Platinum/Gold Spread. *Futures Magazine*, November, pp. 36–38, ISSN 0746-2468	I.3
4	Perchanok, K. (2011) Crude Oil Calendar Spreads. *Futures & Options Magazine*, 10, October, pp. 74–79, ISSN 2220-1092	I.4
5	Perchanok, K. (2011) Anomalies in the Behavior of Crude Oil Calendar Spreads. *Modern Science: Actual Problems of the Theory and Practice*, October, ISSN 2223-2974	I.5
6	Perchanok, K. (2012) Trading Power to Spark Profits (Spark Spread). *Futures Magazine*, February, pp. 32–34, ISSN 0746-2468	I.6

Publication 1: Perchanok, K. (2011) *Futures Spreads: Classification, Analysis, and Trading (Russian)*. Moskow: Dashkov & Co (Russia), ISBN: 978-5-394-01316-4.
English version, *Futures Spreads: Classification, Analysis, and Trading*. Charleston: CreateSpace, ISBN: 978-1-466-29016-7 (Appendix I.1)

This book explores in detail the futures spreads, provides their systematisation and analysis methodology. It consists of seven sections. Because each section represents a relatively large and in-depth study of a number of issues surrounding spreads, it is necessary to mention their contents in detail. The first section deals with the basic concepts of futures markets. Chapter 1 gives an idea of the futures spreads and explains the book's premise. Chapter 2 introduces the reader to the futures market history and refreshes the reader's memory about the basic concepts used in futures markets.

The second section centres on calendar spreads. Chapter 3 describes such concepts as

"backwardation market" and "contango market". The remaining chapters of this section examine a variety of calendar spreads favoured by professional futures traders. Special emphasis is placed on calendar spreads in the energy market. The final chapter of this section contains an in-depth study of WTI calendar spreads. This study presents a number of new interesting ideas and offers a different view on pricing in the crude oil futures market.

The third section focuses on intercommodity spreads. It describes not only commodity spreads, but also financial futures spreads. Especially noteworthy in this section is the chapter dedicated to index spreads, as index futures are the most actively traded and index spreads are an indispensable part of the professional investment business.

The fourth section examines in detail two interesting volatile intermarket spreads: NYMEX/ICE heating oil and WTI/Brent spreads. These spreads are very popular with professional traders, with trading volumes on WTI/Brent spreads continuously increasing. However, these spreads have received little, if any, coverage in the literature. An in-depth analysis of the primary causes affecting the behaviour of these spreads was conducted. In particular, it was found that the following main factors influence the behaviour of the NYMEX heating oil / ICE gasoil spread: seasonality, freight costs and weather conditions. In the case of NYMEX WTI crude oil / ICE Brent oil spread, the most influential factors are: behaviour of prices of futures for both oils, freight costs, and market sentiment.

The fifth section is devoted to processing spreads. Whilst researchers have studied crack and crush spreads fairly well, the spark spread has only received modest consideration in a few sources. Despite its recent emergence, this spread has quickly become a must-have tool for energy traders. The special emphasis is placed on fundamental factors affecting each particular spread. Rather than limiting myself to just enumerating such factors, I try to carefully explore how each of them impacts the spread in question. In fact, all the described spreads are subjected to in-depth, fundamental analysis.

The sixth section is dedicated to the analysis of spreads, describing in detail how traders conduct fundamental, technical, seasonal and comparative historical analyses.

The seventh section focuses on spread trading, providing a detailed description of approaches to designing spread trading strategies. The final chapter is a case study of a spread trade; actually, it sums up the material discussed in the book.

> Publication 2. Perchanok, K. and Hrytsyuk, I. (2011) *The Encyclopedia of the Indicator RSI (Relative Strength Index)*. Charleston: CreateSpace, ISBN: 978-1-466-29030-3 (Appendix I.2)

This book takes a different approach, and instead analyses the relationship between the RSI values and the price movement of the underlying asset. In essence, the book examines the RSI overbought/oversold indicators and the price of the asset, and then analyses the relationship between RSI and the asset price changes within a time interval. When the RSI leaves the overbought/oversold area, the underlying asset price change may move counter to the dominant trend originally behind the initial growth or decline of the RSI.

The book describes financial instruments by category and type: commodity futures, metals futures, agricultural futures, FOREX, shares index, and spreads and futures for bonds and shares. With the underlying assumption that the price behaviour of different financial instruments varies, the book aims to test the relationship between the price change and the RSI indicator for each financial instrument.

Sections two through nine are dedicated to individual financial instruments. Each section provides a description of the specific financial instrument as well as the structure of using the RSI indicator for each category of financial instrument. The section on futures spread deserves special mention, as the existing literature on futures spread tends not to utilise the RSI indicator to estimate spread price movements. I suggested a new method of analysing the RSI, which may be used for underlying assets of any type, and specifically could be useful in case of futures spreads. In depth study of possibility to employ RSI in the work with futures spreads is absolute novelty in the literature.

> Publication 3. Perchanok, K. (2011) Platinum/Gold Spread. *Futures Magazine,* November, pp. 36–38, ISSN 0746-2468 (Appendix I.3)

This article discusses platinum-gold spread. The main idea behind this spread is to profit from the different behaviours of gold and platinum prices. First of all, this spread is of interest to the speculators and, to a lesser extent, to the hedgers. The article discusses in detail following issues: principles of spread structuring, and weighing of the positions by size and the mechanics of its functioning. The biggest part of this paper is devoted to an in-depth analysis of fundamental factors influencing this spread.

Publication 4. Perchanok, K. (2011) Crude Oil Calendar Spreads. *Futures & Options Magazine*, 10, October, pp. 74–79, ISSN 2220-1092 (Appendix I.4)

This article discusses in detail crude oil calendar spreads Light Sweet Crude Oil (WTI) (NYMEX). A spread involving simultaneous buying and selling of futures contracts for the same commodity, but with different delivery months, is known as intramarket spread. The spread of this type is very often called calendar spread. This is probably the most common type of spreads. This spread also is of great interest for both speculators and hedgers. The paper discusses questions surrounding principles of spread structuring, weighing of the positions by size, functioning mechanics and a method to calculate investment results. The biggest part of this article is devoted to an in-depth analysis of fundamental factors influencing this spread.

Publication 5. Perchanok, K. (2011) Anomalies in the Behavior of Crude Oil Calendar Spreads. *Modern Science: Actual Problems of the Theory and Practice*, October, ISSN 2223-2974 (Appendix I.5)

The article discusses crude oil calendar spreads Light Sweet Crude Oil (WTI) (NYMEX). Since the beginning of trading in these futures, the market has never seen a situation when contango values exceed carrying charges many times over. However, since 2008, the market began to observe anomalous calendar spreads behaviour, which this article describes. It also analyses the causes of such anomalies.

Publication 6. Perchanok, K. (2012) Trading Power to Spark Profits (Spark Spread). *Futures Magazine*, February, pp. 32–34, ISSN 0746-2468 (Appendix I.6)

This article deals with one of the least described in the academic and practitioner literature-processing spreads. This spread is called spark spread. The key idea behind this spread is to make use of derivatives to trace electricity generation economics. Just as a generator buys natural gas to produce and sell electric power at a certain gross margin, this process will be similarly replicated at the "paper" level through purchase of natural gas futures and sale of electricity futures. This spread is primarily of interest to hedgers, i.e. power generating companies that wish to fix their margin by selling electricity futures and buying natural gas futures. Speculators, too, may find the spark spread very interesting due to high volatility of electric power and gas prices. The article discusses in detail the following issues: principles of spread structuring, and weighing of the positions by size, the mechanics of its functioning. The biggest part of this publication is devoted to an in-depth analysis of fundamental factors influencing this spread.

2.3 The Inter-Relatedness of the Publications

The publications represent the author's investigative and career-related journey into futures spreads trading.

The publications are interrelated around the theme of futures spreads, which Figure 1 illustrates in the context of the background literature, methodological approaches and the development of new approaches (framework) of their practical application as the essential part of the thesis.

Figure One sets forth the interrelationships.

The publications are closely linked. The first publication was the basis for all the others. All the issues coined and discussed in the book found further, wider and deeper development in the subsequent publications. Each of them expanded the original research on different aspects surrounding futures spreads.

Publications 1, 3, 4, 5 and 6 are focused on the spreads systematisation, classification and description. Publication 1 describes a wide variety of spreads including intermarket, intramarket, intercommodity and processing spreads. This publication lays the ground for their

classification and grouping. The next publications concentrate on the individual spreads and their deeper study. Appropriate systematisation and classification formalise existing approaches to this issue and more importantly, allows us to identify major fundamental factors affecting each particular spread. Broad description helps to understand the nature of a spread.

Publications 1 and 2 concentrate on the development of spread analysis methodology. Spread analysis is a key to understanding their functioning and the basis, which allows practical use of different spread types. It is essential for any researcher and practitioner to realise which analysis types they can apply to spreads. In my study, I emphasised attention on the four which I considered most effective: fundamental, seasonal, technical and comparative-historical. To conclude appropriate futures spreads analysis, one must understand also how spot and futures prices in commodity markets are linked. Publications 1 and 5 discuss this question.

After I describe, systemise and group spreads I conclude with the appropriate analysis and identify major fundamentals factors impacting each particular spread. This allows us to start to consider how to apply these results in practice. Publications 1 and 2 discuss the development of approaches to designing trading strategies based on the use of spreads.

The overall ontological approach which the published papers follow is that of critical realism allowing the reader to adopt an ontological position encompassing both positivist and interpretivist epistemology (Cupchik, 2001). This enables one to use both material facts and patterns interpreted through human activity, within the context of an epistemology spanning both quantitative and hermeneutic traditions. This approach is consistent with the existing body of research within futures pricing theory, fundamental and seasonal analysis, technical analysis, spreads structuring and mechanics, within each of which seminal contributions reflect both the positivist and interpretivist paradigms, and, in turn, use quantitative and qualitative research methods (Buckley, 2002; Barnes, 2001; Creswell, 2003; Wright and Ricks, 1994).

In particular, the author has employed a range of research methods in the submitted publications, including:

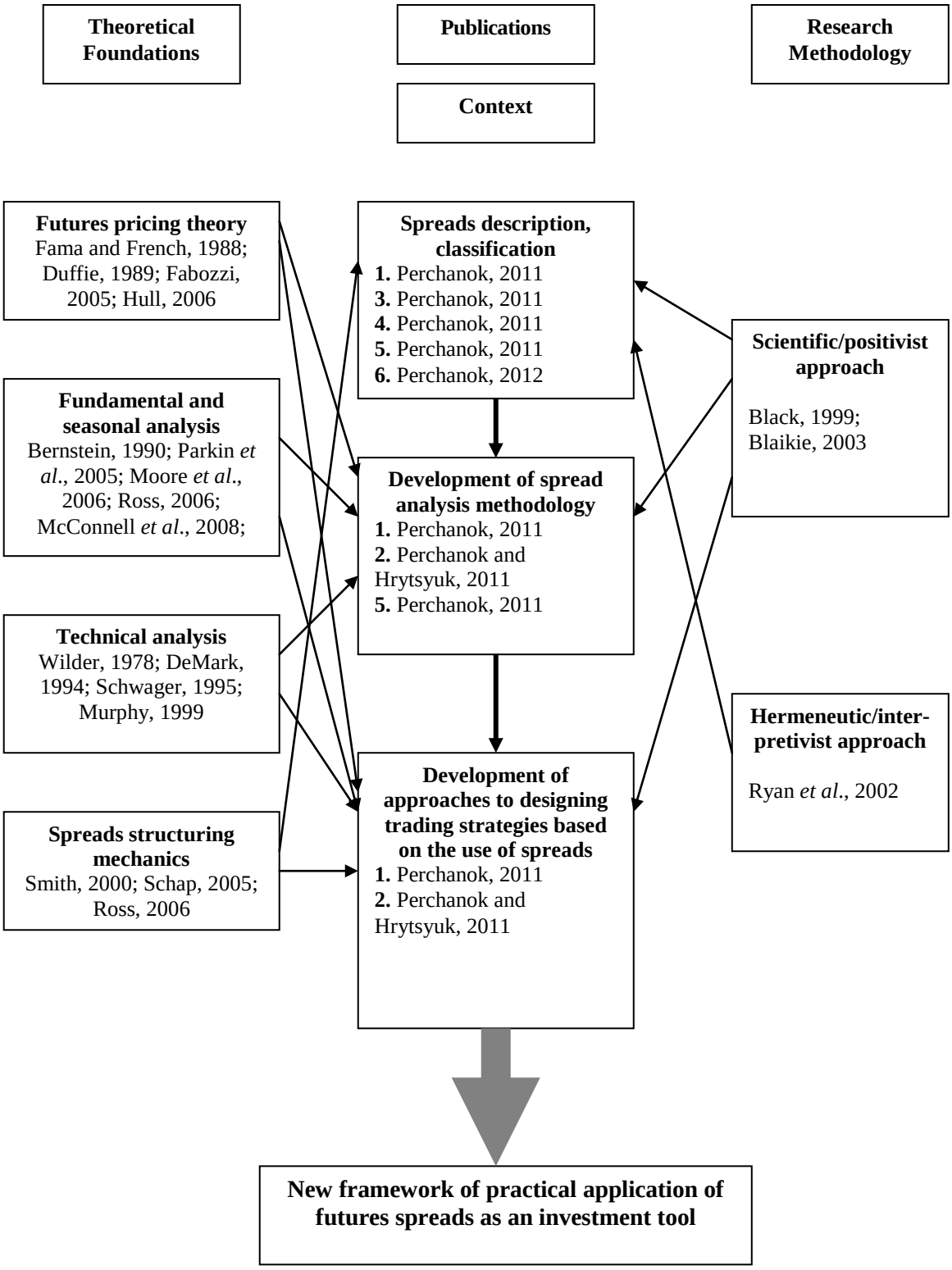
– Fundamental analysis essentially comes down to applying a few basic economic concepts. The balance between supply and demand plays the decisive role in the

pricing of different commodity groups. The determination of fundamental factors affecting particular spreads takes place by periodically referring to macroeconomic concepts.

– The Dow Theory and technical analysis methods. Technical analysis is an important tool for studying financial markets and is one of the key mechanisms for making trading decisions in the futures market. Financial scholars and practitioners have developed and described in detail dozens of tools to assist in decision-making. This work uses some of them.

– Analysis and evaluation of statistical data published by various government agencies, including the EIA, the Federal Reserve System, data from the ECB Statistical Data Warehouse, the International Monetary Fund and the US Department of Agriculture.

Figure One


Theoretical Foundations
Publications
Context
Research Methodology
Futures pricing theory
Fama and French, 1988; Duffie, 1989; Fabozzi, 2005; Hull, 2006
Fundamental and seasonal analysis
Bernstein, 1990; Parkin et al., 2005; Moore et al., 2006; Ross, 2006; McConnell et al., 2008;
Technical analysis
Wilder, 1978; DeMark, 1994; Schwager, 1995; Murphy, 1999
Spreads structuring mechanics
Smith, 2000; Schap, 2005; Ross, 2006
Spreads description, classification
1. Perchanok, 2011
3. Perchanok, 2011
4. Perchanok, 2011
5. Perchanok, 2011
6. Perchanok, 2012
Development of spread analysis methodology
1. Perchanok, 2011
2. Perchanok and Hrytsyuk, 2011
5. Perchanok, 2011
Development of approaches to designing trading strategies based on the use of spreads
1. Perchanok, 2011
2. Perchanok and Hrytsyuk, 2011
Scientific/positivist approach
Black, 1999; Blaikie, 2003
Hermeneutic/inter-pretivist approach
Ryan et al., 2002
New framework of practical application of futures spreads as an investment tool

2.4 Summary of Chapter Two

This chapter summarised six publications. Two critically peer-reviewed books and four articles investigated different aspects of futures spreads. Five broad findings emerged:

- Spreads are a much more sophisticated tool than futures.
- All analysis types must be used for successfully applying spreads as an investment vehicle.
- Fundamental factors are the main driving force in spread behaviour.
- Some of the traditional futures spreads pricing models must be revised and amended due to the recent changes in the market (specifically, the cost of carry model).
- Increased number of algorithmic programs as the market participants leads to the increasing importance of technical analysis methods for the successful use of spreads as an investment instrument.

The publications were summarised to show how they linked together as a coherent and sustained investigation of different issues surrounding futures spreads. Their interrelatedness was shown in relation to the underlying themes of spreads classification, systematisation, analysis and practical application. Building on these areas, the following chapters critically explore in detail the background literature to the publications and to the thesis.

Chapter Three: Understanding the Causes of Market Anomalies of Crude Oil Calendar Spreads

3.1 Introduction

One of the theoretical foundations of my thesis is the issues surrounding price formations on the futures markets. The theory of storage is a cornerstone theory which addresses some of these issues. This theory also plays an important role for the market of crude oil calendar spreads.

Beginning with the 2008 financial crisis, crude oil futures market participants began to observe situations where contango spread values exceeded carrying charge amounts many times over and lasted relatively long. The chapter describes these unusual occurrences on the example of the behaviour of crude oil calendar spreads and analyses the causes for such anomalies. Moreover, most researchers have focused on studying the market in a state of normal backwardation, paying much less attention to the market in contango. The recent appearance of "wild" contangos of anomalous dimensions in the futures markets shows that the theory of storage and the cost of carry model requires revision in order to align the model's theoretical foundation with the empirical observations. This chapter's main aim is the desire to draw attention to the need for updating the theory of storage and the cost of carry model. In addition, the chapter also examines the causes of the phenomenon of "wild" contangos in the futures markets.

This chapter demonstrates the standing of my research in relation to other works in this field.

3.2 Literature Review

The theoretical foundation for modelling the price dynamics of crude oil futures and spot markets is based on the theory of storage and the co-integration of these two markets via arbitrage. The theory of storage (Working, 1948, 1949; Brennan, 1958; Telser, 1958; Williams, 1986) has played a dominant role in explaining the pricing relationship between

futures and spot markets, as well as the relationship between futures of different maturities.

The theory of storage states that the price difference between the price of purchasing the commodity today (spot) and futures (i.e. the basis) or the difference between two futures contracts (i.e. the spread) depends on three elements: (1) the cost of storage; (2) the convenience yield; and (3) the risk premium for holding inventory (Ates and Wang, 2007). The magnitude of the convenience yield depends on the level of inventory and demand shocks.

Most of the previous work (Brennan, 1958; Gray and Peck, 1981; Fama and French, 1987, 1988; Ng and Pirrong, 1994; Pindyck, 1994; Gao and Wang, 2005) applied the theory of storage to explain the intermarket dynamics of spot and futures prices and their relative volatility for non-energy storable commodities. In general, the results suggest that intermarket behaviour of price dynamics and relative volatility are consistent with those implied from the theory of storage.

Different authors, including Cho and McDougall (1990), Ng and Pirrong (1996) and Susmel and Thompson (1997), have researched the application of the theory of storage for modeling price variations in energy commodities. In particular, Cho and McDougall (1990) examined the relationship between variation in the basis and the level of inventory in the crude oil, gasoline and heating oil markets.

As an integral part of the theory of storage that allows modelling price formations on futures markets could be used the cost of carry model (Moles, 2004; Hull, 2006). Theoretically, the equilibrium futures price should be equal to the spot price, plus the cost of carry, which is defined as the sum of the cost of storage, plus the interest rate (Chance, 1991). According to the cost of carry model, the basis (basis = spot price – futures price) cannot exceed the cost of carrying the physical commodity, which mainly consists of financing and storage costs. Thus, when the basis is equal to the cost of storage, the market is said to be at full carrying charges. According to the theory of storage, the futures market seldom reaches a “full carry” situation because any excess of this value will create opportunities to implement arbitrage strategies (i.e. strategies that are practically risk-free for the investor and that are based on a temporary market imbalance), (Hull, 2006). Later, I

will describe in greater detail the arbitragers' role. Moreover, some researchers, including Anand (2000), argue about the impossibility of full carry markets.

In 2008, crude oil futures market participants began to observe situations where the contango spread values exceeded the carrying charge amount many times over. This lasted relatively long(first time-about three months). This chapter illustrates these unusual occurrences on the example of the behaviour of crude oil calendar spreads and analyses the causes for such anomalies.

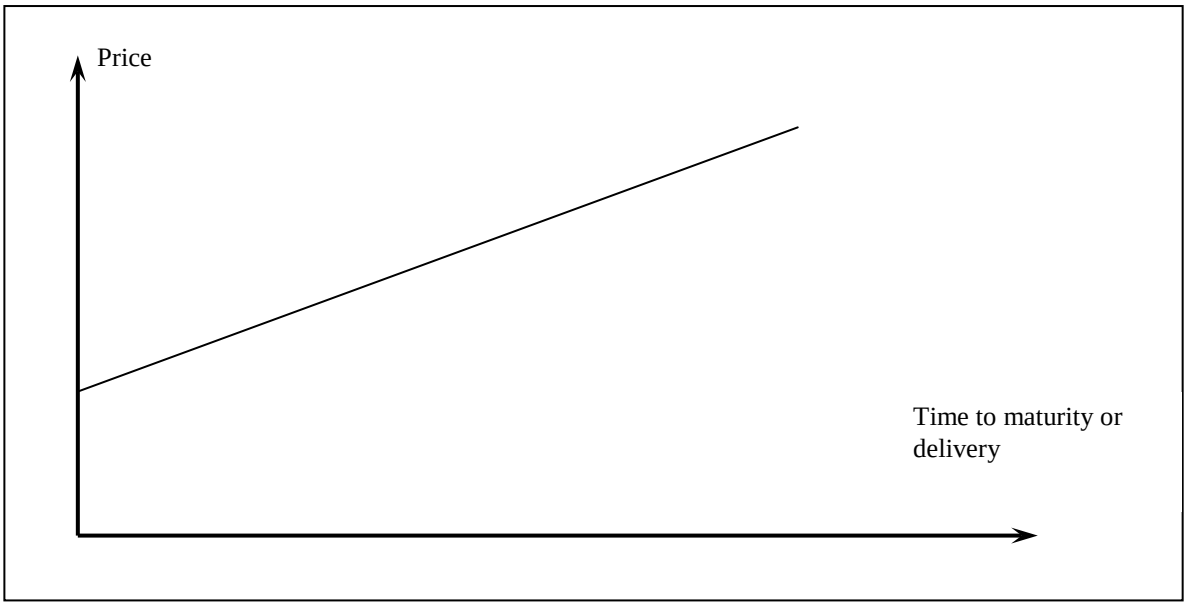
Starting with Working (1948, 1949) onwards, the majority of scholars have focused on studying the market in a state of normal backwardation (i.e. when the basis is positive), paying much less attention to the market with a negative basis, (i.e. contango). The recent appearance of "wild" contango of anomalous dimensions in the futures markets shows that the theory of storage and the above mentioned cost of carry model require a revision in order to align its theoretical foundation with empirical observations (Publications 1, 5). The desire to draw attention to this issue was the main purpose of this chapter. In addition, the author set the task of understanding the causes of this phenomenon.

The chapter is structured as follows: the first part discusses the theoretical foundation of contango and backwardation concepts, as well as the role of arbitrageurs in the co-integration of futures and spot market. The second part concentrates on analysis of crude oil calendar spreads from the end of 2008 to mid 2010. The third part contains results and the fourth part – conclusions.

3.3 Market Behaviour: Contango and Backwardation

Contango is a price situation in which futures prices exceed spot prices (prices in the physical market). Accordingly, backwardation is a market condition in which spot prices exceed futures prices. So, if a market is in contango, the basis will be negative as the futures price will be higher than the spot price, while in a backwardation market the basis will be positive as the spot price will exceed the futures price (Moles, 2004; Publication 1).

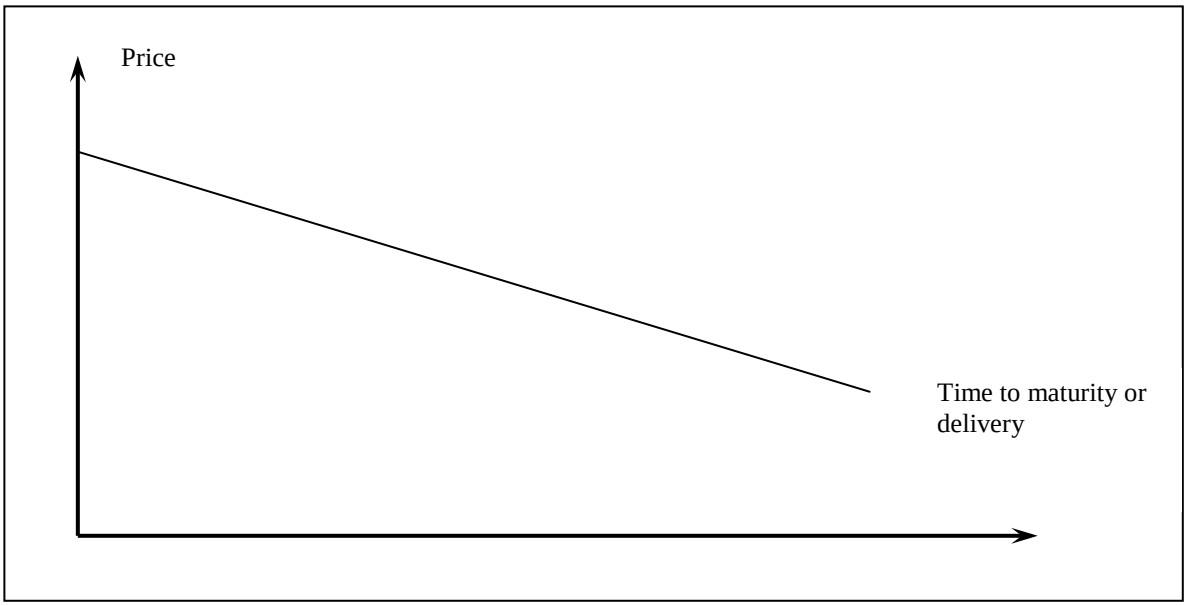
Figure 2 graphically illustrates contango pricing.



Source: Publication 1; Moles (2004)

Figure 2: The basis is negative and the market is in contango.

Figure 3 graphically illustrates backwardation pricing.



Source: Publication 1; Moles (2004)

Figure 3: The basis is positive and the market is in backwardation.

To better understand this, let us refer to the futures pricing theory and, in particular, examine commodity markets. So, according to the cost of carry model for pricing futures, the relationship between the futures price and the spot price can be expressed by the following equation: (Black, 1976; Hull, 2006)

$$F_0 = S_0 e^{rT}, \qquad (1)$$

where F_0 is the futures price, S_0 is the spot price, e is exponential, r is the risk-free rate, and T is time to contract maturity.

This formula reflects the futures price when no other expenses are incurred except financing costs. Since we are speaking about commodity futures, it is evident that in addition to certain financial carrying costs there will be some storage costs. Therefore, to account for these storage costs, the equation is expanded (1). As a result, we obtain the following formula:

$$F_0 = S_0 e^{(r+u)T}, \qquad (2)$$

where u is the annual storage cost that is proportional to the spot price.

By using this formula we can easily compute the futures price based on the known spot price, risk-free rate, carrying costs and time between the spot price and the futures price. Thus, if the futures price is equal to the theoretical price derived from the equation (2), a market is in "full carry", i.e. the futures price fully reflects the costs of storing and financing the commodity. However, this is not always the case, and futures prices are often below "full carry". Moreover, commodity markets often become "inverted". Whereas the situation in a contango market is more or less clear, for a backwardation market, the above equation (2) seems slightly inaccurate. The formula should be expanded (2) by adding a convenience yield (Kaldor, 1939; Brennan, 1958; Telser, 1958). As a result, the formula (2) will look as follows:

$$F_0 = S_0 e^{(r+u-y)T}, \qquad (3)$$

where y is the convenience yield.

The introduction of the convenience yield concept helps to understand how price formation occurs in a backwardation market. If $r+u$, i.e. storage costs plus financing costs, is greater than the convenience yield y $(r+u>y)$, then the market will be in contango. If the convenience yield exceeds full carrying cost, i.e. $y>r+u$, then the market will be in backwardation.

So, what does convenience yield mean? Convenience yield is the benefit of holding physical goods in the spot market. The essence of this concept is probably easier to explain with an example. Let's assume that, in anticipation of a sharp increase in demand for heating oil, a petroleum product trader will prefer holding a physical commodity rather than futures contracts for heating oil. For instance, this may take place when unusually cold weather sets in at the end of winter, when heating oil inventories are nearly exhausted and heating oil spot prices may surge, shifting the market from contango to backwardation. Another example is a drastic rise in wheat prices caused by loss of a major part of a futures crop due to drought, heavy rains or other natural calamities. In other words, the convenience yield can be described as the benefits of holding the commodity in the spot market (Brennan, 1986; Publication 1).

Studies based on the storage model relate the convenience yield directly to the level of inventories (Fama and French, 1988). Generally, the theory of storage suggests that the marginal convenience yield falls with inventory, but at a decreasing rate (Brennan, 1958; Telser, 1958; Fama and French, 1988). At low levels of inventory, the marginal convenience yield is larger than carrying costs and the spot – futures price spread is positive. As the level of inventories goes up, the marginal convenience yield falls towards zero and the spot – futures price spread becomes negative and converges towards the cost of carry. Pindyck (1994) suggests a convex relationship between the convenience yield and stock levels with the marginal convenience yield rising rapidly as inventories approach zero and remain close to zero over a wide range of moderate to high stocks. Some models consider a non-linear relationship with the marginal convenience yield rising at low level

of inventories and then declining in a non-linear manner to zero. At sufficiently high inventory levels, the marginal storage becomes increasingly expensive as storage facilities reach full capacity levels and the marginal benefit from adding stocks becomes zero (Larson, 1994).

Note that the convenience yield only applies to commodity markets where the physical commodity can appear to be in short supply, causing a short-term rise in prices. Normally, this concept does not apply to financial markets. Take, for example, stock index futures. It is obvious that there can be no shortage or short supply (Publication 1).

The following conclusions can be drawn about the features of the contango and backwardation markets. The carry in a contango futures market nearly covers all storage costs, encouraging market players to hold the commodity and sell it in the future rather than in the spot market. On the contrary, the price situation in a backwardation market encourages withdrawal from storage and sale of commodities in the spot market at current prices. Empirically, this means that in a contango market players expect future prices to increase above current prices, while in a backwardation market current prices exceed possible future prices (Publication 1).

Now that I have discussed the relationship between futures and spot prices in detail, let us briefly discuss what contango and backwardation markets mean for spreads. In a contango market, contracts for near-month delivery are cheaper than contracts for more distant months. In a backwardation market, the situation is the opposite (Schap, 2005; Publication 1).

A description of the concept of contango and backwardation would be incomplete without mentioning the theoretical role of arbitrageurs and arbitrage strategies, through which futures and spot market co-integration occurs. Hull (2006) describes such strategies in detail.

If we turn to formula (2) and assume that U - storage cost is disproportionate to the spot price, then we obtain the following formula:

$$F_0 = (S_0 + U)e^{rT}, \qquad (4)$$

Consumable commodities, rather than investment assets, usually do not bring interest, but may require significant storage costs. Consider the arbitrage strategies which are used to calculate the futures prices of goods on the basis of spot prices. Assume that (4) is not satisfied and the inequality is valid

$$F_0 > (S_0 + U)e^{rT}, \qquad (5).$$

To take advantage of this opportunity, the arbitrageur could use the following strategy:

1. Get a loan of $S_0 + U$ under the risk-free interest rate and buy one unit of the commodity by paying the cost of storage.
2. Conclude a forward contract to sell the commodity unit.

If we think of a futures contract as a forward, this strategy will lead through a period of time t to a profit equal to $F_0 - (S_0 + U)e^{rT}$. This strategy can be easily implemented for any product. However, if the arbitrageur will do so, the price of S_0 will grow and the price of F_0 will fall until the inequality (5) does not change its sign. Consequently, (5) can not hold indefinitely.

Suppose further that

$$F_0 < (S_0 + U)e^{rT}, \qquad (6).$$

Investors tend to use many types of investment assets such as gold or silver solely for investment. If the case of the inequality (6), the arbitrageur can implement the following strategy:

1. Sell the commodity to compensate the cost of storage, and invest under a risk-free rate.

2. Conclude a forward contract to purchase the commodity.

As a result, at the contract's expiration the arbitrageur will make a profit, which is $(S_0 + U)e^{rT} - F_0$ exceeds the investor's profits who just held the stored commodity. Consequently, (6) can not hold indefinitely. So, because of (5) and (6) cannot happen for a long time, we conclude that $F_0 = (S_0 + U)e^{rT}$.

For commodities unused for investment purposes, these arguments are unfounded. Individuals and companies storing goods in warehouses do so because of their consumer value rather than their investment attractiveness. They are reluctant to sell physical goods and avoid buying forward contracts, because they cannot spend forward contracts. Consequently, there are no barriers to inequality (6). Thus, for the consumed commodity can be asserted that

$$F_0 \leq (S_0 + U)e^{rT}, \qquad (7).$$

If the cost of storage is directly proportional to the spot price, the inequality

$$F_0 \leq S_0 e^{(r+u)T}, \qquad (8).$$

3.4 Analysis of Crude Oil Calendar Spreads from the End of 2008 to Mid 2010

Trading in Light Sweet Crude Oil (WTI) futures takes place in New York on the NYMEX Exchange. The contract size is 1000 barrels (42000 gallons), minimum price increment: $0.01 per barrel ($10.00 per contract), ticker: CL. More detailed specifications of this contract can be found on the CME Group (2012) website.

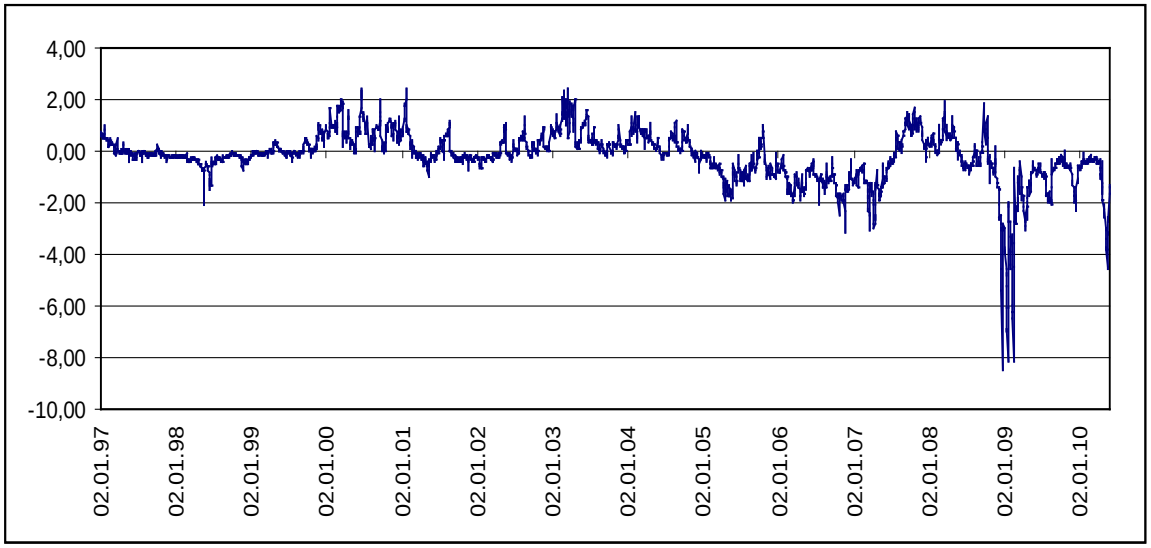
A spread involving simultaneous buying and selling of futures contracts for the same commodity, but with different delivery months, is known as intramarket spread (Working, 1933; Kawaller *et al.*, 2002; Schap, 2005; Publication 4). The spread of this type is very often called a calendar spread (Schap, 2005). This is probably the most common spread

type. According to the convention adopted by the CME (CME Group, 2012), the purchase of a crude oil calendar spread would mean buying a nearby contract and selling a distant contract; whereas, a spread sale would mean buying a distant month contract and selling a nearby one.

For a long time researchers expected that the oil market should trade in backwardation most of the time, meaning that the price of the front month's futures contracts should be higher than the price of more remote contracts. For example, Litzenberger and Rabinowitz (1995) report that from 1984 to 1992, backwardation in the crude oil markets occurred over 70% of the time. Using futures data on crude oil, heating oil and gasoline from roughly the same period, Edwards and Canter (1995) reported that energy markets show a high frequency of backwardation.

There are several theoretical arguments for backwardation that are common in energy markets. One argument based on the theory of storage points to the role of the convenience yield (Working, 1948; Brennan, 1958). Convenience yield exists because inventories provide holders with consumption/production flexibility. Markets are in backwardation if the convenience yield, net of storage costs, exceeds the interest rate. This is likely to happen when the supply level is low and thus, spot energy prices are high (Charupat and Deaves, 2003).

From the perspective of the theory of storage argument, energy markets have characteristics that make them prone to short supply and thus, backwardation. A shortage of storage facilities, an uncertainty in OPEC production decisions and, especially for heating oil and gasoline, seasonal spikes in demand, all contribute to the markets generally being in short supply. Therefore, it is reasonable to expect backwardation to be the norm in energy markets. Figure 4 shows a chart of crude oil two-month spread over the period from 1997 to 2010.

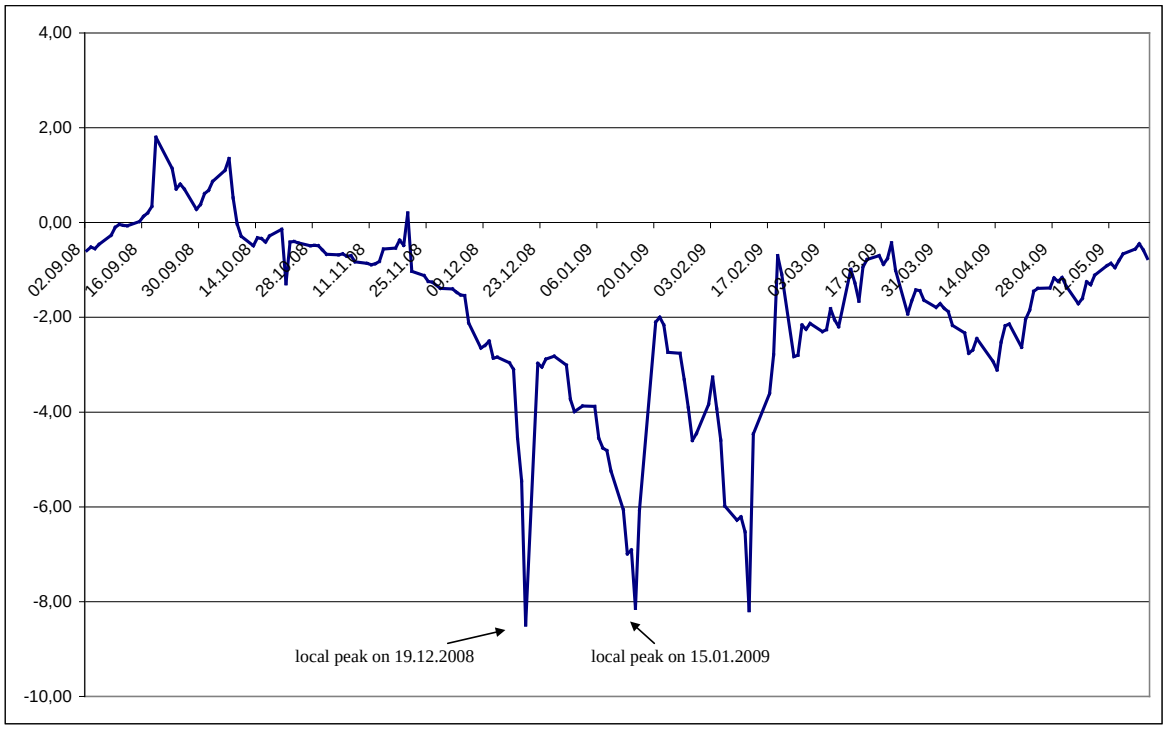


Source: U.S. Energy Information Administration (2012a)

Figure 4: Chart of Crude Oil Calendar Spread between Two Consecutive Months.

The above chart illustrates that the spread values were both positive and negative during this period; in fact, the market actually alternated between contango and backwardation. Moreover, the market was in contango more than 50% of the time. Another interesting fact is that between 1997 and 2008, the average value of this spread was close to zero and the spread represented a fairly stable price structure, fluctuating within a range of max +2 and min -2, with long contango periods giving way to equally long periods of backwardation.

In the second half of 2008, the market went into contango, and beginning from mid-October 2008, we could see a sharp widening of the spread, which reached a local peak on December 19, when the spread between the front month and the next one future contracts was $-8,49 per barrel. During several days preceding the expiry date of the nearest month futures contract, the spread narrowed dramatically to almost $-2,82. Towards the end of December 2008, and the beginning of January 2009, we could again see the spread sharply widen to $-8,14 and reach the local peak on January 15 (see Figure 5).



Source: U.S. Energy Information Administration *(*2012a)

Figure 5: Chart of Crude Oil Calendar Spread between Two Consecutive Months over the Period from September 2008 to May 2009.

Then, we see an abrupt return to the initial position over a short time before the expiry of the nearby contract. This scenario repeats itself once again in February 2009. The spread spent all of 2009 in contango.

In December 2008, and at the beginning of 2009, the spread sharply widens on the back of aggressive reductions in oil prices (see Figure 6).

Source: eSignal

Figure 6: Chart of Oil Prices between 1994 and 2010.

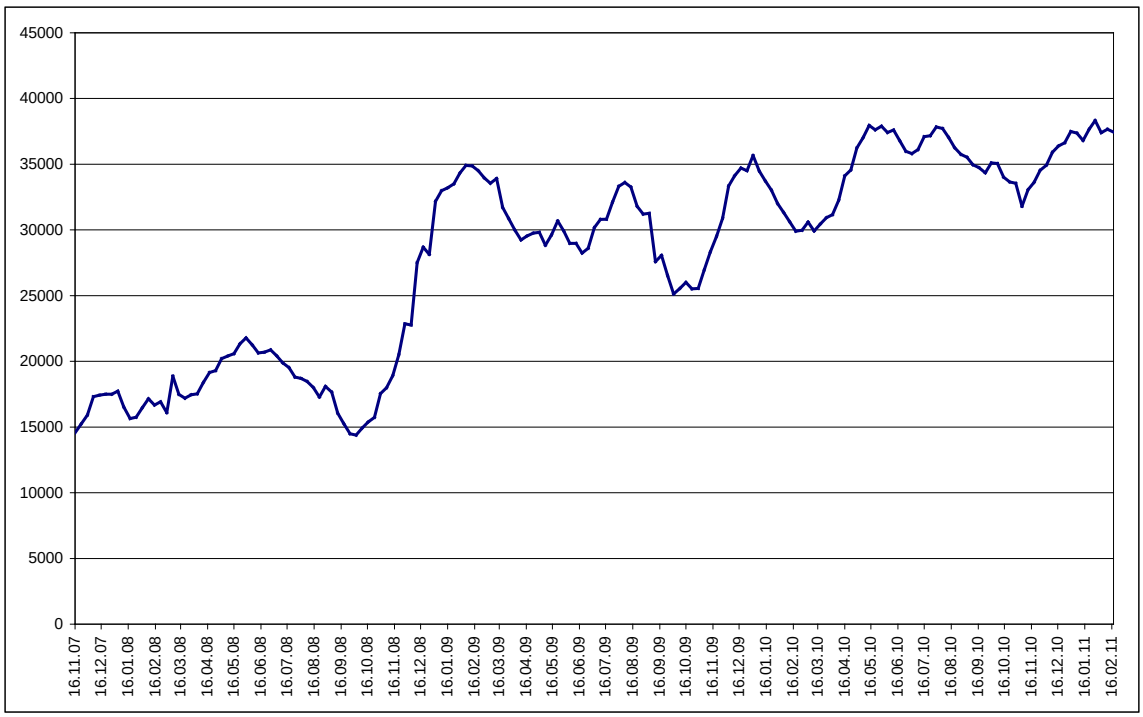
As mentioned in the introduction, in the accordance with the cost of carry model, the basis (basis = spot price – futures price) cannot exceed the cost of carrying the physical commodity, which mainly consists of financing and storage costs (Hull, 2006). Thus, when the basis is equal to the cost of storage, the market is at full carrying charges. According to the theory of storage (e.g. cost of carry model), the futures market seldom reaches a "full carry" situation because any excess of this value will create opportunities to implement arbitrage strategies (arbitrage strategies are defined as strategies that are practically risk-free for the investor and that are based on a temporary market imbalance). Therefore, the situation which occurred between December 2008, and February 2009, was, in fact, such an imbalance. According to the existing theory of storage, arbitrageurs should have quickly erased the discrepancy by actively purchasing nearby futures and selling distant ones simultaneously. Thus, the arbitrageur accepts delivery under the purchased contract, pays all storage and financing costs, and makes delivery under the back month expiration contract (Publications 1, 5).

Arbitrage profit is equal to the difference between the value of two futures contracts and the actual cost of storage. Theoretically, it constitutes a risk-free profit. The presence of arbitrage opportunities should also limit the upside of contango, both in volume and in time. Despite the theoretical model, a market imbalance is observed, whereby the spread value exceeds full costs by several times. This situation lasted a few months in 2008, 2009

and 2010, which is not at all characteristic for arbitrage models. I tried to find an explanation for this phenomenon in several different sources.

Many authors (Cho and McDougall, 1990; Ng and Pirrong, 1996; Susmel and Thompson, 1997) refer to the base theory, analysing the correlation between an increase in oil inventories, the difference between spot prices and futures contracts, and spread between various futures contracts. What this research study basically reveals is that an increase in oil inventories leads to reduced oil prices, and pushes the market into contango.

Developing this logic, it can be asserted that in a contango situation, futures prices cover storage costs, thus stimulating future increases in inventories in storage, which, in turn, deepen the contango. In fact, we observed this process when Cushing crude oil inventories swelled from approximately 14.4 million barrels in October 2008 to 35 million barrels by the middle of February 2009 (see Figure 7).



Source: U.S. Energy Information Administration (2012b)

Figure 7: Weekly Cushing, OK Ending Stocks excluding SPR of Crude Oil. (Thousand Barrels)

There is also a theoretical possibility that contango will continue to widen until some macro changes occur, which will lead to a decrease in inventories. Such macro changes can include, for example, a sharp growth in the consumption or a significant reduction in the supply of crude oil. In this case, a reduction in supplies caused by OPEC's decision to curtail production occurred. A collapse of prices on the global oil market dictated this decision (BBC News, 2008; Mouawad, 2008). It finally led to a gradual decrease in Cushing oil inventories. As a result, spreads returned to a more or less normal level in March 2009 (see Figures 4 and 5). This raises the question, "Why hadn't the arbitrage model "worked" in that particular situation?" A possible explanation may be that the volume of full costs for storing oil could have rocketed suddenly as Cushing storage had reached its limits. This implies that an increase in storage costs tends to increase the "full carry" ceiling value and deepen the contango even further. However, total capacity at Cushing was about 50 million barrels at the end of 2008. Therefore, it is unlikely that this situation could be explained by a lack of further possibilities for storing oil supplies.

Accordingly, it is hard to suppose that storage costs had risen sharply in this context, thereby pushing up the alleged ceiling of full carrying chargers.

Another possible explanation could be the crisis in global financial markets, which was accompanied by a decrease in liquidity. What happens if at some point in time a decrease of liquidity comes and, consequently, an increase in the risk-free rate at which a market participant may take the money? If the appeal to (1) and (2), the futures price should rise significantly, increasing the basis and widening the contango between the price on the spot market and the futures price. The same scenario can play out for spreads, when the difference between the price of futures with earlier expiry dates and the price of futures with later expiry will increase, thus deepening the existing contango.

However, I do not agree with such an explanation. It is true that we saw a significant reduction in liquidity on the markets, which probably contributed to the fact that different players on the spot and futures oil markets began to experience certain difficulties in attracting financial resources, or else the cost of these financial resources had increased. However, it can be recalled that practically all large central banks of the world massively lowered discount rates at that time, actively inflating the market by additional liquidity and

stimulating the banks to extend credits (Banking News & Directory, 2012). Therefore, it is doubtful that the problems in attracting financial resources constituted a reason for such a significant market imbalance.

Now let us take a look at how the market developed further. In 2009, we see a sharp (in percentage terms) increase in oil prices, when prices virtually double from their minimum values. All spreads return to their normal levels from the beginning of March 2009, maintaining the contango price structure, but not moving beyond full carrying charges. All these processes were accompanied by the gradual recovery of the global economy and stock market, stabilisation of the bond market and consumer demand.

However, what do we see in December 2009? Once again, future spreads sharply widen. They do not reach the values that we observed almost one year ago, but they also move beyond reasonable theoretical values. It must be said that the market reached a balance in this situation fairly quickly, having moved the spreads back to their maximum theoretical values. Spreads remained in the fore-mentioned situation until mid-February, 2010. Then the situation changed and the spreads began to narrow quite sharply. Many spreads almost approached zero, promising to shift to backwardation in the very near future. As a minimum, this process seemed unusual and strange if to refer to previous explanations of some of the authors (Cho and McDougall, 1990; Susmel and Thompson, 1997). They connect the substantial widening of spreads with the large growth of inventories, in our case – at Cushing. In fact, from January 2010, oil inventories began to grow week after week (U.S. Energy Information Administration, 2012a), reaching almost record values (see Figure 6). Proceeding from this logic, spreads should widen; whereas we see them narrowing. Analysts stated that this process was connected with prevailing optimism about strengthening of the global economy and a continuing increase in the demand for crude oil (Habiby, 2010).

At the beginning of April 2010, spreads began to widen sharply again, reminding us of the processes which occurred between December 2008 and February 2009. Publication 1 (p. 107) suggests that:

> In a few days, spreads exceeded the ceiling value of full carrying charges many

> times, and continued to widen dramatically. The main difference between the current widening and preceding ones was that spreads did not return within their normal boundaries, even when there was a technical “impetus” connected with the expiry of the front futures contract.

This raises the following question: If the widening of spreads is connected directly with the increase in crude oil inventories at Cushing, and this seems to be the fundamental factor, then why did we see such a sharp narrowing of spreads in the situation of a record increase in inventories, which proceeded to grow for 11 consecutive weeks? An alternative question – What caused such an aggressive widening of spreads starting from April 2010? None of the phenomena which occurred during the crisis period, namely, huge declines in oil prices and lack of liquidity on the market, have been present. Moreover, in the second half of April 2010, on the one hand, oil prices reached local maximums of $87 per barrel (see Figure 6), and on the other hand, the market was filled with cheap and available liquidity. Such questions raise doubts about prevailing explanations, which are based on the current theory of storage and arbitrage model, and on the significant correlation between spread values and size of oil inventories.

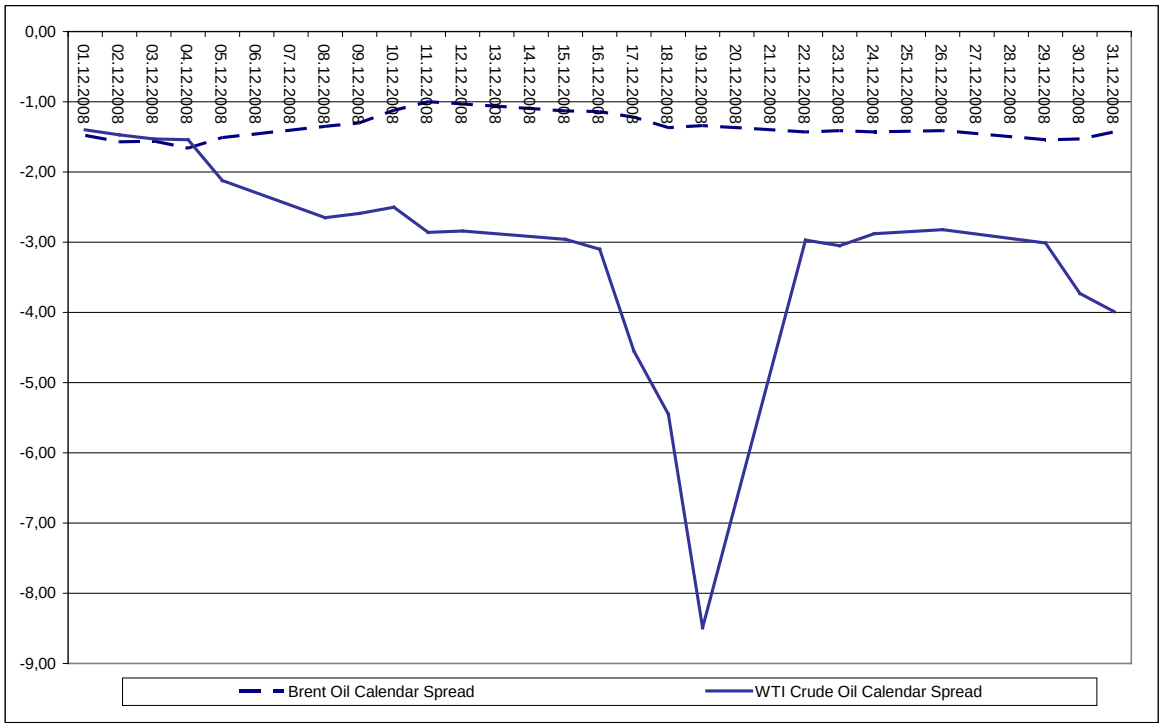
3.5 Tentative Explanation

In my opinion, the following dynamics are taking place:

a) It seems that in order to find an explanation, it should be looked at the very essence of the Light Sweet Crude Oil (WTI) futures contract quoted on the NYMEX. Theoretically, there should be a physical delivery of the commodity to Cushing when this futures contract expires (CME Group, 2012). That is, futures prices and spread values actually reflect the situation at the Cushing facility rather than the general balance between supply and demand in the U.S. It can be often seen that crude oil inventories in the United States, in general, do not experience such sharp increases in percentage terms as in Cushing (Publication 1). Moreover, this facility contains no more than 10% of total U.S. inventories (excluding strategic reserves) (U.S. Energy Information Administration, 2012b). That is, when futures are linked tightly to a concrete local site, this effectively tempts speculators to manipulate futures prices, creating “bubbles”. In this case we are dealing with a

“contango bubble”. Earlier, we dealt with an antifundamental spread narrowing which occurred in February and March 2010.

I can support this idea by the fact that many major market players have come to realise this disadvantage of WTI oil futures (Publication 5). In particular, during the “wild contango” period which lasted from December 2008 to February 2009, Saudi Arabia raised the question of abandoning the WTI as a crude oil benchmark (Blas, 2009). In fact, more than half of the world oil trading is actually tied up to Brent. Brent oil futures are listed on both the ICE and the NYMEX Exchange. There are two basic differences between these two oil benchmarks. First, Brent and Brent oil futures are not linked to a specific territory. Second, physical deliveries are not foreseen under Brent futures contract. Settlements are made in cash at the ICE Brent Index Price at the contract expiry date (ICE, 2012). These factors make Brent the most universal benchmark for oil prices in the world. Brent futures prices and spreads between futures reflect the global balance between crude oil supply and demand much more clearly. Therefore, we do not observe these phenomena with Brent futures. Although Brent futures are also in contango, we do not see such drastic speculative manipulations (“bubbles”) (see Figure 8).



Source: QuoteCenter

Figure 8: Comparative chart of WTI Oil Calendar Spread and Brent Oil Calendar spreads for the period from 01.12.2008-31.12.2008 based on two consecutive months futures.

In addition, I can confirm the argument that everything that happens with WTI futures seems speculative in nature, and not at all connected with fundamental reality by the fact that in all those situations during the period of "enormous contango", there were abrupt jerks towards narrowing of spreads which speculative short position technical closures of the expiring month contract caused. At the same time, one of the arbitrage model hypotheses states that there are arbitrage players in the market who will take delivery under an expiring contract, provide storage and further delivery against distant futures, thereby contributing to a gradual narrowing of the spread (Hull, 2006).

However, what happens when only 2% of the total number of contracts ends up in the physical delivery (as is common with the ripe futures markets)? This implies that, at the very least, it would be difficult to apply arbitrage models to this situation. In other words, in this situation it is necessary to develop an alternative model which would reflect today's increased volatility on the WTI futures market (and in the markets in general).

b) The 2008 crisis led to changes in financial markets which were unobservable previously. In particular, I am talking about the fact that the world's largest banks have lowered interest rates to almost 0 (Banking News & Directory, 2012). Additionally, the Fed has brought rates to a value of 0.25%, which remained for three years (2009-2012) and, as stated at the recent Federal Open Market Committee (FOMC) meetings, will remain so until 2014 (Board of Governors of the Federal Reserve System, 2012). The financial world is facing a new reality, which is called "zero risk-free rate".

The impact of this factor on theoretical finance is difficult to overestimate. In particular, a large number of theoretical models include the concept of risk-free rate, and, as an assumption to these models, imply that the risk-free rate is not zero. The same is true for the described cost of carry model. If to insert the value of r = 0 in the formula (1), the futures price will be equal to the spot price, that is, markets can not be in contango. Moreover, since the summer of 2011, analysts have started to observe a situation where short-term U.S. and German bonds traded at a negative yield. Following this logic, a negative risk-free rate should lead to a permanent presence in the backwardation commodity markets, regardless of the situation with fundamental supply and demand balance. Otherwise, arbitrageurs would open the possibility of a risk-free profit. However, despite that the WTI crude oil market was in contango for a long time, the precious metals markets are in contango. Base metals markets switch periodically between contango and backwardation. This situation points to the fact that many financial models must be adapted to the current state of affairs. In my opinion, the discussion from the prospective of zero or negative risk-free rate must be undertaken as well.

If to ignore the theoretical models, and pay attention to which implications for financial markets have a zero risk-free rate on a practical level, an interesting picture will be found. In particular, the great number of investors including institutional ones, have been focused for decades on obtaining nominal and real risk-free income. Since 2008, the situation has changed drastically and the real risk-free rate of return has become negative. This leads to the fact that traditional investors are attempting to adapt themselves to new situations by trying to find other ways of investing. This includes new approaches: discovering other markets, such as commodities and narrowing the investment horizon, thereby trying to reduce exposure to long-term risks. The emergence of larger speculative capital in the

markets leads to higher volatility and appearance of values of financial instruments which are disconnected from the fundamental situation and lack any logic (Publication 5; Perchanok, 2012).

Further development of computer technology has led to the fact that trading machines start to play a significant role. Perchanok (2012: 60) suggests that:

> Although in earlier times the volume of these machine operations represented only an insignificant market share, currently their actions are a major factor in defining the direction and speed of movement of various financial assets' prices. Of course, even before the appearance of trading programs, sudden speculative price spikes or slumps occurred that were in conflict with fundamental factors. However, there were quite a number of arbitrageurs, investors, and commercial players who, by their actions, quickly restored the status quo in the market, returning prices to normal ranges.

Now, it is becoming increasingly apparent that fundamental analysis and a focus on fundamentals have ceased to play any significant role in trading decisions. Such changes suggest that algorithmic trading programs, not people are making most of these decisions (Perchanok, 2012).

Widely regarded as one of the main tools of technical analysis is the concept of a trend and it can be most easily incorporated into algorithms of trading machines. Publication 1 states that one can express spread trends much more strongly than simple outright positions. Therefore, the actions of trading machines focused on trend following increase the trending move, bringing the size of spreads to absurd values. These values contradict with fundamental logic and theoretical models, which should explain spread values (e.g. the cost of carry model).

Discussion about the need to supplement the theory of storage and the cost of carry model would not be complete without mentioning a particular school of thought, best represented by the work of Anand (2000) who finds it impossible for the market to be in a full-carry condition for a long time because of arbitrage opportunities. Anand (2000: 32) suggests

that:

> We use the cost-of carry model to show that no-arbitrage conditions rule out the possibility of the convenience yield being zero, or, equivalently, the possibility of markets being at full carry. We show that an option component to the convenience yield exists, and this option has value when the market is at full carry. The spread is analysed for option-like properties to establish the existence of the option. Further, cointegration tests are used to show the existence of the option in the cost-of-carry relationship.

Anand (2000: 35) further suggests that:

> When the convenience yield equals zero (at full carry), this creates an arbitrage opportunity for the cash and carry trader. As is generally understood, an arbitrage implies a position that is costless, with a zero probability of a negative payoff, and a positive probability of a positive payoff. The position has the structure of a call option on a convenience yield, which is in the money when the market moves away from full carry.

Additionally, Anand (2000: 36) explains:

> Therefore, as stated earlier, a market at full carry provides a free option to the cash and carry trader. Given a positive probability of the option payoff being positive and the assumption that this option is priced into the futures contract, the market *can never be at full carry*.

Whilst Anand agrees with the possibility of reaching the state of full-carry market, although not mentioning the possibility of exceeding these levels, he argues that the persistence of this condition is impossible for a long time due to arbitrageurs. However, the real situation on the market is in conflict with the authors' work and with other researchers who support this concept. As Publication 1 mentioned, the arbitrageurs' activity does not play as active a role as previously due to the increased role of speculative capital, which limits the effect of the actions which arbitrageurs take. Thus, the arbitrageurs' premise of

quickly liquidating the market discrepancy is not quite true in the present market situation. Tokic (2011) expresses a similar idea. In his article he examines how the interaction of different participants in the crude oil futures markets affects the crude oil price efficiency. Tokic (2011: 2051) states that:

> Normally, the commercial market participants, such as oil producers and oil consumers, act as arbitrageurs and ensure that the price of crude oil remains within the fundamental value range. However, institutional investors that invest in crude oil to diversify their portfolios and/or hedge inflation can destabilize the interaction among commercial participants and liquidity-providing speculators. We argue that institutional investors can impose limits to arbitrage, particularly during the financial crisis when the investment demand for commodities is particularly strong.

So, if a significant effect from arbitrage activity cannot be counted on, it is possible to assume the appearance of abnormal market situations which are inexplicable in terms of existing models.

3.6 Conclusion

This chapter had two aims: to find a possible explanation for the occurrence of "wild" contango on the WTI crude oil futures market and to draw attention to the need for updating the theory of storage and the cost of carry model. Achieving these, the author makes the following conclusions:

a) Already in 2007, opinion began to appear that the WTI Crude Oil Benchmark pricing does not adequately reflect the situation on the international oil market (Habiby, 2007). The events of years 2008-2010 showed a further decrease in the status of this benchmark as a determinant of world oil prices. Tight binding of a futures contract to the physical delivery into Cushing Hub makes WTI very much locally-oriented. This opens opportunities for excessive speculative influence not only on the outright prices, but also on the calendar spreads.

b) The theory of storage is a fundamental theory which was created by Working (1948, 1949) and popularised by later authors. This theory reflected the situation when the futures markets were not excessively occupied by the speculators and abundant speculative capital. By that time markets players based their decisions on the fundamental balance between demand and supply. Therefore, the theory of storage brought up a theoretical foundation under the observed market processes. It addressed very well the existence of steep backwardation because this market condition is based upon purely fundamental factors. However, enormous contangos did not exist at that time and appeared only recently. Giant speculative presence, excessive liquidity, rising efficiency of the ripe futures markets, appearance of round the clock trading and algorithmic trading machines strengthened the divergence between fundamentally explainable from a theoretical point of view values of contangos and values of observed ones. There is an urgent need for further research in order to effectively amend and adapt the theory of storage in a timely manner in line with the latest market situation.

3.7 Summary of Chapter Three

This chapter examined the causes of occurrence of contangos enormous dimensions on crude oil calendar spreads markets. It discussed the need for updating the theory of storage and adapting it to the current market circumstances. It also provided an expanded literature review which showed the standing of my research.

Chapter Four: Development of a Framework for Effective Analysis for Future Spreads Trading

4.1 Introduction

Futures spreads trading requires the constant and active use of different types of analysis for making trading decisions. Despite the importance of this subject, research on it is very limited. My publications contributed to the development of the framework for spreads analysis.

Chapter Four's objective is to consider in detail the possibility of practical application of all types of analyses to spreads, assess supplementary function of comparative-historical analysis, and to demonstrate inefficiency of application for practicing investors of the regression-correlation analysis.

This chapter proposes an algorithm of co-integration of the four types of spreads analysis for the purposes of creating trading strategies and decision-making.

This chapter demonstrates the standing of my research in relation to other works in this field.

4.2 Literature Review

The futures spreads market can barely be called efficient. Thus, futures spreads trading requires the constant and active use of different types of analysis to make trading decisions. Despite the importance of this subject, research on it is very limited.

There are five basic types of analysis that can be used when working with spreads: fundamental, seasonal, technical, comparative historical, and regression-correlation (Smith, 2000; Publication 1).

Fundamental analysis of commodity markets is based on the following principle: any

economic factor that reduces the supply or increases the demand will increase the price (Schwager and Turner, 1995). Conversely, we see that any factor which increases the supply or reduces the demand usually leads to stock accumulation and a fall in prices (Schwager and Turner, 1995; Thomsett, 2006; Errera and Brown, 1999). Fundamental factors play an important role not only in the case of spreads, but also in the case of outright futures positions, currencies, and shares. Whatever segment of the market that may be mentioned, in the long run, these fundamental factors will play a determining role (Ross, 2006b). However, there is a certain difference between spreads and other investment instruments. In fact, fundamental factors impact spreads much more strongly than other instruments (Smith, 2000; Ross, 2006b). Furthermore, fundamental factors also affect spreads much more quickly. In terms of spreads, this type of analysis has been studied by Smith (2000), Ross (2006b), Murray (2004), and Publication 1.

Seasonal analysis is based on life processes and methods employed by statistical analysis (Moore *et al.*, 2006; Bernstein 1990). Essentially, when analysing analogous historical periods, investors attempt to find recurring patterns, and if they identify the high recurrence of a certain behaviour that prices previously exhibited, they assume that such behaviour is likely to occur in the future (Moore *et al.*, 2006; Publication 1). Hence, the longer the selected time span for analysis, the more credible the analysis pattern and, consequently, the more reasons to expect that this pattern will repeat itself in the future. This type of analysis is widely used in working with spreads; the possibility of its application has been studied by the following authors: Moore *et al.* (2006), Smith (2000), Ross (2006a, 2006b), Tolmasky and Hindanov (2002), Murray (2004, 2006), Carpenter and Levy (1998), Salcedo (2004), Publications 1 and 3.

Technical analysis is the study of market dynamics with the purpose of forecasting future price trends; it is focused on investment decision-making (Murphy, 1999). As applied to the futures market, the term *market dynamics* captures two information sources available to a technical analyst—namely, transaction prices and transaction volumes. In investigating price movement and trade volume dynamics, technical analysis puts aside the issuer and the environment where it operates—that is, knowing the reasons behind price movements is not absolutely necessary in a technical analysis. Usage of technical analysis in spreads trading is studied less than other types of analysis (McComas, 2003; Smith, 2000; Ross,

2006b; Publication 1).

Comparative-historical analysis is based on the assumption that, under similar circumstances (fundamental factors), futures prices or spreads should behave in a similar way (Smith, 2000; Publication 1). It suggests searching for situations in the past that are similar to the current one, tracing the behaviour of prices in that historical period, and predicting the development of the current situation on this basis. Because of its supplementary function, this type of analysis is limitedly used in the work with spreads and therefore was not significantly highlighted in the literature. Attention to this type of analysis is given in the works of Smith (2000) and Publication 1.

Regression analysis involves identifying the relationship between a dependent variable and one or more independent variables (Markin, 2006). A model of the relationship is hypothesized, and estimates of the parameter values are used to develop an estimated regression equation (Markin, 2006; Prosvetov, 2008). Various tests are then employed to determine whether the model is satisfactory. If the model is deemed satisfactory, the estimated regression equation can be used to predict the value of the dependent variable based on values for the independent variables (Theil, 1971; Chow, 1983).

Correlation and regression analysis are related in that both deal with relationships among variables. The correlation coefficient is a measure of the linear association between two variables (Markin, 2006; Prosvetov, 2008). Values of the correlation coefficient are always between -1 and +1. A correlation coefficient of +1 indicates that two variables are perfectly related in a positive linear sense, a correlation coefficient of -1 indicates that two variables are perfectly related in a negative linear sense, and a correlation coefficient of 0 indicates that there is no linear relationship between the two variables (Markin, 2006; Prosvetov, 2008). Smith, 2000 contributed to the study of this type of analysis in relation to spreads.

This chapter aims to extend the currently limited literature on the analysis of futures spreads. Its objectives are to consider in detail the possible practical application of all types of analyses to spreads, to assess the supplementary function of comparative-historical analysis, and to demonstrate the inefficiency of application of the regression-correlation analysis for practicing investors.

This chapter proposes a framework of co-integration of the four types of spreads analysis for the purposes of creating trading strategies and decision-making.

The remainder of the chapter is structured as follows: section two contains a short discussion about the Efficient Markets Hypothesis (EMH) and the usefulness of performing analysis, section three deals with fundamental analysis, section four covers seasonal analysis, section five discusses technical analysis, section six explores comparative-historical analysis, section seven critically examines regression-correlation analysis in relation to spreads, section eight offers a framework of co-integration of different analysis types, and section nine provides conclusions.

4.3 Short Discussion about Efficient Markets Hypothesis (EMH) and Usefulness of Analysis Performing

Before I move on to different types of analysis, it is necessary to mention the Efficient Market Hypothesis (EMH).

The EMH is the cornerstone of modern financial economics. The paradigm was coined in the 1960-70s by Roberts (1967) and formalised by Fama (1970). They identified three forms of market efficiency distinguished by the type of information that prices of securities should correctly incorporate. For a long time the EMH has been the dominant paradigm in finance.

The weak form (or random walk) of the EMH assumes that prices fully reflect the information contained in the historical sequence of prices. Thus, in a competitive market, it should not be profitable to base investment decisions on information obtained from past prices or returns of publicly traded securities. According to Malkiel (1999; 2003; 2011), the stock price changes should be random and unpredictable - i.e., stock price movement follows a random walk (Roberts, 1959). This version implies that technical analysis is fruitless.

The semi-strong form of the EMH assumes that current stock prices reflect not only historical price information, but also all publicly available information relevant for

company securities. If markets are efficient in this sense, then an analysis of balance sheets, income statements, announcements of dividend changes or stock splits, or any other public information about a company will not yield abnormal economic profits. Investors cannot trade profitably on the basis of announcements since the relevant information had already been reflected in the stock prices by the time of an announcement (Williams, 1977; Fama, 1991). This version implies that insider trading may be profitable.

The strong form of the EMH ensures that all information that is known to any market participant about a company is fully reflected in the market prices. Hence, not even those with privileged information can make use of it to secure superior investment results. There is a perfect revelation of all private information in the market prices (Malkiel, 1992). This version implies that fundamental analysis is also useless, prices are always fair, and no investor would be able to make consistently superior forecasts of prices. This form justifies the creation of index funds' passive strategies.

By 1975, the preponderance of evidence indicated that markets were efficient. Statistical studies showed that technical analysis did not add value (consistent with the weak form of market efficiency). Event studies found that the market quickly reacts to new information (consistent with the semi-strong form of market efficiency). And studies of professional investors' performance made a strong case for the strong form of market efficiency.

As more researchers tested the efficient market hypothesis, some rather controversial evidence began to appear. Rozeff and Kinney (1976) published their article on stock market seasonality, finding that January stock returns were higher than in any other month. Gibbons and Hess (1981) reported "the Monday effect": stock prices tended to go down on Mondays. Both of these findings were clearly inconsistent with the weak form of market efficiency. An unexpected criticism of the efficient market hypothesis came from academic economists. Grossman and Stiglitz (1980) argued that if all relevant information were reflected in market prices, market agents would have no incentive to acquire the information on which prices are based.

Moreover, there were studies suggesting that the stock market actually overreacts to certain announcements. In 1981, Shiller published the article "Do Stock Prices Move Too Much to

Be Justified by Subsequent Changes in Dividends?" and concluded that they do. This phenomenon came to be known as "excess volatility." In their article, De Bondt and Thaler (1985) concluded that the stock market tends to overreact to long series of bad news. So, by 1985, there were enough anomalies discovered for one to seriously doubt the validity of the efficient market hypothesis.

From the above it can be concluded that there are both supporters and opponents of the EMH. I do not set a goal in this chapter to join the discussion. However, below are a few main reasons why the futures spreads markets, in our opinion, can barely be called efficient, and why it is meaningful to use different types of analysis:

1. Increased volatility. This can be demonstrated by the spread Brent oil/ WTI Crude oil, which is described in more detail in Perchanok (2012). This spread widened during a period of less than one year from 1,5 dollars to 26 dollars, which corresponds to 1500%. Such volatility inherently conflicts with the EMH.

2. The presence in the market of a huge number of players who operate very large amounts of capital and use in their work algorithmic trading programs focused on technical analysis. When the majority of market participants follow the same technical patterns in making their trading decisions, they "make" these methods work in practice.

3. Market manipulation with the use of excessive speculative capital. Some players make the market move in the direction of their interest to cause involuntary activation of Stop/Loss of other market participants (Harrington *et al.*, 2012).

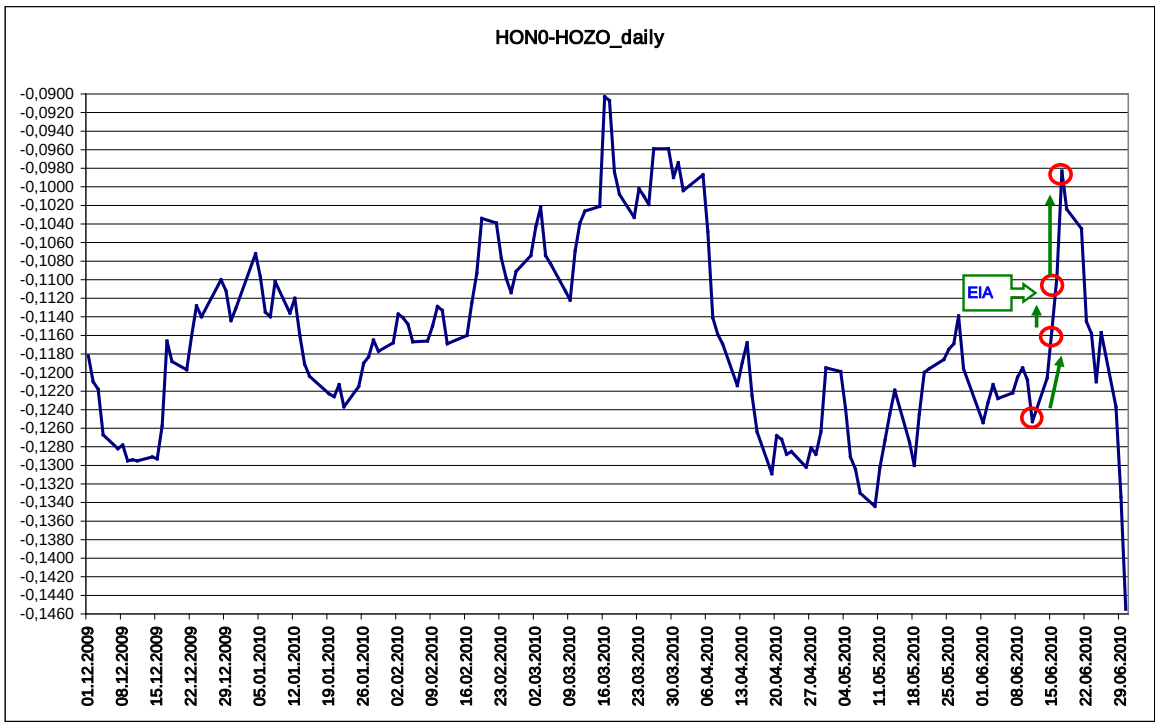
4. The existence of very strong seasonal patterns in some types of spreads. The possibility of capitalising on these seasonal trends and receiving abnormal returns contradicts EMH in not only its weak form, but its strong one as well, because implies the necessity to actively manage its position. Of course, active management relies on the use of seasonal analysis.

Thus, I believe that, with respect to spreads, various types of analysis are useful.

4.4 Use of Fundamental Analysis in Working with Futures Spreads

There is a certain difference between spreads and other investment instruments. In fact, fundamental factors impact spreads much more strongly than other instruments. Furthermore, fundamental factors affect spreads much more quickly (Publication 1). For example, if to look at the FOREX currency market, it may take fundamental factors from 3 to 5 months to break a strong trend. At the same time, movement of spreads in the same direction as the trend may stop immediately if important fundamental factors affecting these spreads appear along the way. This means that they are much more sensitive to fundamental factors and more logical in their movements than outright positions. Even though spreads may be considered as highly speculative investment tools, a speculative impact unsupported by a fundamental situation tends to be weaker in the case of spreads.

Let's consider an example described in the Publication 1 of how fundamental factors impacted heating oil calendar spreads. Figure 9 shows a spread chart between June (HONO) and December (HOZO) heating oil futures contracts.



Source: Publication 1

Figure 9: HON0/HOZ0 Spread Chart.

On 11.06.2010, this spread, like other heating oil calendar spreads, began to narrow gradually, but the size of this narrowing was insignificant. On 15.06.2010, the narrowing of the spread became more aggressive. On 16.06.2010, the EIA issued an oil market report showing a considerable growth in heating oil inventories during the previous week. This marked an extremely important fundamental factor that should have forced the spreads to widen. However, the opposite took place: the spreads continued to narrow aggressively, reaching a local minimum on 17.06.2010 (we should not forget that the market was in contango and that the graph values were in negative territory). This situation is also curious in that heating oil spreads tend to exhibit a seasonal pattern, somewhat expanding toward the end of June. It is important to note that the spread ignored two significant factors as seasonality and changes in inventories. What happened next? The chart shows that the spread movement swung in the opposite direction, widening sharply and reaching its absolute maximum for that year within a very short period of time. This means that the fundamental factors affected the spreads so strongly that they were forced to “turn around” and “depart” quickly in the opposite direction. Moreover, all these movements occurred within an approximate period of two weeks.

If to think about the range of movement of the spread and apply it to the movement in heating oil prices, then a trend of extreme force and duration would be required to make heating oil futures travel a path of this size (naturally, if the movement size is scaled as a respective percentage ratio). This example clearly shows how sensitive spreads may be to the impact of fundamental factors.

If the investor plans to work with spreads, he should first make an in-depth analysis of each individual spread. The issue is complex, as each type of spread is impacted by its individual and inherent fundamental factors. Moreover, each spread can be impacted by a considerable number of fundamental factors, so it is essential to pick out those whose impact has a determining character.

The following algorithm is suggested:

1. Choose a spread that should be analysed.

2. Determine which group this spread belongs to: calendar, intercommodity, intermarket,

or processing.

3. Collect information on factors which will affect the price of each position in the spread.

4. Define the interoperability of these factors.

5. Trace the reaction of the spread to these factors.

Determining which group the spread belongs to is crucial, as in the case of calendar spreads. We are only interested in factors related to one and the same contract. In the case of intercommodity spreads, for example, both parts of the spread—i.e., different contracts—should be analysed. The same can be said for intermarket spreads, but the analysis should include not only the futures contracts composing the spread, but also the situation on territorial markets where the contractual goods are to be delivered. The situation becomes even more complicated in the case of complex or industrial spreads, as the number of elements integrated into the spread increases.

The “search for information” step is of key importance in spread management (Publication 1). Data for an effective fundamental analysis is not always easy to find. At the very least, the needed information is not always available in one place. For example, a great source of information is reports presented by various U.S. government agencies and departments. The information in these reports is fundamentally important and helps to define factors affecting corresponding futures contracts and spreads. The Energy Information Administration of the U.S. Department of Energy (EIA, 2012) publishes information on the state of affairs in the energy sector on its website every week. The United States Department of Agriculture (USDA, 2012) publishes reports concerning agricultural goods and provides access to archives containing historical information on agricultural goods. The United States Geological Survey (USGS, 2012) presents reports containing information that may be useful for defining the objectives of an analysis on the metals market. If the question concerns currencies or bonds, the information available on the websites of central banks in different countries becomes indispensable. Finally, analytical notes published by news channels, such as Bloomberg or Reuters, can be of great practical use.

In a number of works (Smith, 2000; Publication 1; Schap, 2005), fundamental analysis of

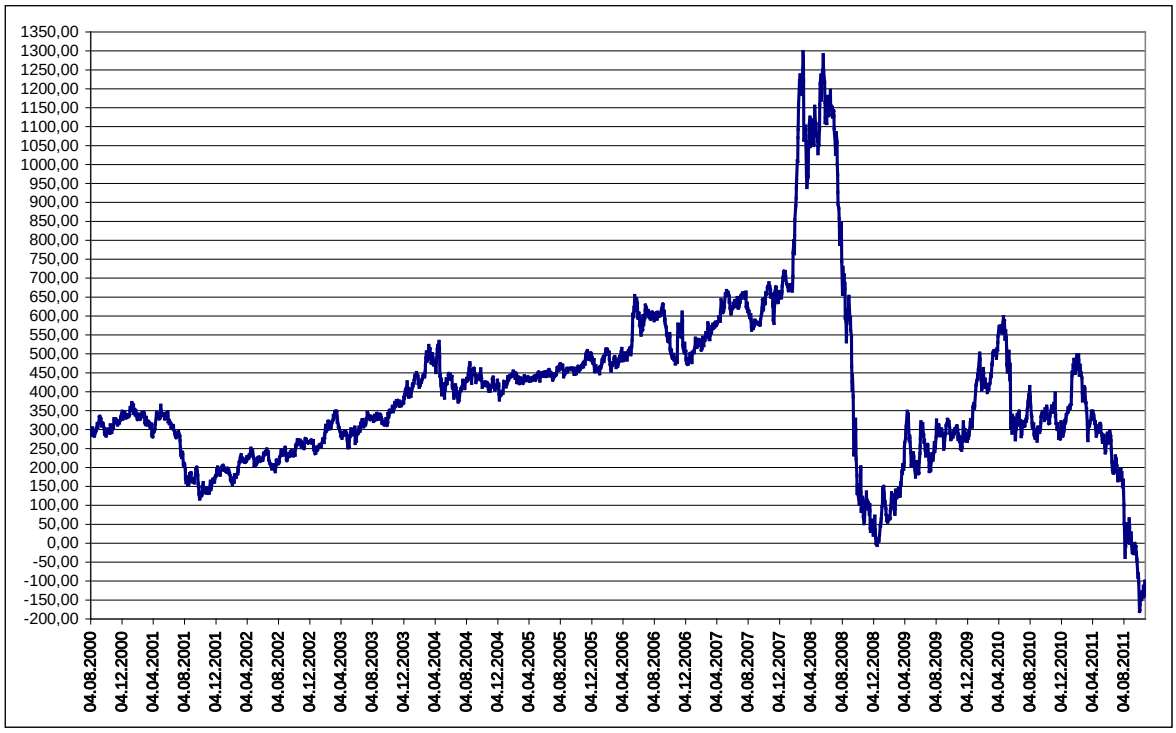
spreads is indicated as the main tool of analysis. Long time spreads were very sensitive to changes in the fundamental situation, and this type of analysis successfully performed its function. However, since 2008, the situation in the financial markets has begun to change, and the fact that market participants ignore some fundamental factors in making their trading decisions has become more noticeable (Publication 1). It is becoming increasingly apparent that fundamental analysis and a focus on fundamentals have ceased to play any significant role in trading decisions (Perchanok, 2012).

This can be explained by an increase in liquidity, the activity of speculators, and the fact that most of these decisions are being made not by people, but by algorithmic trading programs.

Such changes have led to some spreads reaching values that cannot be explained by fundamental analysis, as they are illogical according to it. This situation is described in more detail in Publication 1 and Publication 5.

Consider the spread platinum/gold. Fundamental factors that will influence the spread platinum/gold movement include: economic situation, inflation rate, platinum supply/demand balance, seasonality, and general sentiment among market participants (Publication 3).

Platinum is a precious metal much more rare than gold, with a production volume approximately 30 times less than that of gold. Platinum is widely used in jewelry and for industrial purposes. The main demand for it comes from the automotive industry, where it is used for the manufacture of catalytic converters. Industrial demand for platinum is inelastic, since there are practically no alternatives to it, except for palladium, which belongs to the same group of metals. Platinum supply, unlike gold, is also inelastic, since there are no large reserves of platinum in warehouses (Lee, 2011). In addition, 80% of the world's production of platinum is concentrated in South Africa—a country that is not a model of stability. The production cost of platinum is significantly higher than that of gold (Lee, 2011; Publication 3). Taking into account all of these factors, it can be said that the price of platinum should significantly exceed the price of gold, as was observed for many years when platinum was worth an average of 20-30% more than gold (see Figure 10).



Source: Quote Center

Figure 10: Platinum/Gold Spread Chart for 2000-2011.

If to look at the history of the past 10 years, it is only during the crisis of 2008 that the price of platinum was at the same level as the price of gold, and for a short time it was even $20 cheaper than gold. However, this situation did not last long, and the spread began rapidly widening, which led to the restoration of the traditional differences in prices.

Beginning in September 2011, the price of gold became steadily higher than the price of platinum—that is, the value of the spread was less than 0. On some days, the size of the spread reached -225 dollars. These values cannot be explained from a fundamental point of view (Perchanok, 2012). The platinum/gold spread is not the only spread that achieved abnormal values. Further examples of different anomalies in spreads could easily be found. This allows us to state that there is a clear tendency of weakening fundamentals and fundamental analysis in general.

4.5 Use of Seasonality Analysis in Working with Futures Spreads

In the case of spreads seasonality is much more pronounced. In reality, practically all spreads exhibit seasonality, beginning with gasoline and corn calendar spreads, where seasonality is a key determinant, and ending with interest rate spreads, which are less affected by seasonal influences (Moore *et al.*, 2006). The fact that spreads are much more prone to cyclic movements than outright futures positions is explained by the fact that spreads are less susceptible to speculative pressures and more driven by intrinsic, natural, production, and life processes (Publication 1).

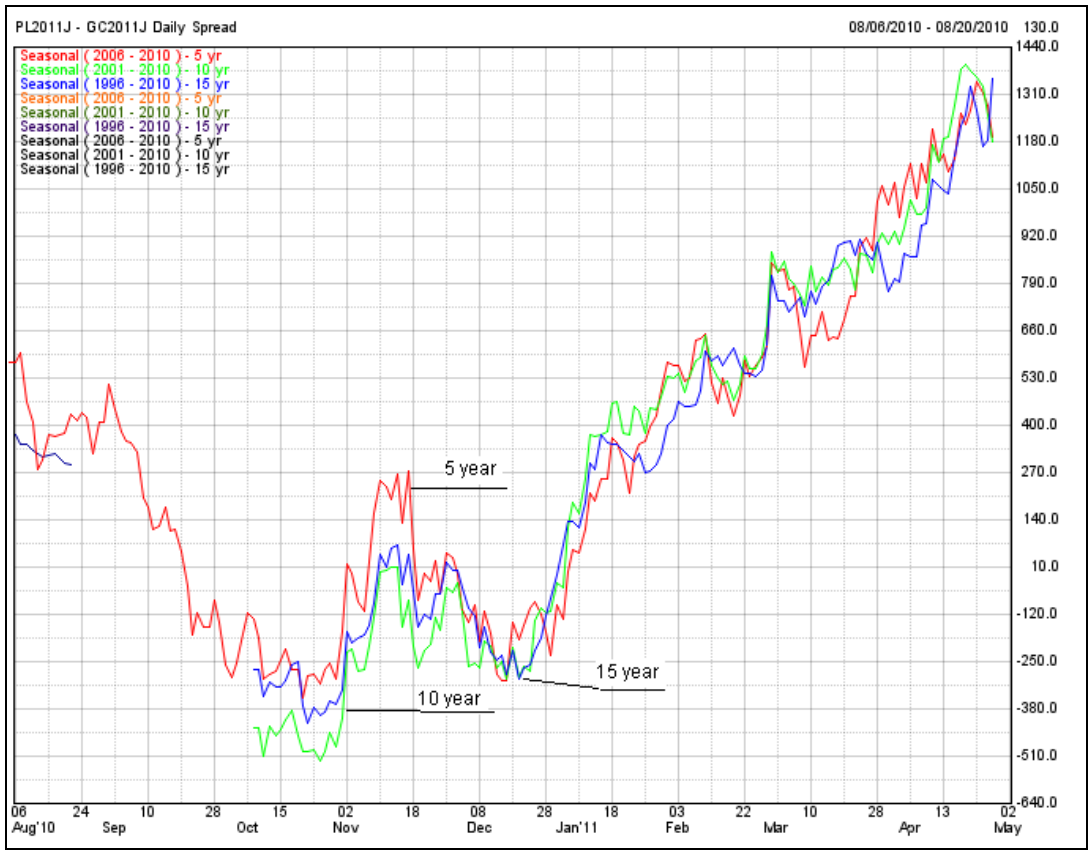
Such an enviable regularity of spreads displayed from year to year allows investors to benefit when making investment decisions. Many investors even rely on seasonality and seasonal analysis as the key tool in their work with spreads. This makes sense, since movements of spreads, as mentioned earlier, have a good deal of logic behind them. However, I believe that one should not rely solely on this analysis when making trading decisions.

Seasonal analysis is based on the methods employed in statistical analysis. Essentially, when analysing analogous historical periods, investors attempt to find recurring patterns, and if they identify the high recurrence of certain behaviour exhibited by prices in the past, they assume that such behaviour is likely to occur in the future (Murray, 2004; Publication 1). Hence, the longer the time span selected for analysis, the more credible the analysis of patterns is and, consequently, the more reasons there are to expect that this pattern will repeat itself in the future. In order for a pattern to be considered reliable, it should exhibit stability for at least three to five years.

Figure 11 shows that the platinum/gold spread displays a strong seasonal pattern, with the spread widening between January and May. This is primarily due to the difference in the demand growth cycles of these metals. In particular, starting from September to approximately the end of February the demand for gold is rising. This growth is driven by the requirements of the jewellery industry, which strives to meet the demand of the population during Christmas, Chinese New Year and autumn weddings in India. Such growth in the demand for gold makes the spread narrow. Starting in January, the industrial

demand for platinum begins to grow; during the whole spring the price of this metal is rising, causing the spread to widen (Publication 3).

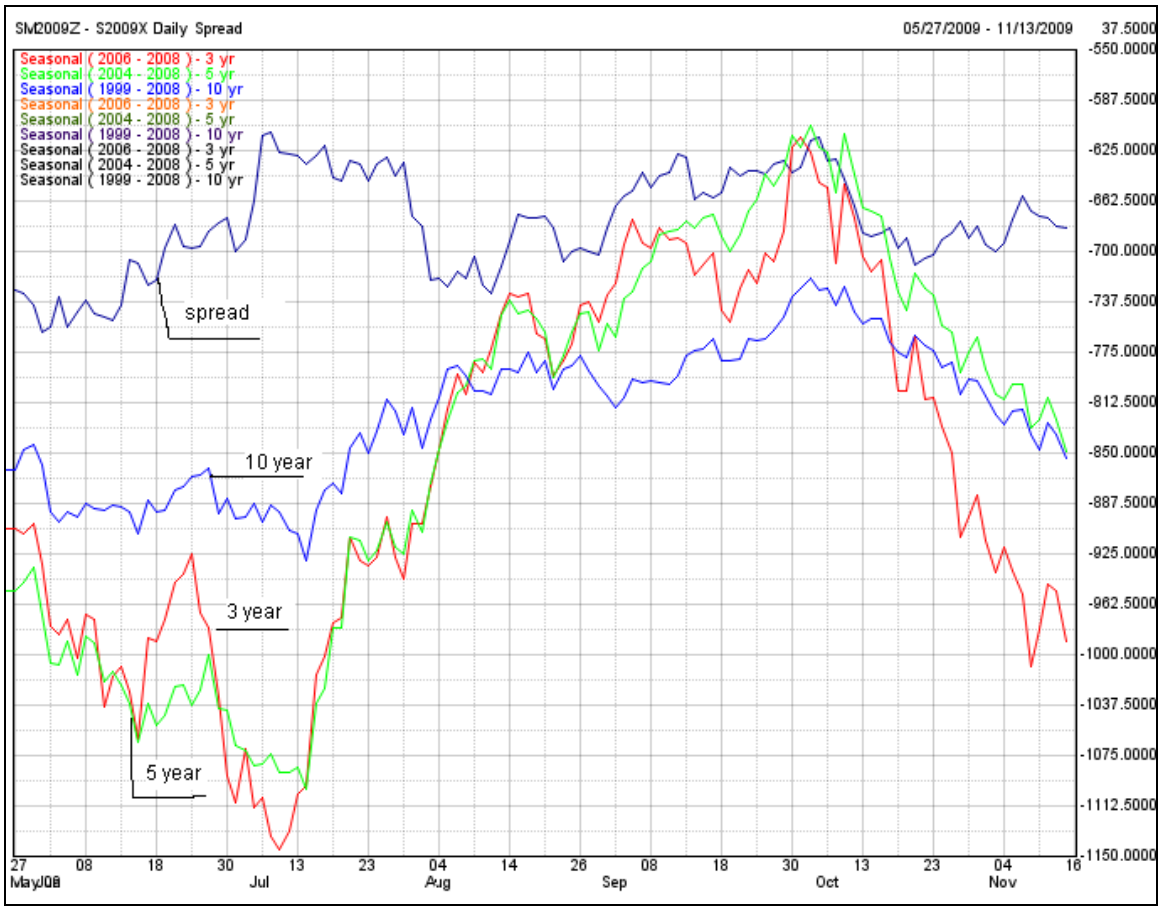
Despite the weakening of the influence of fundamental factors, the seasonality of this spread continues to influence it. The traditional pattern of widening in spring remained intact in 2012.



Source: Capitol Commodity Services Quotes and Charts

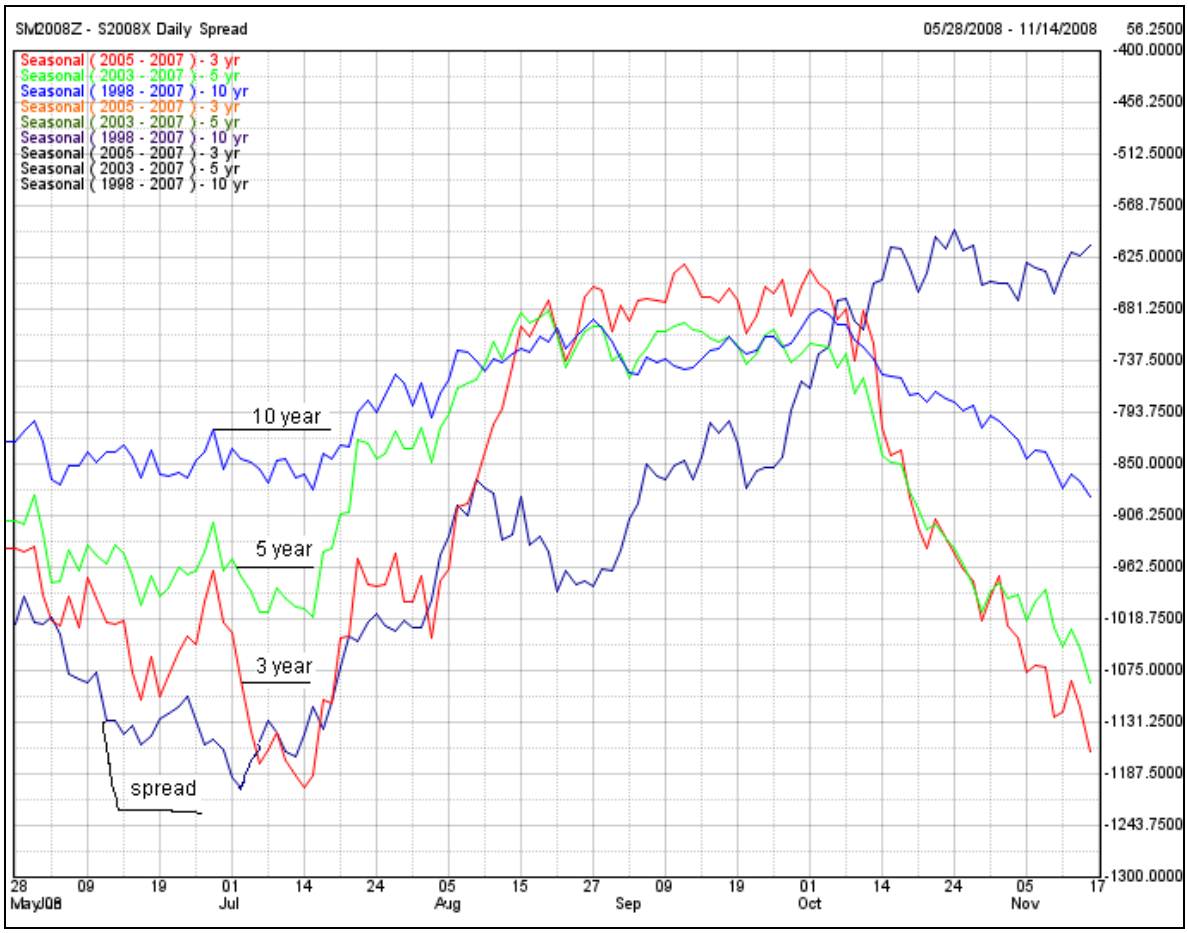
Figure 11: Seasonal Pattern of the PLJ/GCJ Spread for 15, 10, and 5 Years.

Figures 12 and 13 show the seasonal pattern of the soybean meal/soybean spread and a chart of the soybean meal/soybean spread, respectively.



Source: Capitol Commodity Services Quotes and Charts

Figure 12: Seasonal Pattern of the Soybean (December 2009)/Soybean Meal (November 2009) Spread for 10, 5, and 3 years.



Source: Capitol Commodity Services Quotes and Charts

Figure 13: Seasonal Pattern of the Soybean Meal (December 2008)/Soybean (November 2008) Spread for 10, 5, and 3 Years.

Despite the fact that this spread exhibits a very strong seasonal pattern and tends to narrow in July-September, this did not happen in 2009. The spread in late July 2009 was already very narrow. It remained in a sideways trend till late September and thus did not follow its seasonal pattern. This is unlike in 2008 (Figure 12), when the spread narrowed from -1190 (in July) to -750 (at the end of September).

Whenever algorithmic software is used for seasonal analysis, this analysis has a number of strategic limitations. In particular, seasonal patterns can rapidly change or disappear. Moreover, this often occurs with very steady seasonal cycles. As a rule, this happens due to the impact of significant fundamental factors. I can give the following example. For a long time, the U.S. remained the only major exporter of soy. Therefore, the seasonal cycle in the behaviour of soy spreads was oriented toward the seasonality typical of the U.S. This

concerned allocation of land for sowing, growing and harvesting crops, etc. In the late 1980s to the early 1990s, soybeans were offered in the market by Latin-American countries including Brazil, Argentina, Uruguay, and Paraguay. The aggregate output of these countries started to outweigh U.S. production. Since these countries are located in the southern hemisphere, their production cycle is different from that in North America. This factor caused huge changes in the behaviour of soybean spreads and broke the previous seasonal patterns.

Another example is currencies and currency spreads. There were some credible calculations made for a number of currency spreads that provided some insight as to the presence of seasonal cycles. However, it is safe to say that even if such patterns did exist, they vanished after the 2008 financial crisis. This is explained by radical changes in the levels of refinancing rates in many countries across the world, which disrupted previously existing relationships and correlations. This can be demonstrated with the following example. For many years, the Swiss franc base rate has been close to zero, while the UK pound base rate was 5% prior to the 2008 crisis and 0,5% after the crisis. Thus, the difference in the base rates between the Swiss franc and the UK pound that had existed for decades disappeared within a few months. It would be logical to assume that such appreciable change has greatly impacted the existing relationships between currency exchange rates, and even more so the behaviour of currency spreads. All of this shows that one should not rely solely on seasonal analysis when assessing the current situation. Seasonal analysis should be combined with other types of analysis to achieve adequate results from an evaluation of the current situation.

4.6 Use of Technical Analysis in Working with Futures Spreads

The classical theory of technical analysis, which contains fundamental principles laid down by Charles Dow towards the end of the 19th century, is founded on three postulates—fine points on which the technical analysis is based, and its methodological logic (Murphy, 1999).

First postulate: *The market considers everything* (or the rate considers everything; the price considers everything).

Second postulate: *Price movements are subject to specific tendencies* (or prices move in one direction within a certain time interval; the market follows certain trends).

Third postulate: *History repeats itself*.

In my opinion, not all of the technical analysis tools can be used in work with spreads. Our observations show that it is much better to use configuration methods to make a technical analysis of spreads, such as trend lines, minimum-maximum, support and resistance, and trading ranges.

Let's consider each of these methods in detail.

Support and resistance lines (levels)

Support and resistance lines represent the foundation of classical trend analysis (Murphy, 1999; Williams, 2005). Their emergence, in the opinion of technical analysts, can be explained using the following logic. A resistance line connects market important maximums or market peaks. It emerges when buyers neither can nor wish to buy a given futures contract, spread or security at higher prices. Each time the price moves upward, sellers' resistance builds up and sales increase, which also puts pressure on the price. The upward trend is halted, as though held back by an invisible ceiling, which it cannot break through at that moment. If "bulls" gather their forces together, and "bears" slacken their grip, the price is likely to break the resistance level established earlier. Otherwise, the price will inevitably move the opposite way.

A support line connects market important minimums. Support lines emerge and exist inversely to resistance lines. Here, "bulls" exchange places with "bears." Sellers are active market players who push the price downward, whereas buyers will then find themselves on the defensive side. The more active the sellers and the more passive the buyers, the more probable it is that the support line level will be broken and the prices will slide even further downward.

If the support or resistance levels are distinctly broken, they usually move in opposite

directions. Therefore, as a rule, once a very strong support level gets through, it turns into an equally consistent resistance level. Conversely, when a strong resistance level is broken, it turns into a consistent support level.

Figure 14 shows a crack spread chart in which support and resistance lines are represented. Due to the decline in the spread at the end of 2008, initial support turned into resistance in an altered situation.

Source: eSignal

Figure 14: CLQ0/HOQ0/RBQ0 Crack Spread Chart.

It is better to draw support and resistance lines through the areas containing price clusters rather than through extreme price excursions. Price clustering shows that the behaviour of a determining number of traders changed its direction, whereas maximum price excursions in such areas make the weakest market participants panic and hastily close their loss-making positions.

Analysis of support and resistance lines helps traders to keep track of changes in the trend—both swings and acceleration.

Trend lines

A trend line is a natural product of the trend itself (Murphy, 1999). It is a straight line that connects maximum or minimum price peak points. If we look at the crack spread chart presented above, we see that the fall at the end of 2008 was followed by growth extending into mid-2010 with a clearly defined trend (Figure 15).

Source: eSignal

Figure 15: CLQ0/HOQ0/RBQ0 Crack Spread Chart.

Trend lines can be classified by their importance using the following indicators:

— *Time scale*: The larger the time scale, the more important the trend line. The trend line on a weekly chart displays a more important trend than that on a daily chart, and the trend line on a daily chart shows a more important trend line than that on a one-hour chart.

— *Length*: The longer the trend line, the more reliable it is. A short trend line displays behaviour of masses within a short time interval, whereas a longer line reflects their behaviour within a longer timeframe.

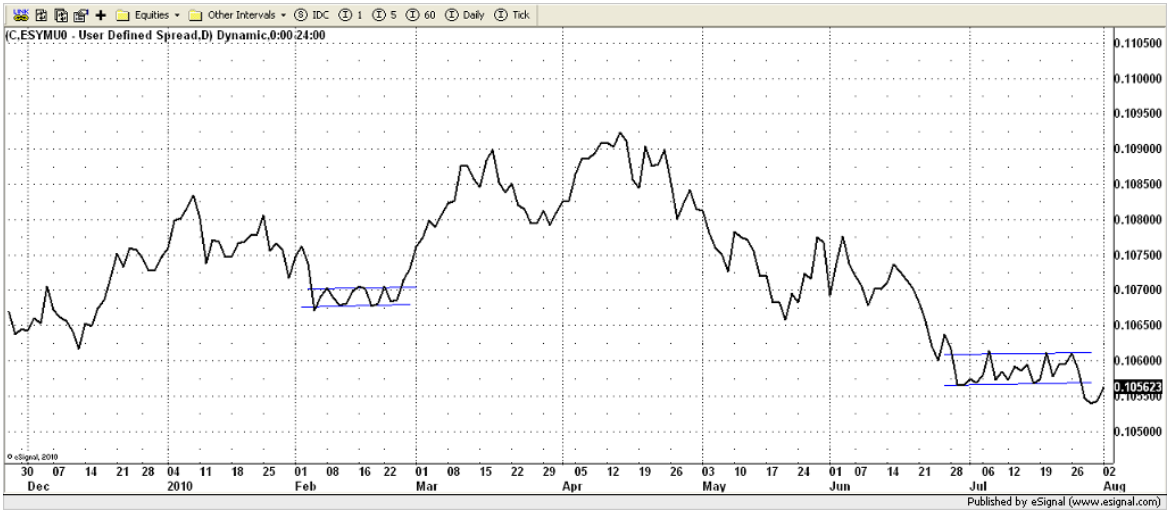
— *Number of times prices touch the trend line*: The more touches of prices, the more reliable the trend line. A preliminary trend line is drawn through only two points; the third contact point makes it more reliable, and the fourth or fifth touch points show that the dominant group on the market has significant potential.

— *Slope angle*: The angle between the trend line and the horizontal line displays the emotional intensity among the dominant market crowd. A steep trend line means that the dominant crowd is dynamic, whereas a relatively flat trend line means that the dominant crowd is rather inert. A flat trend line usually takes longer to develop.

To plot a trend line, it is enough to have two points through which it is drawn, and one more point to "validate" the trend. The trend line exists until it is broken through due to a sharp upward or downward price movement. Sharp changes in trend line directions do not occur very often. If there is no consolidation, the longer this situation continues, the sharper the subsequent swing. Several other chart examples of trend line tracing are shown below.

Trading ranges

Significant temporary price fluctuations between support and resistance levels lead to the formation of the so-called trading range, the limits of which are defined by these lines (Murphy, 1999; Williams, 2005). It is characteristic for some spreads to remain in a narrow trading range for a long period of time, considered almost as a kind of sideways trend. At a certain point in time, they leave this range under the influence of various fundamental factors and their movements can come across as very sharp and strong (Figure 16).



Source: eSignal

Figure 16: ESU0/YMU0 Spread Chart.

In conclusion, I would like to note that technical analysis methods have definite shortcomings. First, the criteria defining configuration patterns are relatively subjective (one analyst will examine one figure or one line, whereas another will study others, and the third will see absolutely nothing). The second imperfection is predetermined by particular market situations, which is generally true for all technical methods. Therefore, on one hand, configuration methods are very simple, but, on the other hand, they are subjective and in general do not provide a highly credible forecast of price movements. In my opinion, these methods should only be used in combination with other analysis methods—namely, fundamental and seasonal analyses.

In my opinion, there is a powerful tool of technical analysis that allows one to perform a dynamic assessment of the situation: the Relative Strength Index (RSI). This subject is addressed in more detail by Publication 2. However, I draw attention to some important abstracts.

RSI

The ***Relative Strength Index*** (RSI) is one of the main tools of technical analysis (Wong *et al.*, 2002; Murphy, 1999). It was developed and described by Welles Widler (1978). The formula of this indicator is based on the theory of probability. I would like to note that the general concept underlying this indicator holds that any movement in a particular direction will stop and the direction will change sooner or later. The stronger the initial movement, the stronger the pullback (Publication 2). Naturally, a movement that has lasted a few days will cause a greater reverse movement than one that has lasted a few hours or minutes. If we think about it, such a wave-like movement is somewhat phenomenal in its essence. We are used to pullbacks that are commonly called corrections and are integral to the behaviour of any financial market. Generally, it is hard to predict which direction the prices will "go" within short time intervals. However, it can be asserted with 100% confidence that a reverse movement will occur and we can also expect it to be considerable in strength.

There are a number of technical analysis methods that enable reverse movements to be assessed with a varying degree of accuracy (Stochastic Oscillator, Relative Momentum

Index). It should also be noted that the RSI indicator is an oscillator and its signals work most effectively only when the market experiences relatively lateral movement, whereas in a soaring or plummeting market the trend areas may well contain a considerable number of false signals (Murphy, 1999; Publication 2).

The RSI is plotted on a chart scaled from 0 to 100. The 70 and 30 values are used as warning signals; the zone below 30 is called the oversold zone and that above 70 is referred to as the overbought zone.

The RSI has only one parameter, which is the number of calculation periods. When introducing this indicator, Welles Wilder (1978) recommended using a 14-day period for RSI calculation. Later on, 7-, 9- and 25-day periods also became common. It should be kept in mind that the shorter the calculation period, the higher the oscillator's sensitivity and the greater the amplitude of its oscillation.

In my opinion, the daily RSI is the most interesting for assessing spreads. Since spreads tend to exhibit prolonged movements in any direction, their RSI quite easily moves into the area of extreme values and can stay there for a long time, sometimes reaching values such as 10 and 90. As practice shows, it is fairly hard for spreads to sustain a daily RSI value higher than 85 and lower than 15 for more than several days. Moreover, their potential for further movement along the trend is rather limited. These RSI levels may well be considered a market entry signal. Apart from the daily RSI, the 5-minute RSI can also be utilized, but it should be kept in mind that its values should be very extreme and approach 10 for spread purchase and 90 for spread sale. The 5-minute RSI is best suited for assessing intercommodity and intermarket spreads, while the daily RSI is suitable for spreads of all categories (Publication 2).

4.7 Use of Comparative-Historical Analysis in Working with Futures Spreads

It can be said that comparative historical analysis combines fundamental, technical, and seasonal analyses. First, one needs to select a period in which to examine the behaviour of prices and then compare fundamental data to find a configuration of fundamental factors most similar to the current one. After that, the investor can make an appropriate trading

decision for the current window while considering the current spread value. This approach seems to be very sophisticated, as the emergence of similar configurations of fundamental factors is highly unlikely due to a large number of these factors. In this case, the investor should select one or two fundamental factors and search for data based on them. The danger is that, firstly, the "key" factors may be selected incorrectly, and secondly, the evaluation of the comparison results is subjective in nature, not to mention the fact that it is necessary to look through a fair amount of statistical information. Based on the above, I would say that such an analysis is both difficult to perform and impractical.

A simpler version of this analysis consists of analysing charts for past periods. I would suggest the following sequence of steps: compare charts of the subject spread for several past years; if a chart or charts generally similar to the current one are found, compare the details of the current and found chart(s) to gain some insight into the possible behaviour of the current spread. The comparison may involve a number of parameters. This simple algorithm allows someone to perform this analysis even with very limited experience.

4.8 Critics of Regression and Correlation Analysis in Relation to Spreads

Spreads can be also analysed with the help of regression and correlation analysis. But the author believes that the use of regression and correlation analysis, in practice, is not really effective, and, therefore, refrained from in-depth study of it in relation to spreads. This position reflects my personal conviction based on my own practical experience. Below are the arguments for my position:

1. The aim of any analysis in trading is to assist in making various trading decisions. However, the use of regression-correlation analysis for the average trader is complicated because it requires adequate mathematical apparatus. Although traders have sophisticated software, such analysis still requires very specific knowledge in order to operate the software effectively. The majority of practical traders do not have such a high level of knowledge in mathematics. As evidence would show, most textbooks on practical trading never mention this type of analysis (Williams, 1999; Luca, 2000).

2. In short-term trading, application of this type of analysis is complicated by its very nature. It involves multiply steps: identification of the dependent and independent variables, creation of a hypothesized model of their relationship, estimation of the parameter values needed to develop an estimated regression equation, running of the various tests in order to determine if the model is satisfactory, application of the regression equation, and assessment of the results. Obviously, such analysis takes a very long time, and for an investor whose trading horizon is limited to a period of several months, it loses its relevance in analysing the situation.

3. One of the features of correlation analysis is that it is impossible to isolate the influence of extraneous factors because they are either unknown or cannot be isolated. Therefore, the correlation method used to determine what would be the result of the relationship between the cause and the effect assumes that extraneous factors did not change or that the change does not distort the basic relationship. If such an assumption is appropriate for theoretical research, then in practice, changes in extraneous factors happen very quickly, and together with a high degree of volatility, a practical trader is unable to take these factors into account. If any of the above factors had a negligible impact on the situation at the current time, its influence could increase in the near future, and it would become one of the key factors. Since the use of this type of analysis requires a large sampling time, including 10- to 20-year-old data, the results of this analysis would be questionable, because in the past 10 years, the world has experienced significant changes due to globalisation, which may not be reflected in the older data. Moreover, the recent events of 2008 changed the process of pricing in the future markets due to increased liquidity and the sharp reduction of the refinancing rates undertaken by the major central banks.

4. Neither regression nor correlation analyses can be interpreted as establishing cause-and-effect relationships (Markin, 2006). They can indicate only how or to what extent variables are associated with each other. The correlation coefficient measures only the degree of linear association between two variables (Prosvetov, 2008). Any conclusions about a cause-and-effect relationship must be based on the judgment of an analyst. Moreover, identification of the variables requires the use of other types of analysis that must be performed first in any case.

Thus, the regression-correlation analysis is, in my opinion, a tool for theoretical researchers. The rapidly changing situation and the high volatility do not offer adequate opportunity to apply this type of analysis in practical trading.

4.9 Framework of Co-integration of Different Analysis Types

Based on my research on spreads trading, I propose the following framework of co-integration of the different types of analysis in relation to the spreads:

1. Choosing the spreads to be used as a trading vehicle;
2. Making a plan of seasonal spread movements for a year using seasonal analysis;
3. Gathering and assessing, on a weekly basis, fundamental information on each spread using fundamental analysis;
4. Making a comparison between current and historical data;
5. Making a comparison between the magnitude of current spread movement and that in previous years;
6. Making use of technical data to determine the best trade entry and exit points;

Graphically, this algorithm is represented by a Diagram 2.

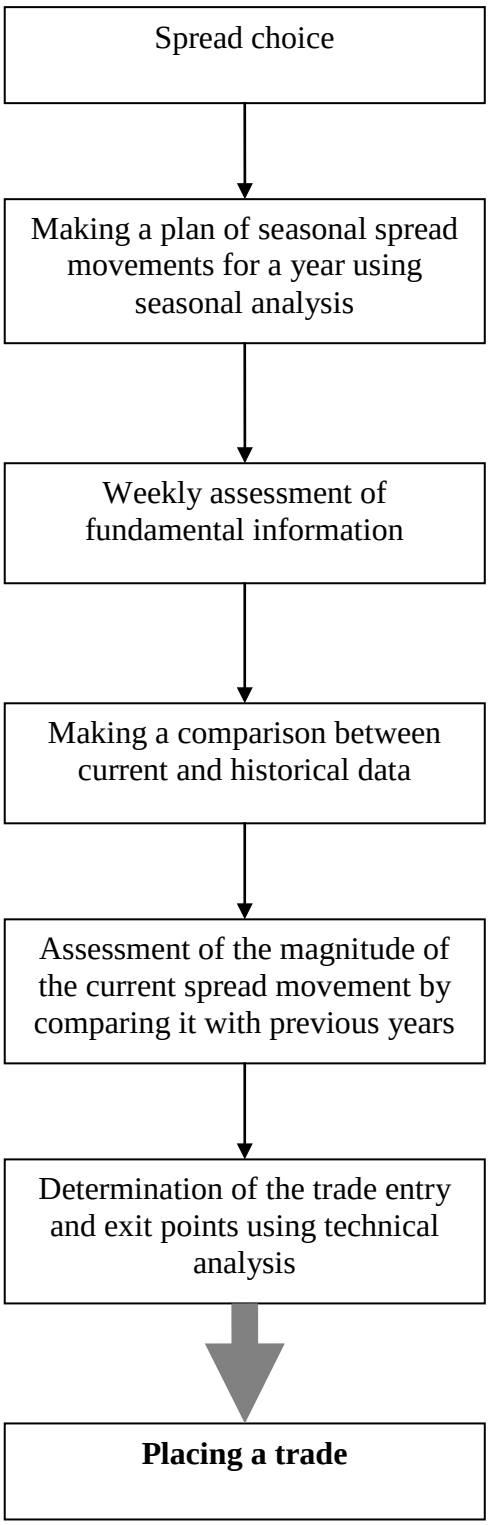


Diagram 2: Algorithm of co-integration of the different types of analysis in relation to the spreads.

The algorithm described above shows how the four types of analysis can be used to search for potentially interesting trades. Let us discuss each step in this algorithm separately.

1. Choosing the spreads to be used as a trading vehicle

An approach to trading strategy development is highly dependent on the types of spreads. Since there is a rich variety of spreads, investors should be very clear about what spreads they are going to trade in.

Spreads can be classified into different groups using various criteria, beginning with the relation between the futures comprising a spread—for example, agricultural futures, metals futures, etc.—and ending with the level of volatility. This largely depends on the investor's interests and objectives. Of course, an experienced investor has a clear idea about what spreads he is going to trade in, whereas a beginning investor will find this choice rather challenging. Although it is hard to advise someone on choosing the spreads, to simplify the task, I would suggest categorising spreads as follows:

— by commodity group;
— by the degree of seasonal influences;
— by volatility.

The spreads falling within category 1 are classified by the commodity group to which the futures comprising these spreads belong, i.e.:

— energy products, including crack spreads;
— agricultural products, including grains, soybean complex, meat, etc.;
— industrial metals;
— precious metals;
— currencies, including currency indices;
— interest rates, including interest rate indices;
— stock futures;
— stock index futures;
— weather futures;
— emission allowances, etc.

Classification by commodity group allows investors to understand better which particular group they are going to deal with. This choice will determine which fundamental and seasonal factors investors will have to analyse because these factors are peculiar to each commodity group (and, of course, they are even more specific for each particular spread).

Classification based on the degree of seasonality influences would enable investors who rely heavily on seasonal analysis to focus on those spreads in which seasonality is more pronounced as a major influence factor. Although it is very difficult to measure the extent to which seasonality affects the multitude of existing spreads, I will try to do it by dividing the spreads into three groups:

— those with a high degree of seasonal influences;
— those with a medium degree of seasonal influences;
— those with a low degree of seasonal influences.

The spreads that display a high degree of seasonality influences include: heating oil, natural gas, gasoline, soybean and soybean products calendar spreads; heating oil/gasoline spread, and heating oil/gasoil spread.

The spreads that exhibit a medium degree of seasonality influences include: crude oil calendar spreads, heating oil/crude oil spread, gold/silver spread, gold/ platinum spread, crack spread, crush spread, and spark spread.

The spreads that are little affected by seasonal effects include: stock index spreads, stock index - single stock futures spreads, currency spreads, WTI/Brent spread, and platinum/silver spread.

By grouping spreads according to their volatility, the investor can better identify the spreads that he would prefer for trading based on a perceived risk exposure. It would be logical to suppose that the more volatile a spread, the higher the risk exposure. A more conservative investor would therefore likely prefer less volatile spreads. The volatility of a spread depends both on the type to which it belongs (calendar, intercommodity, intermarket, or processing) and on the volatility of the futures comprising the spread. A general rule in this situation may be formulated as follows: calendar and intermarket

spreads are less volatile than intercommodity and processing spreads. As for the futures, their volatility varies dramatically. Below is a list of some of the futures contracts arranged in ascending order of volatility:

— interest rate futures;
— currency futures;
— commodity index futures;
— agricultural futures;
— stock index futures;
— precious metals;
— energy futures;
— industrial metals.

Certainly, this ranking is rather conventional, since volatility changes over time and largely depends on the time interval under analysis.

2. Making a plan of seasonal spread movements for a year using seasonal analysis

As mentioned earlier, various types of spreads are affected by seasonal factors to different extents (Moore *et al.*, 2006). To explain how the above described approach works, I will assume that an investor is interested in working with a spread that is significantly affected by seasonal factors—for example, a gasoline calendar spread. From a seasonal analysis of this spread, the investor finds out that its size changes according to a certain seasonal pattern from year to year: it dramatically narrows starting in March and begins to sharply widen in September. Thus, one comes to the conclusion that he or she is mostly interested in the early spring and early autumn periods and there isn't much need to track this spread during the months that do not fall into the period of interest. At the same time, nobody is able to guess when the gasoline spread will start to narrow in the spring, but the investor can start actively tracking the behaviour of this spread well in advance, for example, from late February, waiting for a suitable moment to bet. Then, a break in tracing the spread can be made, if the trader is not interested in its interim fluctuations. In August, the investor has to start tracing this spread again in order to correctly assess the time to enter the market. Of course, making a timetable for "heightened attention" to one spread seems to be a bit strange, but imagine that the investor's arsenal includes more than 100 different

spreads. The attention given to each spread will have to be limited to the minimum necessary.

3. Gathering and assessing, on a weekly basis, fundamental information on each spread using fundamental analysis

As soon as the investor starts to trace a spread in expectation of its potential seasonal movement, it is necessary to begin collecting information to be able to perform an adequate fundamental analysis. Since the fundamental factors do not change instantly, it will be sufficient to conduct a weekly assessment of the situation in the subject area. For instance, when it comes to a gasoline calendar spread, the best time to assess it is after the EIA data are released.

4. Making a comparison between current and historical data

As new information about the spread of investor's interest is accumulated, and new fundamental data affecting this spread are published every week, he or she needs to conduct a comparative analysis between these data and data for a similar period in past years. This may give additional clues to understanding the nature and size of future spread movements. For instance, the EIA announces that the gasoline inventories in the last week of March were at the upper end of the average range for the last five years. After looking at the data on inventories in past years, the investor discovers that even when the inventories were at the bottom of this range, the spread did not start to narrow dramatically. It can hardly be expected that when the inventories are at the upper end of the range, the spread will start to narrow actively.

5. Making a comparison between the magnitude of current spread movement and that in previous years

This comparison will help to better appreciate the levels reached by this spread and what may be the local minimums and maximums for it. If the investor succeeds in finding a similar spread in the past, which is close by its characteristics to the current spread, he or she will gain a greater insight into how this spread may behave in the near future.

Obviously, this is highly subjective, but if this method of analysis is treated as supplementary, it may also prove to be useful in performing our next step in the algorithm: evaluating a potential profit.

6. Making use of technical data to determine the best trade entry and exit points

In the chapter dedicated to technical analysis, I discussed quite extensively what methods can be used in work with spreads. If the seasonal, fundamental and other factors suggest that the spread should start widening, but at the moment it moves within a certain corridor, it would be logical to suppose that if the spread goes beyond the limits of this corridor in the expected direction and fixes there, it may serve as a good signal to enter the market. Accordingly, if the movement within the expected trend has met considerable resistance, which is below the level of the anticipated profit, then perhaps one should think about closing the trade at the level of this resistance, as it is quite possible that it will not be "broken through," and the spread will turn around and move in the opposite direction. It should be noted that a technical analysis should preferably be employed at the final stage of spread assessment as a logical completion of the preparation for trading strategy implementation.

Based on the works of Smith (2000) and Publication 1, I created a schematic plan that should help to implement in practice (e.g., formalise) the steps of the offered algorithm.

Sample plan for situation analysis before placing a position

General

Data: _____
Name of instrument: _____
Number of contracts: _____
Margin: _____
Commission: _____

Fundamental analysis

What is the current supply situation? What is the current demand situation? Are demand and supply balanced? Estimated forecast for this year.

_____
_____
_____
_____

Seasonal analysis

Analysed period: from _____ to _____
Probability of a successful trade, % _____
Average movement: _____
Maximum rise: _____
Maximum fall: _____
Comments on seasonal analysis:_____
_____

Technical chart analysis

Trend: long-term _____
medium-term _____
short-term _____
Support levels: _____
Resistance levels: _____
Annual contract maximum: _____
Annual contract minimum: _____
Comments on technical analysis: _____
_____

Historical analysis

How many years have been studied? What method of study was used? Were there any years similar to today's situation? Which factors were similar and which were different? What happened to the price in similar years? Describe the expected price movement scenario (position lifetime).

_____
_____
_____

Conclusions from all analyses

What are the reasons for opening the position? Which indicators and factors are favorable/adverse to opening the positions? What must happen for the position not to work? Expected scenario of how the price (position) will behave.

_____
_____
_____
_____

Expected actions

Position: buy_____ sell _____
Opening level: _____
Opening day: _____
Stop/Loss level: _____
Will trailing Stop/Loss be used? _____
Take/Profit target: _____

4.10 Conclusion

When working with spreads, investors should consider the results of the four types of analysis: fundamental, seasonal, technical, and comparative-historical. Financial markets in recent years have tended to show the weakened role of fundamental factors and analysis, with the simultaneously increasing importance of technical analysis. Seasonal and comparative-historical analyses play only a supplementary role in making trading decisions. Regression-correlation analysis is barely applicable for practicing traders.

In this chapter I reviewed the specifics of the application of each type of analysis in practice. The algorithm of co-integration of four types of analysis for making trading decisions was offered.

After intensive study, I consider the most useful tool of technical analysis to be the ***Relative Strength Index*** (RSI). This tool could be of specific interest to the investors utilising discretionary contrarian strategies based on futures spreads. This indicator could be integrated most efficiently into strategies with a short-to-medium-term investment horizon.

4.11 Summary of Chapter Four

This chapter considered in detail the possibility of practical application of all types of analyses to spreads, assessed supplementary function of comparative-historical analysis and demonstrated inefficiency of application for practicing investors of the regression-correlation analysis.

The chapter proposes an algorithm of co-integration of the four types of spreads analysis for the purposes of creating trading strategies and decision-making.

The chapter also includes an expanded literature review and demonstrates the standing of my research in relation to other works in this field.

Chapter Five: Contribution to Knowledge

5.1 Introduction

This chapter demonstrates the achievement of the specific thesis objectives set out in Chapter One. It then sets out the contribution made by the six publications and the thesis to theoretical knowledge, to practitioner knowledge and to methodological theory and practice. It summarises the significance of the contribution, and reflects on the limitations of the research investigations, and of the thesis itself. It then provides an indication of areas for further research, and discusses wider implications for research. It also expresses some personal reflections on the PhD process, and concludes with the final overview.

5.2 Achievement of the Thesis Aim and Objectives

Chapter One set out the general aims of the thesis and the four specific research objectives which are to:

1. Systematise, classify and describe spreads based on the most liquid metal, energy and index futures contracts.

The existing literature on this subject was reviewed and my own system of classification and grouping was proposed based on the common approaches. Different heavily traded spreads were described in detail.

2. Develop a spread analysis methodology using technical, fundamental, seasonal and historical comparison analyses.

I achieved this through deep research of the different types of analysis and reviewed the specifics of application of each analysis type. For each spread mentioned in the publications, I conducted fundamental analysis, which could be used as a methodological template. I then reviewed a wide array of academic and practitioner literature to assist in deeper understanding of the subject under investigation.

3. Develop approaches to designing trading strategies based on the use of spreads as an investment tool.

I then reviewed different approaches to designing trading strategies. The key to the successful spreads trading is the ability of the trader to implement the results of different analysis types into daily work. Besides, a trader must clearly realise the specifics of each spread. The submitted publications broadly address these issues.

4. Develop a theoretical model for implementing a practical task of using futures spreads as an investment tool.

To achieve this objective, the research offered the algorithm of co-integration of four analysis types. The thesis discussed the money management theme in application to spreads.

The proposed new framework was formalized in the form of an article submitted for a review.

5.3 Contribution to Knowledge

5.3.1 Summary of Contribution

The publications upon which this PhD by publication is based collectively make a contribution to practitioners, theoretical and methodological knowledge (Table 2).

Table 2: Summary of Contribution

Publication		Contribution to:		
Reference	**Publication No**	**Theoretical Knowledge**	**Methodological Knowledge**	**Practitioner Knowledge**
Perchanok (2011)	1	Yes	Yes	Yes
Perchanok and Hrytsyuk (2011)	2	-	Yes	Yes
Perchanok (2011)	3	Yes	Yes	Yes
Perchanok (2011)	4	Yes	Yes	Yes
Perchanok (2011)	5	Yes	-	-
Perchanok (2012)	6	Yes	Yes	Yes

5.3.2 How Each Publication Contributed to Theoretical, Practitioner and Methodological Knowledge

The proposed thesis and the constituent publications contribute new insights to the questions surrounding futures spreads and the possibility to utilise them as an investment tool. The following results demonstrate the originality of the research:

– The thesis contributed to the theory of storage (Working, 1933, 1949) by drawing attention to the problems related to the market of crude oil calendar spreads.

– Publications 1 and 2 developed a spread analysis methodology using technical, fundamental, seasonal and historical comparison analyses. On this basis, the author has analysed and evaluated the fundamental factors relating to each individual spread.

I considered in detail the possibility of practical application of all types of analyses to spreads, assessed supplementary function of comparative-historical analysis, and demonstrated the inefficiency of application for practicing investors of the regression-correlation analysis. I then proposed an algorithm of co-integration of the four types of spreads analysis for the purposes of creating trading strategies and decision-making.

Development of spread analysis methodology contributes greatly to theoretical, practical and methodological knowledge.

– Publication 1 proposed a classification system for futures spreads based on the most liquid metal, energy and futures index contracts.

An approach to trading strategy development is highly dependent on the types of spreads. Since there is a rich variety of spreads, investors should be very clear about what spreads they choose to trade. Spreads can be combined into different groups using various criteria, beginning with the relation between the futures comprising a spread, for example, agricultural futures or metals futures, and ending with a level of volatility. This largely depends on the investor's interests and objectives. I offered grouping by the following criteria: by commodity, degree of seasonal influence and volatility.

Classification by commodity group allows investors to understand better with which particular group they are going to deal. with. This choice will determine which fundamental and seasonal factors investors will have to analyse, because these factors are peculiar to each commodity group (and, of course, are even more specific for each particular spread).

Grouping based on the degree of seasonality influences would enable investors who heavily rely on seasonal analysis to focus on those spreads in which seasonality is more pronounced as a major influence factor. Although it is very hard to measure the extent to which seasonality affects the multitude of existing spreads, I divided the spreads into three categories:

— with a high degree of seasonal influences;

— with a medium degree of seasonal influences; and

— with a low degree of seasonal influences.

By grouping spreads according to their volatility, the investor can better identify the spreads that he would prefer for trading based on a perceived risk exposure. It would be logical to suppose that the more volatile a spread, the higher the risk exposure. A more conservative investor would therefore be likely to prefer less volatile spreads. The volatility of a spread depends both on the type to which it belongs (calendar, intercommodity, intermarket or processing) and on the volatility of the futures comprising the spread.

Spreads classification and grouping contributes to practical, as well as methodological knowledge.

– Publication 2 provided an evaluation of the possibility of applying one of the most popular technical indicators, the RSI, to futures spreads.

There are a number of technical analysis methods that enable one to assess reverse movements with a varying degree of accuracy. RSI is the most widely used. Until my publication there have been no serious attempts to investigate the possibility of applying this indicator in spread trading. This tool could be specifically of interest to the investors who utilise discretionary contrarian strategies based on futures spreads. Most efficiently, one could integrate this indicator into strategies with a short-to-medium term investment horizon. The evaluation represents contribution to theoretical, practical and methodological knowledge.

– Publications 1 and 6 examined in detail one of the newest and least described spreads in the literature - the spark spread.

This spread has recently emerged and became very widely used by professional participants of energy markets such as hedgers and speculators. Despite this, it has

received very small attention in the methodological literature. Perhaps this is because of the complexity of this financial instrument. My attempt to publish research on the fundamental factors affecting this spread was one of the first. Practitioners might be interested in the explanation of the difficult underlying concept such as heat rate. Methodological input is also quite significant because the publications proposed methods of calculating investment results.

– Publication 5 analysed and researched thoroughly reasons for the occurrence of an abnormal contango on the WTI oil market.

Chapter Three covers this subject in more detail. Here I would stress that this publication provides theoretical contribution drawing attention to the problem of application of the theory of storage and Cost of Carry model in current circumstances. This article contributes to the practitioner knowledge by showing that the WTI crude oil benchmark has become disconnected from the world oil prices.

– Publication 1 described in detail a methodology for dealing in the index/stock spread.

1. This spread is of interest to investors who pursue the following objectives: hedging against general market risks by selling the index and simultaneously assembling one's own stock portfolio or vice versa; eliminating risks inherent in a particular set of individual stocks and concurrently buying or selling the index as a whole. The publication also discussed broad categories of spreads such as index spreads. Although both subjects are broad and deserve further investigation, my work provides the foundation for that. The most relevant contribution here is to provide practitioners with methodological knowledge.

2. The practical application of futures spreads requires the trader to deal with such issues as plotting a chart and calculating a spread's tick value, which I considered separately for each spread in my work. Publications 1, 3 ,4 and 6 attributed to that. There is a definitive contribution to the methodological and practitioner knowledge.

5.4 Limitations of the Research

The main limitation of my thesis is the impossibility of reviewing all existing variations of futures spreads. There are many possibilities to construct futures spreads. Almost any financial instruments related to each other could be spread out. This opens up before practicing traders and academics significant opportunities for the practical use and study of this subject. At the same time, it imposes certain limitations on what one can research within the frame of a single thesis.

In my research I focused on the major commodity spreads and examined in more detail spreads based on energy and precious metals futures. The theme of these spreads can be considered well studied in my thesis. The work did not consider spreads on interest rate futures as this subject deserves a separate deep and extensive individual study. My study considered the subjects of index spreads and single stock-index spreads. I proposed the basic principles of working with them and analysed them. However, the application of these spreads is so wide, that it also requires a separate, concentrated study.

During the course of research I discovered a problem with the use of cost of carry model for the market of crude oil calendar spreads. These issues were highlighted in my work in detail, but the adaptation of the model to the current market conditions must be done within the framework of additional research.

Whilst accepting the above limitations, I am aware that they are inherent in any scientific research undertaken on such a broad subject matter, especially if the subject is not covered in sufficient depth in the practical and academic literature. In general, I think that I have achieved the goals set before me from the start of the study and consider the limitations as an opportunity for further research, as I will discuss in more detail in the next section.

5.5 Opportunities for Further Research

As mentioned above, there is a vast variety of futures spreads. Having studied in detail spreads based on energy and precious metals futures, there is still much to explore. In the future I would like to focus on a more detailed study of index spreads, because I believe

that this category of spreads is interesting both from practical and theoretical points of view. The main reason for this is that trading in index futures and the ETFs is huge in terms of turnover and represents financial market segments in which thousands of instruments are traded. The subject of index spreads is barely researched. Particularly promising, in my opinion, is exploring the possibility of capitalising on the index spreads, which are comprised of the indices denominated in different currencies.

Another interesting aspect to study is testing the application of different technical indicators in the index spreads trading. Of particular interest is the RSI indicator. Researchers on this topic face problems such as determining overbought and oversold levels for individual index spreads and market monitoring in search of spreads with extreme values.

5.6 Personal Experience as a Part of the PhD and Research Process: A reflective Journey

My first acquaintance with the stock exchange was in 1993, when I worked at the exchange as a broker. Since then my interest in this subject has never waned. Since 2004, I delved into the study of financial markets. Initially, the scope of my interests was wide enough and included such tools as FOREX, CFD and futures. In addition to the text books I have read, a significant amount of analytical literature allowed me to understand better the functioning of markets. By 2008, I had already a deep knowledge and mature perception of the markets. My interests have focused on the topic of futures spreads which I decided to explore further. Since this topic is very broad, the study required all of my previously acquired knowledge, as well as a significant amount of new theoretical and practical information. The research process helped me to focus and organise my thoughts. The desire to share my ideas with a wide range of practitioners and academics evolved into eight publications, six of which are the basis of this thesis.

It is worth mentioning that as a researcher, but also an active trader, I had a chance to trade in reality most of spreads researched in my work. This practical experience helped me with my publications. The realisation that some aspects require deeper study received its impetus from sometimes negative results that I experienced from live trading. As an

example, I could provide anomalies on the crude oil calendar spreads markets. By that time I was already researching and trading futures spreads. Before 2008, a spread sale at carrying charges was a secure and profitable trade for many years. Suddenly, it created losses. These losses urged me to investigate deeper this issue which resulted in the appearance of Publication 5. I could provide several similar examples.. All of it shows that the research process was a challenging journey closely linked to practice.

Overall, the PhD and research process provided me with a solid foundation in the theoretical and empirical tools of modern finance, drawing heavily on the discipline of economics.

5.7 Summary of Chapter Five

The final chapter identifies the contribution of the thesis to theoretical and practitioner knowledge, and explores the limitations of the whole process. It sets out reflections and learning points including implications for further research.

The original research aim, to gain a deeper understanding of futures spreads, was achieved.

References

Anand, A. (2000) The impossibility of full carry markets. *Derivatives Quarterly*. **6**, 31-49.

Ates, A. and Wang, H. K. G. (2007) Price dynamics in energy spot and futures markets: the role of inventory and weather. *CFTC Working Paper*.

Banking News & Directory. (2012) *Central bank rates* [online]. Available from: http://www.banksdaily.com/central-banks/ [Accessed 11th March 2012].

Barnes, T. J. (2001) Retheorizing economic geography: from the quantitative revolution to the "Cultural Turn". *Annals-Association of American Geographers*. **91.3**, 546-565.

BBC News. (2008) *OPEC agrees record oil output cut* [online]. Available from: http://news.bbc.co.uk/2/hi/business/7786456.stm [Accessed 20th December 2008].

Bernstein, J. (1990) *Jake Bernstein's seasonal futures spreads: high-probability seasonal spreads for futures traders*. New Jersey: John Wiley & Sons.

Bessembinder, H., Coughenour, J. F., Seguin, P. J. and Smoller, M. M. (1995) Mean reversion in equilibrium asset prices: evidence from the futures term structure. *Journal of Finance.* **50**, 361-375.

Billingsley, R. and Chance, D. (1988) The pricing and performance of stock index futures spreads. *Journal of Futures Markets.* **8**, 303-318.

Black, F. (1976) The pricing of commodity contracts. *Journal of Finance Economics*. **3**, 167-179.

Black, T. R. (1999) *Doing quantitative research in the social sciences: an integrated approach to research design, measurement and statistics.* London: Sage.

Blaikie, N. (2003) *Analysing quantitative data: from description to explanation.* London: Sage.

Blas, J. (2009) Saudis drop WTI oil contract. *Financial Times*. 29 October, p 26.

Board of Governors of the Federal Reserve System. (2012) *Federal Reserve press release* [online]. 13 March . Available from: http://www.federalreserve.gov/newsevents/press/monetary/20120313a.htm [Accessed 13th March 2012].

Board, J. and Sutcliffe, C. (1996) The dual listing of stock index futures: arbitrage, spread arbitrage and currency risk. *Journal of Futures Markets.* **16**, 29-54.

Brennan, M. J. (1958) The supply of storage. *American Economic Review*. **48**, 50-72.

Brennan, M. J. (1986) A theory of price limits in futures markets. *Journal of Financial Economics*. **16**, 213-233.

Buckley, P. (2002) Is the international business research agenda running out of stream? *Journal of International Business Studies*. **33.2**, 365-374.

Butterworth, D. and Holmes, P. (2002) Inter-market spread trading: evidence from U.K. index futures markets. *Applied Financial Economics.* **12**, 783-791.

Carpenter, R. E. and Levy, D. (1998) Seasonal cycles, business cycles, and the comovement of inventory investment and output. *Journal of Money, Credit, and Banking*. **30**, 331-335.

Chance, D. M. (1991) *An introduction to options and futures.* Dryden Press: Chicago.

Charupat, N. and Deaves, R. (2003) Backwardation in energy futures markets: Metallgesellschaft revisited. *Energy Studies Review*. **1**, 1-26.

Cho, D. W. and McDougall, G. S. (1990) The supply of storage in energy futures markets. *The Journal of Futures Markets*. **10**, 611-621.

Chow, G. (1983) *Econometrics.* New York: McGraw-Hill.

CME Group. (2012) *Energy products: light sweet crude oil (WTI) futures* [online]. Available from: http://www.cmegroup.com/trading/energy/crude-oil/light-sweet-crude_contract_specifications.html [Accessed 11th March 2012].

Creswell, J. W. (2003) *Research design: qualitative, quantitative and mixed methods approaches.* 2nd ed. Thousand Oaks, CA: Sage.

Cupchik, G. (2001) Constructivist realism: an ontology that encompasses positivist and constructivist approaches to the social sciences. *Forum Qualitative Social Research.* [online]. Available from: http://www.qualitative-research.net/fqs [Accessed 11th March 2012]

De Bondt, W. and Thaler, R. (1985) Does the stock market overreact? *Journal of Finance.* **3**, 793-808.

DeMark, T. R. (1994) *The new science of technical analysis.* New Jersey: John Wiley & Sons.

Duffie, D. (1989) *Futures Markets.* London: Prentice Hall.

Edwards, F. R. and Canter, M. S. (1995) The collapse of Metallgesellschaft: unhedgeable risks, poor hedging strategy or just bad luck? *Journal of Futures Markets*. **15**, 211-264.

Elfakhani, S. and Wionzak, R. J. (1997) Inter-market spread opportunities between Canadian and American agricultural futures. *International Review of Economics and Finance.* **6**, 361-377.

Errera, S. and Brown, S. L. (1999) *Fundamentals of trading energy futures & options.* Houston: Pennwell Corp.

Fabozzi, F. (2005) *The Handbook of Fixed Income Securities.* 7th ed. New York: McGraw-Hill.

Fama, E. F. (1970) Efficient capital market: a review of theory and empirical work. *Journal of Finance*. **25**, 383-417.

Fama, E. F. (1991) Efficient capital markets II. *Journal of Finance*. **46** (5), 1575-1617.

Fama, E. F. and French, K. R. (1987) Commodity futures prices: some evidence on forecast power, premiums and the theory of storage. *Journal of Business*. **60**, 55-74.

Fama, E. F. and French, K. R. (1988) Business cycles and the behavior of metal prices. *Journal of Finance* . **43**, 1075-1093.

Gao, A. H. and Wang, G. H. K. (2005) Asymmetric volatility of basis and the theory of storage. *The Journal of Futures Markets*. **25**, 399-418.

Gibbons, M. and Hess, P. (1981) Day of the week effects and assets returns. *Journal of Business*. **54**, 579-596.

Gray, R. W. and Peck, A. E. (1981) The Chicago wheat futures market: recent problems in historical perspective. *Food Research Institute Studies*. **18**, 89-115.

Grossman, S. and Stiglitz, J. (1980) On the impossibility of informationally efficient markets. *American Economic Review*. **70**, 393-408.

Habiby, M. (2007) WTI prices don't reflect international oil market, study says [online]. *Bloomberg News*. 13 April. Available from: http://www.bloomberg.com/apps/news?pid=newsarchive&sid=apum7LTvljdc [Accessed

20th May 2012].

Habiby, M. (2010) Oil declines as dollar strengthens [online]. *Bloomberg News*. 18 March. Available from: http://www.independent.ie/business/stocks-markets/oil-declines-as-dollar-strengthens-2103912.html [Accessed 20th March 2012].

Haigh, M. S. and Holt, M. T. (2002) Crack spread hedging: accounting for time-varying spillovers in the energy futures markets. *Journal of Applied Economics.* **17**, 269-280.

Harrington, S. H., Keoun, B. and Harper, C. (2012) JPMorgan trader Iksil fuels prop-trading debate with bets [online]. *Bloomberg News*. 9 April. Available from: http://www.bloomberg.com/news/2012-04-09/jpmorgan-trader-iksil-fuels-prop-trading-debate-with-bets.html [Accessed 9th April 2012].

Hendrickson, L. and McKelvey, B. (2002) Foundations of "new" social science. *PNAS.* **99:3**, 7288-7295.

Hull, J. (2006) *Options, futures, and other derivatives.* 6th ed. New Jersey: Prentice-Hall.

ICE. (2012) *Energy products. ICE Brent crude oil futures* [online]. Available from: https://www.theice.com/productguide/ProductDetails.shtml?specId=219 [Accessed 11th March 2012].

Kaldor, N. (1939) Speculation and economic stability. *Review of Economic Studies*. **9**, 1–27.

Kawaller, I. G., Koch, P. D. and Ludan, L. (2002) Calendar spreads, outright futures positions and risk. *Journal of Alternative Investments*. **Winter**, 59-74.

Klombies, K. (2006) Will grains follow metals? *Futures Magazine*. **July**, 34-36.

Larson, D. F. (1994) *Copper and the negative price of storage.* PRWP 1282, International

Economics Department, World Bank, Washington, D.C.

Lee, J. (2011) Platinum: fire sale on the rich man's gold [online]. *Kitco News*. 29 December. Available from: http://www.kitco.com/ind/Lee/printerfriendly/dec292011.html [Accessed 9 April 2012].

Litzenberger, R. H. and Rabinowitz, N. (1995) Backwardation in oil futures markets: theory and empirical evidence. *Journal of Finance*. **50**, 1517-45.

Luca, C. (2000) *Trading in the global currency markets*. 2nd ed. New York: New York Institute of Finance.

Malkiel , B. G. (2011) *A random walk down Wall Street: the best investment tactic for the new century.* New York: W.W. Norton & Company.

Malkiel, B. (1992) Efficient market hypothesis. In P. Newman, M. Milgate, and J. Eatwell (eds.), *New Palgrave dictionary of money and finance*. London: Macmillan.

Malkiel, B. G. (1999) *A random walk down Wall Street.* New York: W.W. Norton & Company.

Malkiel, B. G. (2003). *The efficient market hypothesis and its critics*. Princeton, NJ: Center for Economic Policy Studies, Princeton University.

Markin, J. P. (2006) *Theory of economic analysis*. Moscow: Knorus.

McComas, A. (2003) Getting technical with spreads. *Futures Magazine*. **July**, 52-55.

McConnell, C., Brue, S. and Flynn, S. (2008) *Economics.* 18th ed. New York: McGraw-Hill/Irwin.

Moles, P. (2004) *Derivatives*. Edinburgh: Edinburgh Business School.

Moore, S., Toepke, J. and Colley, N. (2006) *The encyclopedia of commodity and financial spreads.* New Jersey: John Wiley & Sons.

Mouawad, J. (2008) OPEC agrees to another cut in production. *The New York Times*. 18 December, p B5.

Murphy, J. J. (1999) *Technical analysis of the financial markets: a comprehensive guide to trading methods and applications.* New York: York Institute of Finance.

Murray, A. R. (2004) Better trading with seasonals. *Futures Magazine*. **June**, 60-64.

Murray, A. R. (2006) Market cycles – are they fundamental? *Futures Magazine*. **August**, 48-51.

Ng, V. K. and Pirrong, S. C. (1994) Fundamentals and volatility: storage, spreads and dynamics of metal prices. *Journal of Business*. **67**, 203-230.

Ng, V. K. and Pirrong, S. C. (1996) Price dynamics in refined petroleum spot and futures markets. *Journal of Empirical Finance*. **2**, 359-388.

Parkin, M., Powell, M. and Matthews, K. (2005) *Economics.* 6th ed. Harlow: Longman Publishing Group.

Perchanok, K. (2012) Trading machines taking control of the financial market. *The Hedge Fund Journal*. **74**, 60-63.

Pindyck, R. S. (1994) Inventories and short-run dynamics of commodity prices. *Rand Journal of Economics*. **25**, 141-159.

Prosvetov, G. I. (2008) *Econometrics.* Moscow: Alfa-Press.

Rechner, D. and Poitras, G. (1993) Putting on the crush: day trading the soybean complex spread. *Journal of Futures Markets,* **13**, 61-75.

Roberts, H. (1967) *Statistical versus clinical prediction of the stock market*. Unpublished manuscript.

Roberts, H. V. (1959) Stock-market patterns and financial analysis: methodological suggestions. *Journal of Finance*. **14** (1), 1-10.

Ross, J. (2006a) Exploiting spread trades. *Futures Magazine*. **December**, 34-36.

Ross, J. (2006b) *Trading spreads and seasonals.* Cedar Park: Ross Trading.

Rozeff, M. and Kinney, W. (1976) Capital market seasonality: the case of stock returns. *Journal of Financial Economics*. **3**, 379-402.

Ryan, B., Scapens, R. W. and Theobald, M. (2002) *Research methods and methodology in finance and accounting.* London: Cengage Learning.

Salcedo, Y. (2004) Spreads for the fall. *Futures Magazine*. **September**, 54-57.

Schap, K. (2005) *The complete guide to spread trading.* New York: McGraw-Hill.

Schwager, J. D. (1995) *Schwager on futures: technical analysis.* New Jersey: John Wiley & Sons.

Schwager, J. D. and Turner, S. C. (1995) *Futures: fundamental analysis.* New Jersey: John Wiley & Sons.

Schwarz, T. and Szakmary, A. (1994) Price discovery in petroleum markets: price discovery, cointegration, and the time interval analysis. *Journal of Futures Markets*. **9**, 147-167.

Sharpe, W. F., Alexander, G. J. and Bailey, J. V. (1999) *Investments*. New Jersey: Prentice-Hall.

Shiller, R. (1981) Do stock prices move too much to be justified by subsequent changes in dividends? *American Economic Review*. **3** (June), 421-436.

Simon, D.P. (1999) The Soybean Crush Spread: Empirical Evidence and Trading Strategies. *Journal of Futures Markets*, 19, pp. 271-289.

Smith, C. (2000) *Futures spreads trading: the complete guide.* Greenville: Traders Press.

Susmel, R. and Thompson, A. (1997) Volatility, storage and convenience: evidence from natural gas markets. *The Journal of Futures Markets*. **17**, 17-43.

Telser, L. G. (1958) Futures trading and the storage of cotton and wheat. *Journal of Political Economy*. **66**, 233–255.

Theil, H. (1971) *Principles of econometrics.* New York: Wiley.

Thomsett, M. C. (2006) *Getting started in fundamental analysis*. New Jersey: John Wiley & Sons.

Tokic, D. (2011) Rational destabilizing speculation, positive feedback trading, and the oil bubble 2008. *Energy Policy*. **39**, 2051-2061.

Tolmasky, C. and Hindanov, D. (2002) Principal components analysis for correlated curves and seasonal commodities: the case of the petroleum market. *Journal of Futures Markets*. **11**, 1019-1035.

U.S. Department of Agriculture (USDA). (2012) *Agency reports: USDA scheduled release dates for agency reports and summaries* [online]. Available from: http://www.usda.gov/wps/portal/usda/usdahome [Accessed 11th March 2012].

U.S. Energy Information Administration (EIA). (2012a) *Independent statistics and analysis, EUA* [online]. Available from: http://www.eia.doe.gov [Accessed 11th March 2012].

U.S. Energy Information Administration (EIA). (2012b) *Stocks of crude oil by PAD district, and stocks of petroleum products, U.S. totals* [online]. Available from: http://www.eia.doe.gov [Accessed 20 March 2012].

U.S. Geological Survey (USGS). (2012) *Independent statistics and analysis* [online]. Available from: http://www.usgs.gov/science/science.php?term=799 [Accessed 10th April 2012].

Wahab, M., Cohn, R. & Lashgari, M. (1994) The Gold-Silver Spread: Integration, Cointegration, Predictability, and Ex-ante Arbitrage. *Journal of Futures Markets*, 14, pp. 709-756.

Wilder, W. J. (1978) *New concepts in technical trading systems.* New York: Trend Research.

Williams, J. (1986) *The economic function of futures markets.* Cambridge: University Press.

Williams, J. T. (1977) Capital asset prices with heterogeneous beliefs. *Journal of Financial Economics*. **5**, 219–239.

Williams, L. (1999) *Long-term secrets to short-term trading.* New York: Wiley.

Williams, L. (2005) *Trade stocks and commodities with the insiders*. New York: Wiley.

Wong, W., Manzur, M & Chew, B. (2002) How Rewarding Is Technical Analysis? Evidence From Singapore Stock Market. *NUS Department of Economics Working Paper*, No.0216.

Working, H. (1933) Price relations between July and September wheat futures at Chicago since 1885. *Wheat Studies of the Food Research Institute*. **9**, 187–238.

Working, H. (1948) Theory of inverse carrying charge in futures markets. *Journal of Farm Economics*. **30**, 1-28.

Working, H. (1949) The theory of price of storage. *American Economic Review*. **39**, 1254-1262.

Working, H. (1953) Futures trading and hedging. *American Economic Review*. **43**, 314-343.

Working, H. (1962) New concepts concerning futures markets and prices. *American Economic Review*. **52**, 431–459.

Wright, R.W. and Ricks, D.A. (1994) Trends in international business research: twenty-five years later. *Journal of International Business Studies*. **25.4**, 687-701.