DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF BUSINESS ADMINISTRATION
ACCOUNTING AND FINANCE PROGRAM
MASTER'S THESIS

THE VOLATILITY OF GOLD SPOT AND FUTURES PRICES: A COMPARISON BETWEEN RUSSIAN AND TURKISH FUTURES MARKETS

Zorikto LKHAMAZHAPOV

Supervisor
Assoc. Prof. Dr. Berna KIRKULAK ULUDAĞ

IZMIR - 2013

MASTER THESIS/PROJECT
APPROVAL PAGE

University	: Dokuz Eylül University
Graduate School	: Graduate School of Social Sciences
Name and Surname	: Zorikto LKHAMAZHAPOV
Title of Thesis	: The Volatility of Gold Spot and Futures Prices: A Comparison between Russian and Turkish Futures Markets
Defence Date	: 24.09.2013
Supervisor	: Assoc Prof.Dr.Berna KIRKULAK ULUDAĞ

EXAMINING COMMITTE MEMBERS

Title, Name and Surname	**University**	**Signature**
Assoc Prof.Dr.Berna KIRKULAK ULUDAĞ	DOKUZ EYLUL UNIVERSITY	....
Prof.Dr.Banu DURUKAN SALI	DOKUZ EYLUL UNIVERSITY	....
Prof.Dr.Yaprak GÜLCAN	DOKUZ EYLUL UNIVERSITY	....

Unanimity (✓)

Majority of votes ( )

The thesis titled as "**The Volatility of Gold Spot and Futures Prices: A Comparison between Russian and Turkish Futures Markets**" prepared and presented by Zorikto LKHAMAZHAPOVis accepted and approved.

Prof.Dr. Utku UTKULU
Director

DECLARATION

I hereby declare that this master's thesis titled as **"The Volatility of Gold Spot and Futures Prices: A Comparison between Russian and Turkish Futures Markets"** has been written by myself without applying the help that can be contrary to academic rules and ethical conduct. I also declare that all materials benefited in this thesis consist of the mentioned resources in the reference list. I verify all these with my honor.

Date

…/…/……

Zorikto LKHAMAZHAPOV

Signature

ABSTRACT

Master's Thesis

The Volatility of Gold Spot and Futures Prices: A Comparison between Russian and Turkish Futures Markets

Zorikto Lkhamazhapov

Dokuz Eylül University

Graduate School of Social Sciences

Department of Business Administration

Accounting and Finance Program

Understanding dynamics of gold volatility is of great importance for policy makers because gold plays an essential role in the world economy. This thesis examines the volatility dynamics of spot and futures gold prices in Turkey and Russia, which are key players in the global gold market. The data covers the period from June 27, 2008 through May 31, 2013. Empirically, three long memory tests are implemented to examine the long-range dependence in the conditional variance processes of gold, while procedure of Bai and Perron (2003) is used to detect structural changes in the data.

The findings reveal strong evidence of long memory and the structural breaks in the volatility of both spot and futures series. The break dates, which occurred in 2009, are associated with corrections in the gold prices. The conducted tests prove the evidence of true long memory process. This implies that long dependence in the gold prices is a feature of the gold volatility despite the presence of structural changes.

The study investigates volatility spillover effect between Turkish and Russian spot and futures gold markets using multivariate corrected dynamic conditional correlation model with FIGARCH specification. The results show significant conditional correlations between Turkish gold spot and futures markets, indicating the high level of integration, more efficient transmission of information and improved hedging opportunities.

Nowadays the world economy suffers from the high risk, which is also considered as synonymous of volatility among the financial institutions. It is expected that the findings of this thesis have important implications for understanding the Turkish and Russian gold volatility properties, which is of great interest for investors, policy makers and regulators as volatility is an important input for asset valuations, hedging, and risk management. Particularly, the banks, whose investment portfolio consists of gold can benefit from the results, since they estimate their maximum losses using value at risk methodology (VAR), which is dramatically affected by gold volatility.

Keywords: Long Memory, Structural Breaks, Volatility, Spillover effect

ÖZET

Yüksek Lisans Tezi

Spot ve Vadeli Altın Fiyatlarının Volatilitesi: Rus ve Türk Vadeli Piyasalarının Karşılaştırılması

Zorikto Lkhamazhapov

Dokuz Eylül Üniversitesi

Sosyal Bilimler Enstitüsü

İngilizce İşletme Anabilim Dalı

İngilizce Muhasebe ve Finansman Programı

Altın dünya ekonomisinde önemli bir rol oynadığı için altın volatilitesinin dinamiklerini anlamak politika yapıcılar için büyük önem arz etmektedir. Bu tez dünya altın piyasasının önemli oyuncularından olan Türkiye ve Rusya'nın spot ve vadeli altın fiyatlarının volatilite dinamiklerini incelemektedir. Veriler 27 Haziran 2008 ve 31 Mayıs 2013 arasındaki dönemini kapsamaktadır. Ampirik olarak, üç uzun hafıza testi, altının koşullu varyans süreçlerindeki uzun vadeli bağımlılığı incelemek için uygulanırken Bai ve Perron (2003) prosedürü altın metalinin zaman serisindeki yapısal değişikliklerini belirlemektedir.

Bulgular spot ve vadeli zaman serilerin volatilitesinde yapısal kırılma ve uzun hafıza olduğuna dair güçlü kanıtlar göstermektedir. 2009 yılında oluşan kırılma tarihleri altın fiyatlarındaki düzeltmeler ile ilişkilidir.Yapılan testler uzun hafızanın gerçek olduğunu kanıtlamaktadır. Bu göstergeler altın fiyatlarındaki uzun bağımlılığın yapısal değişikliklerin olmasına rağmen altın fiyatlarının volatilitesinin bir özelliği olduğunu göstermektedir.

Bu çalışma Türk ve Rus spot ve vadeli altın piyasalarındaki volatilitenin yayılma etkisini çoklu düzeltilmiş dinamik FIGARCH özellikli şartlı korelasyonmodeli kullanarak incelemektedir. Sonuçlar, Türk ve Rus spot altın piyasaları ile Türk spot ve vadeli altın piyasaları arasında anlamlı şartlı korelasyon olduğunu göstermektedir. Bu durum yüksek düzeyde bütünleşmeye,

bilgilerin daha verimli transmisyonuna ve gelişmiş riskten korunma fırsatlarına işaret etmektedir.

Dünya ekonomisi bugünlerde finansal kurumlar arasındaki volatiliteden, başka bir ifade ile riskten oldukça kötü etkilenmektedir. Bu tezin bulgularının, volatilitenin varlık değerlemesi, riskten korunma ve risk yönetiminde önemli bir girdi olması nedeni ile yatırımcılar, politika yapıcılar, kanun yapıcıları tarafından Türk ve Rus altın piyasalarındaki volatilitenin anlaşılmasında önemli etkilerinin olması beklenmektedir. Özellikle portföylerinin büyük kısmı altından oluşan ve Riske Maruz Değer (RMD) yöntemi kullanarak maksimum kayıplarını tahmin etmeye çalışan bankalar sonuçlardan yararlanabilirler.

Anahtar Kelimeler: Uzun Hafıza, Yapısal Kırılmalar, Volatilite, Yayılma etkisi

THE VOLATILITY OF GOLD SPOT AND FUTURES PRICES: A COMPARISON BETWEEN RUSSIAN AND TURKISH FUTURES MARKETS

CONTENTS

CHAPTER 2
VOLATILITY

CHAPTER 3
DATA AND METHODOLOGY

CHAPTER 4

EMPIRICAL FINDINGS

ABBREVIATIONS

ADF	Augmented-Dickey–Fuller
ARFIMA–FIGARCH	Autoregressive Fractional Integrated Moving Average Fractional Integrated GARCH
ARMA	Autoregressive Moving Average
BBM	Baillie, Bollerslev and Mikkelsen
BIC	Bayesian Information Criterion
cDCC	Corrected Dynamic Conditional Correlation
COMEX	Commodity Exchange
CPI	Consumer Price Index
DCC	Dynamic Conditional Correlation
DMAX AND WDMAX	Double Maximum Statistics
EGARCH	Exponential GARCH
FIGARCH	Fractional Integrated GARCH
FORTS	Futures & Options on RTS
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
GDP	Gross Domestic Product
GED	Generalized Error Distribution
GPH	Geweke-Porter-Hudak Procedure
GSP	Gaussian Semi-Parametric
JB	Jarque-Bera
KPSS	Kwiatkowski-Philips-Schmidt-Shin test
LWC	Modified Schwarz criterion
mGPH	Modified GPH
PPI	Producer Price Index
SBT	Sign Bias test
SIC	Scwartz Information criterion
SSR	Sum of Square Residuals
VaR	Value at Risk
TURDEX	Turkish Derivatives Exchange Market

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The recent global financial crisis revealed the fact that increased level of market uncertainty has led market participants to think of gold as a safe haven from economic and political turbulence. In the aftermath of the recent financial crisis, gold has become a popular alternative hedge instrument for strategic portfolio diversification. The nominal gold price has risen by 42 per cent from 2007 through 2009 due to increasing demand not only by portfolio investors but also by central banks all over the world (Bauer et al., 2010: 1887). The increasing uncertainty pushed central banks to become net buyers of gold throughout the post-financial crisis period. In the first half of 2011, net gold purchases by central banks amounted to double of the total 2010 (WGC, 2011). Therefore, fluctuations of international gold prices are crucial for the world economy.

Of all the precious metals, gold was the most reliable instrument and it remained liquid when the financial markets clashed. Investors viewed gold as a less volatile investment tool to protect their wealth. Given the increasing popularity of gold, it became more complicated to price gold in comparison with other commodities. Increase in the gold reserves of central banks accompanied with speculations on gold market drove gold prices to hit all-time highs. Thus, gold became more prone to wide swings and high volatility throughout the post-financial crisis period. Since the gold markets have experienced large price variations, and relatively higher price volatility, a study of long memory in gold market, therefore, becomes of interest to both investors and policy makers opting to purchase gold, especially during the economic and politic crises.

Long memory characteristic is important not only for modelling, but also for forecasting gold volatility. The presence of long memory suggests that past returns can be exploited to predict future returns at long horizons. Hence, the feature of long memory is very interesting as it equips economic policy makers with a clear understanding of the gold dynamics in perspective. The evidence of long memory violates the efficient market assumption and induces possibility of speculative profits, which is in contrast to the random walk type behavior (Fama, 1970: 386).

Given the importance of long memory, it is noteworthy to detect whether the long memory property is spurious or not. Spurious long memory may arise due to neglected sudden changes or structural breaks, which are often associated with extreme market conditions such as wars, financial crises, and policy changes. It is therefore, important to detect the spurious long memory produced by structural breaks enabling the investors and policy makers to fully capture the dynamics of volatility.

Although there is a large body of literature studying long memory properties and structural breaks in equity markets, little is known about volatility of gold. The existing papers study the precious metals in developed markets (Tully and Lucy, 2007: 316; Canarella and Pollard, 2008: 17; Arouri, 2012: 207; Ewing and Malik, 2013: 113); less attention has been given to the volatility of precious metals namely gold in the emerging markets (Soytas et al., 2009: 5557).

This thesis is motivated by the large price changes in the Turkish and Russian gold markets. Turkish gold demand ranked as the fifth in the world and it is the eight largest market for gold retail investment, whereas Russia according to the US Geological Survey in 2012 is fourth among top ten gold-producing countries and its gold reserves ranked as seventh in the world. In addition, Turkey is one of the biggest gold jewelry producers in the world (WGC, 2012). The countries located in Europe and Asia, and become influential emerging powers. Turkish and Russian gold markets are important, both in terms of influence on global gold exports and local demand. Moreover, due to the global financial crisis and high inflation central banks of these countries conducted the same policy, increasing their gold reserves to record amounts. Therefore, gold volatility can affect the risk exposure of the policy makers and investors in these countries.

The objective of this thesis is to examine the volatility dynamics of spot and futures gold prices in Turkey and Russia. This is the first study to investigate the presence of long memory and structural breaks in gold using the time series from Turkey and Russia.

This thesis contributes to existing literature in several ways. First, researchers have not previously analyzed the data set of Turkish and Russian gold spot and futures markets. This provides a unique opportunity to examine the spot and futures gold prices volatility. The World Bank classifies both Russia and Turkey as "upper-middle-income countries". Furthermore, gold investment demand in both countries generated by the global financial crisis remains strong. Geographical location, growing jewelry demand and strong positions in the gold markets contributed to selection of the thesis' topic. Therefore, this thesis is pioneering study of the gold volatility in countries with emerging economies, whose gold reserves were dramatically increased for the recent decades. Analyzing and modelling the gold volatility will provide unique information to risk managers and gold traders, as well as biggest consumer of the gold, namely the jewelry industry.

Second, little is known about the long memory properties of gold volatility in the emerging markets. In order to determine whether the gold markets in Turkey and Russia are efficient in processing and reflecting the new information. The current thesis tests long memory property by using GPH, Modified GPH and GSP estimators. Further, FIGARCH models are used to explain the presence of long memory in gold volatility. The findings show that long memory is an important volatility feature for both countries in spot and futures gold prices. This implies that the new market information cannot fully arbitraged away and pricing derivatives with martingale methods may not be appropriate (Mandelbrot, 1971: 394).

Third, this thesis tests the presence of multiple structural breaks by using Bai and Perron approach. The results reveal one break in the spot and one break in the futures volatility. The break dates occurred in April 2009 and associated with short-term price corrections due to the fear of IMF gold sales. Further, the results suggest that the presence of breaks in gold series does not interact with the long memory. This implies that long memory in the gold market is true, not spurious.

Fourth, one of the challenging subjects regarding the volatility is the spillover effects between commodities, securities and international markets. In this study, corrected dynamic conditional correlation model is applied to explore the volatility transmission between spot and futures gold markets. The findings indicate evidence of significant volatility spillover between Turkish and Russian spot gold markets. As concerns the transmission between spot and futures, the evidence of spillover was found only in Turkey.

Fifth, this thesis investigates the futures hedging performance by estimating hedge ratios and hedging effectiveness employing conditional volatility models. The results indicate that Turkish gold futures can be an effective instrument for hedging the spot price changes, whereas in Russia hedging effectiveness is found to be very low. Finally, due to high popularity and importance of Value-at-Risk among banks, risk and portfolio managers, this thesis conducts the comparison performance of volatility models by measuring Value-at-Risk of spot and futures series. According to the findings, modeling long memory in the conditional volatility leads to improve the accuracy of market risk forecasts.

The remainder of the thesis is set up as follows. First chapter provides literature review and overview of the world gold market, its types and participants as well as brief description of gold markets in Turkey and Russia. The concept of volatility is considered in the second chapter. Third chapter consists of data and methodology used in the thesis. Empirical analysis results are discussed in chapter four.

CHAPTER 1
GOLD MARKET OVERVIEW

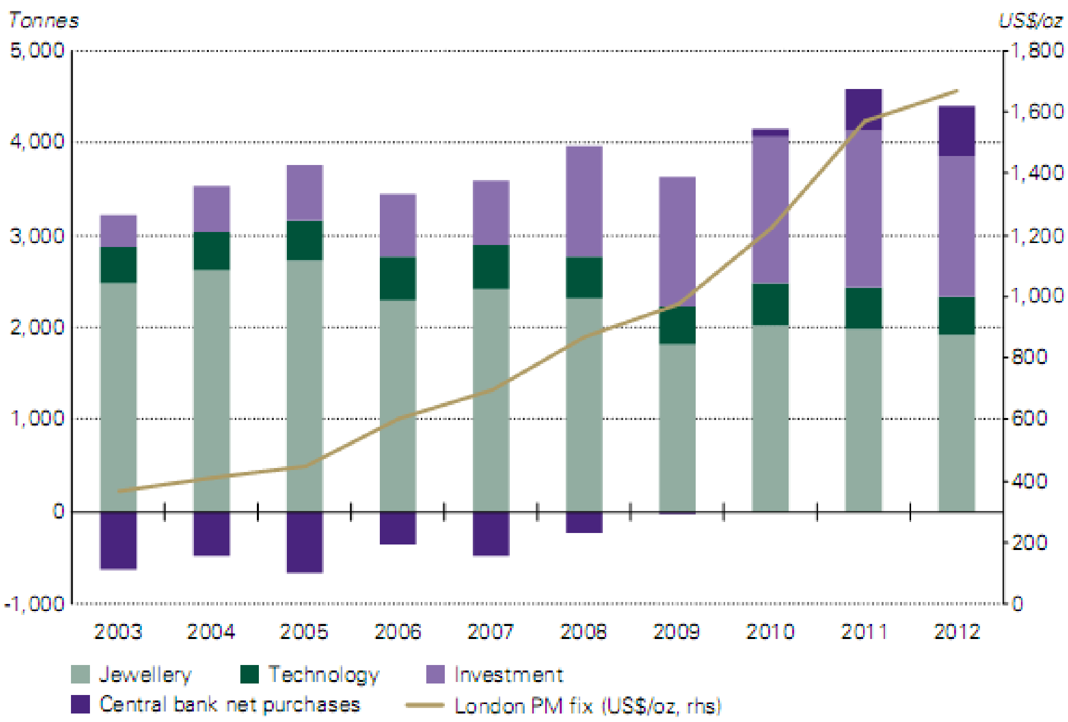
1.1. THE ROLE OF GOLD IN THE ECONOMY AND FEATURES OF THE GLOBAL GOLD MARKET

Gold is the main precious metal recognized around the world. In the ancient time people of the planet used gold as a modern paper money. Gold is actual interest of all nations and generations. It is an ideal metal since gold is homogeneous, compact and resistant to corrosion. Moreover, its extraction very labor consuming, therefore, a lot of work is required even for a small amount of gold. Today, dollar, euro and yen are the major currencies in the world; it would be a mistake to ignore the role of gold. Gold in the present is the second most important reserve asset. Its overall official reserves of approximately 110 thousand tons, or 1.1 trillion dollars and the financial authorities hold about a third of this amount - 34 million tons, or 330 billion dollars (Suetin, 2004: 29).

First feature of the gold market is that gold is used by actually all countries as insurance and reserve fund. The measured state resources of gold concentrated in the central banks and reserves of IMF makes today more than 34000 tones. Gold is held in central banks reserves for a number of reasons: gold is a liquid asset, diversification and economic security, since gold maintains its purchasing power, insurance and confidence; it cushions the bad effects of crises and maintains its value. Secondly, the people keep even greater volumes of gold (jewelry, coins, etc.). One part of this gold also arrives on the market in the form of a gold scrap (Schwartz, 2002: 95). As a result, the main share in the supply of gold falls on its mining. However, mining volumes have inertia, hence; the offer of the extracted gold has rather small variation from year to year, much smaller than the supply of gold scrap and gold sales by banks and investors.

As shown in the Figure 1 jewelry industry remains the main consumer of gold, which demand is substantially determined by the price of gold, the lower the price, the higher the demand. However, these laws are valid in times of global economic recovery, but in times of recession demand in the jewelry industry decreases, even at relatively low prices. At the same time, Figure 1 shows that disappointment of paper gold forced the growth of investment demand and central bank purchases of physical gold. The technology, where gold used in the fabrication of electronics, dental, medical, industrial, decorative and other technological applications keeps relatively the same gold demand over the ten years (WCG, 2012).

Figure 1: Gold demand by category (tons) and the gold price (US$/oz)



Source: World Gold Council, 2012

Gold miners, supplying the bulk of gold to the world market, however they have relatively small capabilities to influence the price of gold by using economic methods, for instance, manipulate the supply when price changes. Thereby, they have only two ways, the first is to influence the policy of international banks in order to reduce and streamline the volume of regular sales of gold. The second is to become adapted to large price fluctuations, thereby be able to reduce unit costs in periods of falling prices and under these circumstances provide profitability of production (Kozhogulov, 2005: 251).

Gold reflects the relative strength of the currency in which it is quoted. For example, the dollar price of gold may increase more in percentage terms than the sterling price of gold; the price change merely reflects the dollar weakness against sterling, rather than an intrinsic change in gold market fundamentals (WCG, 2002). The depreciation of the dollar may fuel interest in gold due to the weakening of the dollars' worth. Gold appears to be the anti-dollar. Financial analysts attribute the rise of gold prices to the US dollar's decline, hence gold reflects the US dollars value on international markets. The weak dollar increases attraction to gold as a stable investment asset. Furthermore, gold is affected strongly to CPI news, announcements of unemployment rate, GDP and PPI. However, it does not expose to federal deficit news.

1.2. TYPES OF MARKETS

Depending on a circle of participants, volume of transactions, types of operations and openness degree it is accepted to distinguish following kinds of gold markets (Livshits, 1994: 19.

- **International**

  Large transactions and a wide range of operations, and the lack of tax and customs barriers characterize these markets. Operations are carried out around the clock and have the wholesale nature. Typically, in such markets relatively small number of participants, since it has high requirements to the reputation and financial status of the participant. The same market makers set the rules of the market. Such international markets are located in Zurich, London, New York, Chicago, Hong Kong and Dubai.

- **Domestic**

  Domestic markets are focused on investors and hoarders. As a rule, coins and small bullions prevail in this market; calculations are conducted in local currency. Such markets are subject to state adjustment by means of economic levers: state participation in pricing, the taxation, restrictions on import and export of gold etc.

Depending on the degree of state intervention, domestic markets can be divided into the following types:

- Free - with a soft state regulation, no limit of the gold import and export from the country.
- Regulated - with a moderate government intervention through the establishment of quotas on imports and exports, the imposition of duties and taxes, licensing.
- Closed - tight control and a complete ban on the importation and exportation of gold. State creates disadvantageous economic conditions for trading the gold; the price of the gold is significantly higher than prices in the international markets.

The domestic markets are located in Paris, Hamburg, Frankfurt-am-Main, Amsterdam, Vienna, Milan, Istanbul, and Rio de Janeiro. Regulated markets operate in Athens and Cairo.

- **The black**

  "Black" gold markets represent the radical form of the domestic market organization, as reaction to the government restrictions on a gold domestic market. Illegal markets, as a rule, function in parallel with the closed. Such markets are in India, Pakistan.

1.3. PARTICIPANTS OF THE GOLD MARKET

Gold-mining companies, central banks, and private owners act as sellers in this market. Manufacturers, jewelers, private investors, speculators are the gold buyers. Moreover, central banks began to act as a buyer again. The following groups of participants are distinguished in the gold market (Prime, 2009: 15).

- Gold Mining Companies

  This is an important category of market participants supplying the bulk of the gold to market. The larger the company, the larger the transactions take place with its participation.

- Industrial Consumers

  A significant part of clients is businesses of different industry branches, which need gold with a various specific characteristics. For the needs of the electronics industry gold can be consumed with pureness of 999.999, while for the jewelers needs it may be limited to gold sand for subsequent melting. Despite the fact that these industries are often purchase precious metals through the metals brokerage firms, who has gold at consignment stores, in some cases namely the brokerage firm, does the purification and refinement of gold on behalf of its clients (Bazhanov, 2004: 46).
- Precious Metals Exchange

  In some countries (notably the U.S.) operate exchanges, where gold and other precious metals futures are traded. The main objective of this trade is hedging the prices of precious metals.
- Central Banks

  Central banks have a dual role in the market. They act as the major operators and have a significant influence on the market. On the other hand, they also establish the trading rules in the market.

  U.S. central bank - the Federal Reserve System has the greatest influence, and then follows Germany's central bank - the Bundesbank (Dutch Bundesbank) and the UK - Bank of England, also known as the Old Lady.

  Other central banks also play a significant role in the market of precious metals since they store a significant part of the national reserves in the form of gold. Due to the large size of these stocks, the central bank may have a decisive influence on the gold market. In earlier times, the share of central banks accounted for about one fifth of all gold purchases, but since 1971, after the exchange of U.S. dollars to gold disappeared, the banks became net sellers.
- Professional dealers and brokers

  This group includes commercial banks, companies trading the precious metals; organizations involved in gold affinage, specialized companies providing the intermediary services. They buy gold for their own account and then resell it to other banks. Sometimes banks buy the metal to increase their reserves.

Such companies can act both as brokers and as a primary dealer by holding their own positions in the precious metal trading. The London Bullion Market Association (LBMA), which represents the interests of participants in the wholesale market, divides them into two categories: the participants, forming the market (market maker), and ordinary members. Dealers play an important role in the market, since most of the precious metals initially are concentrated in their hands.

- Investors

  Broad category with interest to a variety of investment instruments of the precious metals. For example, pension funds and private investors. Certain types of bars and coins are designed for such investors. The role of investors increased especially after 1971. There is a tendency to turn investors into speculators, who apply derivatives like futures contracts and options, to make profit for short time, without physical consumption or delivery. Asian investors, as opposed to the American and European counterparts, tend to accumulate physical gold bars in various forms and consider investing in gold as a means to get out of the critical financial situation.

1.4. GOLD MARKET IN TURKEY

Turkish market is the significant regional center of gold trade, supplying the local jewelers, as well as delivering bullions to its neighbors. Along with the U.S., Switzerland, India and Italy, Turkey is also one of the leading gold refiners in the world. Three refining plants are located in Istanbul in accordance with international standards. In 1995, position of Turkey in the global market strengthened because of the full trade liberalization of precious metal and the establishing of Istanbul Gold Exchange. There were 50 authorized members among the gold exchange participants, including banks and companies working with precious metals. According to Turkish law, only members of the exchange have the right to import and export of precious metals. Around 200 tons of gold is traded at the Istanbul Gold

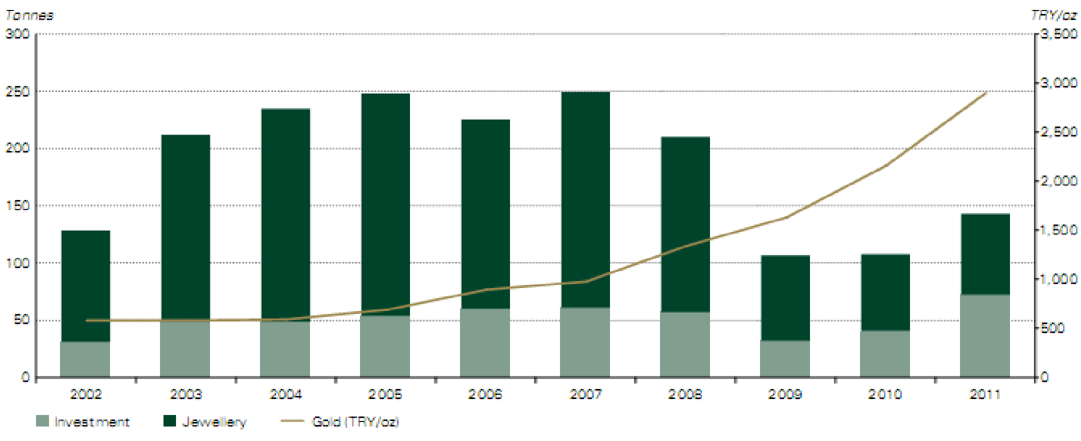
Exchange per year. Istanbul is the center of gold jewelry production, although production in Ankara and Izmir is also extensive (Zharkov, 2009: 17).

Istanbul Gold Exchange has three types of markets: Precious Metals Market includes the spot trade of standard and non-standard gold, silver, platinum and palladium metals. Precious Metal Lending Market provides lending and certificate transactions of defined precious metals. Diamond and Precious Stones Market provides transactions of diamond and precious stones (IGE Book, 2012).

Turkish people have a historical tradition of wearing gold jewelry and about 250,000 people are employed in the Turkish jewelry industry. Such a significant amount of labor and a long tradition of manufacturing gold jewelry turned Turkey into a very serious force in the jewelry market. Local jewelry demand in Turkey is one of the highest in the world, because gold is seen as a decoration for women, as well as a suitable object for investment. In addition, Turkey has a custom of giving gold as wedding gift. Turkish gold jewelry demand placed fifth in the world and it is the eighth largest market for retail investment at 63.8 tones and 72.9 tons respectively (WCG, 2012 Q1).

Turkey exports gold jewelry to more than 100 countries and the main markets are the USA, UAE, Italy, Germany, Russia, Spain and Israel. Turkey can export 200 tons of silver and 400 tons of gold a year, but according to experts, the country is not yet fully realized its production potential (Zharkov, 2009: 18).

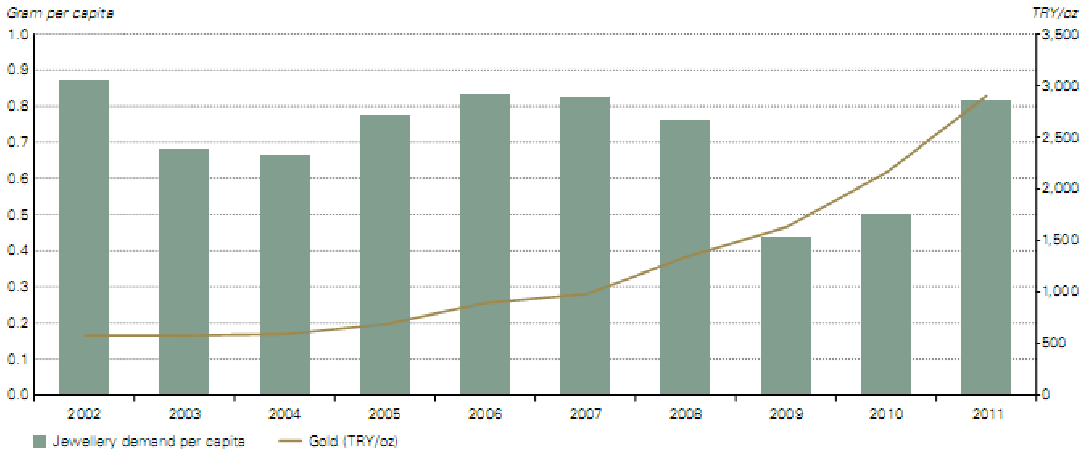
Figure 2: Turkish gold demand in tones and the gold price



Source: World Gold Council, 2012 Q1

Figure 2 clearly illustrates the impact of the global financial crisis on the domestic Turkish jewelry market, as well as in other markets of luxury goods came a sharp decline. The crisis has only increased the slow, which has already started to feel the industry. Domestic gold jewelry demand recovered from 67.4 tons in 2010 to 70.1 tons in 2011. It is interesting to note that as the gold price has increased, the demand for jewelry has decreased; yet gold investment demand has grown.

Figure 3: Gold jewelry demand per capita in Turkey and the gold price



Source: World Gold Council, 2012 Q1

While in 2007 the export of jewelry from Turkey amounted 96.3 tons, in 2008 it was only 83 tons. Moreover, during the first quarter of 2009, exports of jewelry fell by 20%. Another important fact is represented in Figure 3, where jewelry demand per capita has doubled from its low at 0.4 gram in 2009 to 0.8 gram in 2011 (WCG, 2012). Thus, gold remains Turkey's safe – haven, two major reasons that increasing demand will continue to recovering. First, the devaluation of the national currency to US dollar was about 23%, while against gold, the Turkish lira lost even greater. Second, gold was always the traditional form of saving among Turkish citizens. According to the WGC, estimates there are approximately 5,000 tons of accumulated gold in homes across the country.

1.5. GOLD MARKET IN RUSSIA

Today Russia is one of the largest gold producers in the world. During the economic reforms the value of gold, as one of the elements of Russian Central Bank's foreign reserves is constantly growing. For the recent decades, approximately 1,300 tons of gold have been purchased by Russia (WCG, 2012 Q2). Such growth may help to stabilize the ruble and raise the credit rating of the country in the global financial market.

After the collapse of the Soviet Union, gold mining in Russia has declined steadily, and in 1998 reached a historic minimum of 114.6 tones. Then, the industry began to recover and gold mining started to increase in 2000, it has reached the level of 1991, having produced 130.8 tons of gold. In 2002, gold production in Russia exceeded the level of gold production in the USSR. The increase in gold production had an impact of favorable factors (Mateeva, 2005: 510) such as:

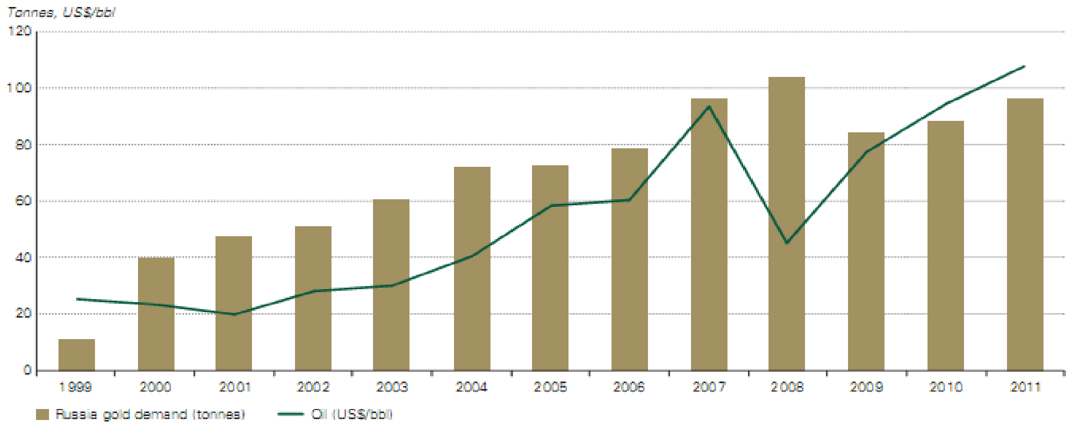
- The high price of gold in world markets.
- The liberalization of the Russian domestic market.
- Structural changes in the gold mining industry.

The gold mining cost value in Russia depends on a concrete deposit and varies largely. The official data on the cost value is not published. According to the experts, the gold mining cost value in Russia (two hundred dollars for ounce) remains lower, than in other countries. While the world average value of mining cost is about two hundred thirty five dollars for ounce at the end of 2003. Russian gold mining costs are lower than in other countries mainly due to cheaper labor and energy carriers (Gourko, 2005: 122).

From December 2000 to October 2010, the price of gold has increased by almost 400%. Central banks around the world were printing money in order to avoid a global financial crisis and this undermined the interest of investors to the dollar and the euro. Moreover, rise of gold prices is also caused by increased demand from the aerospace, automotive and jewelry industries primarily due to the Asian countries (WCG, 2012).

For the Russian gold mining industry favorable pricing environment of the gold market is particularly important, not only as one of the largest producers and exporters of precious metals, but also because a large part of its gold reserves are concentrated in the deposits of hard-cleaning ores located in remote areas, the development of which requires considerable investment .

Figure 4: Russian gold demand and oil price

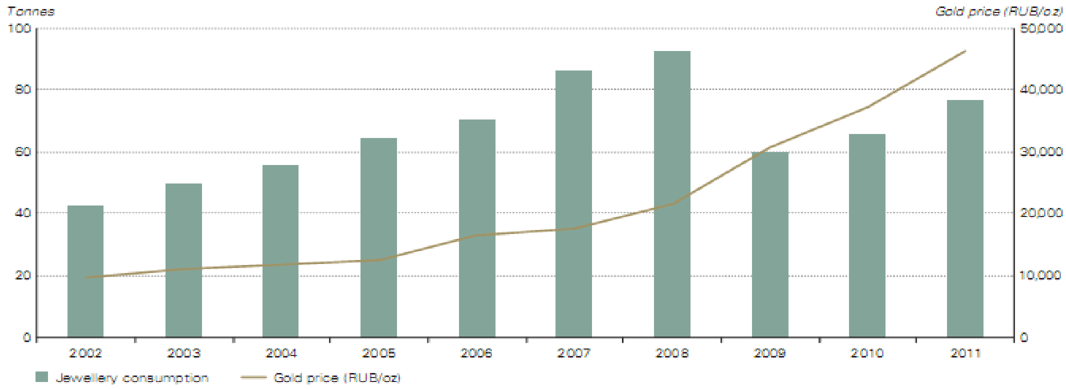


Source: World Gold Council, 2012 Q2

Historically, the giant returns from oil industry were the main reason of strengthening the Russian economy. The shortcoming of such economy model was clearly observed in 2008, when the country underwent the hardest hit, since the oil prices were dramatically fell down (Figure 4). This, in turn contributed to decrease of Russian GDP growth, and as a result, decline in Russian gold demand (excluding central bank purchases) of 18.9% year-on-year to 84.5 tons. However, with recovering of oil prices to their pre-2009 highs, relatively stable currency and low inflation placed Russian gold demand in the top tier of global gold consumers (WCG, 2012 Q2).

An additional stimulus of gold growth could be an increase in demand of the domestic jewelry industry, which has grown at an average rate of 8.7% per annum over the past decade. In 2011, gold jewelry demand rose 16.3% year-on-year and reached 76.7 tons (Figure 5); such success let Russia become the world's fourth-largest gold jewelry consumer (WCG, 2012 Q2). Today, Turkey and Italy are the main countries, who export gold jewelry to Russia. The value of Turkish gold jewelry exports to Russia almost doubled from 2010 levels, to $124.2 million in 2011 (IGE Book, 2012).

Figure 5: Russian gold jewelry demand and the gold price



Source: World Gold Council, 2012 Q2

Moreover, increasing consumer confidence is also translated into gold jewelry demand. Today Russian jewelers consume only 30% of the gold produced in Russia, while the global structure of its consumption oriented exactly to the jewelry industry, absorbing up to 85% of the world's "yellow metal." Namely, this sector of the market has a great growth potential, as opposed to the physical limitations of mining and processing sectors. Yet, while Russian banks and export purchase most of extracted gold, Russia becomes more significant player in the global gold market. Besides, the gold mining industry is a major source of foreign exchange earnings to the Russian economy (Bazhanov, 2004: 46).

1.6. GOLD AS A HEDGE AND FACTORS INFLUENCING ITS VOLATILITY

Gold is the only one among many commodities that, over the years, has served as money in both international trade and financial transactions. Studies on gold examine its properties in various aspects. Some empirical studies show evidence that gold prices are characterized by macroeconomic factors (Koutsoyiannis, 1990: 564; Cai et al., 2001: 257; Levin and Wright, 2006). Tully and Lucey (2007) examine the impact of a set of macroeconomic factors on gold spot and futures prices volatility using the asymmetric power GARCH over the 1983–2003 periods. Their findings show that the dominant role of the dollar is evident in gold price volatility. Kiohos and Sariannidis (2010) explore the short run effects of crude, oil, equity, currency and bond markets on the gold market. Their results indicate that the energy market affects the gold market positively. Further, their findings show that the asymmetric gold volatility tends to overact in response to positive shocks, contrary to the equity markets. Batten et al. (2010) employ a large set of macroeconomic variables to investigate the underlying causes of volatility in precious metals markets. They divide the sample into two periods (1986–1995 and 1996–2006). Their findings show that gold volatility can be explained by monetary variables such as inflation, interest rate and growth rate in money supply over the full sample period. However, the financial market sentiments have more powerful influence on gold than the monetary variables during the second sub-period.

Nevertheless, among the macroeconomic factors inflation remains one of the major explanatory variables affecting the gold prices. For instance, Baker and Van-Tassel (1985) show evidence that price of the gold is determined by the future inflation rate. Levin et al. (2004) demonstrate that the gold prices rise over time at the rate of inflation and can be an effective hedge against inflation. In a related study, Joy (2011) has studied the period between 1986 and 2008 and has used the DCC-GARCH model to indicate that gold is a hedge against the US, but evidence of gold being the safe haven for US dollar was not found. On the other hand, Capie, Mills and Wood (2005) analyze the role of gold as a hedge against the dollar and found a negative relationship between gold and other foreign exchange rates. Several authors explored the benefits of adding gold to a U.S. equity portfolio. Specifically, Conover et al. (2009) report that adding a 25% gold allocation substantially improves performance of a portfolio and that gold provides a good hedge against the negative effects of inflationary pressures. Hiller, Draper and Faff (2006) find that gold, platinum and silver have low correlations with stock index returns, which suggest that these metals may provide diversification within broad investment portfolios. Moreover, they also found that precious metals exhibit some hedging capability during periods of abnormal market volatility. However if investors aim to use gold as equity market hedges, it is important to know the extent and timing of this impact.

The linkage between gold and oil prices is of great interest to some researchers. Among them, Hammoudeh and Yuan (2008) examine volatility of three strategic metals including gold, silver and copper, in the presence of crude oil and interest rate shocks. They employ univariate GARCH models to test the volatility properties of the commodities. Their findings demonstrate more volatility persistent for gold and silver than for copper. Further, they suggest that past oil shocks had a cooling effect on gold and silver volatilities but had no impact on copper volatility. Narayan et al. (2010) use a structural break cointegration to examine the long-run relationship between gold and oil markets for the period of 1963-2008. They argue that the relationship between oil and gold stems from the use of gold as a hedge against inflationary pressures.

1.7. STUDIES ON VOLATILITY SPILLOVER BETWEEN GOLD AND OTHER FINANCIAL ASSETS

The high volatility in gold market has compelled some researchers to look into not only the volatility dynamics of gold, but also into transmission of volatility between gold and other financial assets. In this context, Morales (2008) investigated the volatility spillover effects among precious metals using GARCH and EGARCH models. The main finding of the paper shows that the other precious metals influenced gold prices but no evidence was found in the opposite direction. Sari et al. (2010) examine information transmission among the spot prices of four precious metals (gold, silver, platinum, and palladium), oil price, and the US dollar/euro exchange rate. They report weak long run but strong short-run relationship among precious metals, oil and exchange rate. Badshah et al. (2011) investigate the triangular relationship of equity, gold and exchange rate volatility. In order to capture the contemporaneous spillover effect, they apply the identification through heteroskedasticity technique. Their results suggest that while gold and exchange rate volatility do not spill over to the stock market, there is a bidirectional spillover effect between gold and exchange rate. Ewing and Malik (2013) employ univariate and bivariate GARCH models to estimate the volatility spillover dynamics across gold and oil markets. Their empirical analysis is based on daily futures contracts on COMEX for gold and crude oil. They report that there is a significant transmission of volatility between gold and oil returns in the presence of structural breaks in variance.

Xu and Fung (2005) use a bivariate asymmetric GARCH model to examine the information flow across the US and Japanese markets for gold, platinum and silver future contracts and proved that volatility spillover among the markets is strong but US market was more dominant. Sumner et al. (2013), examine the interdependence among stocks, bonds and gold in the United States. Different from previous approaches, they apply a spillover index methodology to investigate whether gold returns and volatilities can predict U.S. stock market movements or vice versa. Finally, they find that return spillovers were weak for the sample period from January 1970 to April 2009. Such finding raises the question whether gold price movements can be used as a predictor for stocks and bond prices.

1.8. LONG MEMORY AND VOLATILITY IN EMERGING MARKETS

Investigation of gold price volatility has been stipulated by the emergence of global financial crisis. Long-memory is a characteristic of a time series where a strong correlation or “dependence” is observed between the present value of a series and its remote past values. Canarella and Pollard (2008) use the asymmetric power ARCH model to explore the presence of the long memory in conditional volatility of the London gold market. Their findings show the presence of unequal volatility responses to market shocks. The results show that unlike the stock markets, volatilities of gold prices are affected more by good news (positive shocks) than bad news (negative shocks). The recent study by Arouri et al. (2012) examine structural changes and long memory properties in returns and volatility of gold, silver, platinum and palladium traded on the COMEX. They employ ARFIMA–FIGARCH class model in forecasting the precious metals’ returns and volatility. Their findings show the presence of long memory in some precious metals. Further, they confirm the fact that gold is a good hedging instrument among the other metals since it experiences short strays from its mean and variance.

There is a large body of literature studying long memory properties and structural changes in equity markets, but little is known about volatility of gold. The existing papers study the precious metals in developed markets (Trück et al, 2012: 48; Tully and Lucy, 2007: 316; Canarella and Pollard, 2008: 17; Arouri, 2012: 207; Ewing and Malik, 2013: 113), less attention has been given to the volatility of precious metals namely gold in the emerging markets. One such seminal work was carried out by Soytas et al. (2009). In this study, they examine the dynamics of spot gold and silver prices and their co-movements with world oil prices, the Turkish Lira–US dollar exchange rate, and interest rate. They employ a multivariate model covering the data from 2003 through 2007. In their paper, they report the hedging role of gold against devaluation of the Turkish Lira. According to their analysis, there is no predictive power of oil price on the precious metal prices including gold in Turkey. Thus, most of the research that have been conducted mainly focused on the analysis of the role of gold as a hedge against inflation, some studies have also analyzed variables that could be affecting the behavior of gold prices, but little have been done with regard to the research of gold markets in the countries with emerging economies. The current thesis study attempts to fill the gap in the literature by investigating the gold volatility in Turkey and Russia.

CHAPTER 2
VOLATILITY

2.1. CONCEPT OF THE VOLATILITY

With the publishing of the popular book "Risk Uncertainty and Profit", which was written by Knight in 1921, the financial literature during the previous century was focusing on possible methods of estimation the risk in both theoretical and empirical terms. Besides, most of the studies in this field admitted the concept of risk to the returns volatility. New breath of the financial community's interest in the concept of volatility was revived by wide swings and impressive fluctuations in the stock and commodities market prices during the last financial crisis. In finance, probable asset price fluctuations are used to estimate market risk and unpredictable price swings indicate uncertainty. Thus, the most widely used concept for representing risk is volatility of returns and it must be highlighted that it is merely an instrument for evaluating the risk.

2.1.1. Volatility as A Proxy for Risk and Its Importance In The Estimation of the Market Risk

Maximizing returns is one of the major aims of any investor, but with every investment, one bears some risk. Therefore, in order to gain high returns investor should pay determined price, or risk and for many market participants it is associated with volatility, that is how much uncertainty possesses the expected return on an asset (WCG, 2010). Among academics and market practitioners, the risk is divided into two big categories systematic and unsystematic risks. Systematic risk is exposure to events, which affect aggregate outcomes such as foreign market changes, taxes, earthquakes and weather catastrophes; also, it is called like undiversifiable risk. Factors completely specific to an industry or a company produce unsystematic risk, and this risk can be reduced through appropriate diversification. In more detail, Cuthbertson (2001) distinguishes following types of risks: legal risk, liquidity risk, credit risk, operational risk, assimilation risk, incentive risk, market risk, and model and estimation risk. Since changes and impressive price fluctuations produce market risk, this thesis study operates with market risk. Market risk raises a question of uncertainty for any people, who invest their money into risky financial instruments. A various number of market factors, such as change of the price of securities, in interest rates, exchange rates, etc. increases the probability that, say portfolio value will decline. Such possibility can be attributed to the market risk, which has strongly affects the value of any financial institution. Hence, every agent, involved in financial market, especially security market, should estimate and forecast the possible market risk, ignoring and not taking into account of which may lead to the high losses.

According to financial econometrics, normal distribution of returns assumes that asset prices follow a random walk process, which also implies that the distribution of returns is symmetrical, thus, one can evaluate the probabilities of potential gains or losses. This means historical volatility of returns, usually calculated as a historical standard deviation, can be used as a risk indicator. The closing prices are commonly employed to estimate the volatility. However, Parkinson (1980) argues that the intraday high and low prices will give to the practitioner better results of real volatility. Additionally, to eliminate the shortcomings of closing or opening prices, researcher can also improve the analysis with high frequency data. However, such data became available relatively recently.

In reality, the distribution of returns is not normal. Therefore, there was need of other risk measurements techniques. Since investors are much more concerned about the risk of losses than by the risk of gains, most of such approaches, focus usually on the conception of potential loss. Particularly, they are the semi-variance, which responds to a variance estimated solely by using negative deviations from the mean and Value at Risk (VaR), which estimates the maximum losses for a portfolio over specific period. The later method, where the volatility plays a determining role, gained a wide application in estimation of the market risk. The development of the econometric approaches contributed to more accurate forecasts of volatility and therefore, provided financial benefits (Longin, 2000: 1097). Since the conditions of the markets always change, the most reliable estimates are made using daily observations; besides the variables of the value at risk approach may be also evaluated on yearly, monthly, weekly basis.

Furthermore, for estimating distribution of returns it is not enough to consider only the first two moments that is mean and variance, since there are skewness and kurtosis (third and fourth moments), which also play an important role in describing the properties of distribution. Consequently, the assumption of a normal distribution is commonly rejected while investigating the financial time series and it is admitted that the distribution of such returns is skewed and leptokurtic. The descriptive statistics allows the practitioner to reveal the distributional characteristics of the data, it is important noticing that if there two distributions, where one of them normal and another is non-normal. Although the latter may have a smaller standard deviation than the normal distribution, it may be a riskier distribution in terms of value at risk, because it is more leptokurtic. Thus, while estimating the volatility it is essential to determine the real distribution of the returns, since considering only the standard deviation may indicate that non-normal is less risky than normal distribution (Grouard, 2003). Sometimes volatility may be confused with the illiquidity of the market. In such situation, low market volatility must not be explained as low market risk, but as a sign of high liquidity risk. On the other side, the illiquidity of the market may also be a reason of high volatility, because impressive price changes may be needed in an illiquid market in order to match bid and offer transactions. Therefore, liquidity of the market also plays an important role in the analysis of asset volatility.

The last decades can be characterized as increasing more and more interest to the modelling and forecasting volatility. The intensive study on it shows an importance of volatility in financial universe: risk management, portfolio and security valuation, investment. In financial markets, volatility should not be interpreted as risk, but as approximate measure of it. Such definition, allows a better understanding why it became essential in to many investment decisions and portfolio creations. Every investment process bears risk to the some extent. In this connection, qualitative modelling and forecast of the asset volatility may serve as good starting point for estimating the investors' risk. The dramatically increased trading volume of the derivatives also made the volatility an important variable in pricing options. To set the option price, one must know the volatility of asset from now until the expiration date of the option. Moreover, with the constant development of new financial products, today people may purchase such contracts, which are written on volatility itself. Thus, volatility may also serve now as underlying asset and to price such kind of derivatives investor must forecast the volatility of volatility (Poon, 2003: 478).

In banking sphere, the risk management began to play an important role after establishing the Basel Accords. The major reason of such innovation was to provide the guarantee for financial institutions to have enough capital, which would respond to all obligations (Parrenas, 2003). For example, banks must establish their reserve capital at least three times that of Value-at-Risk and using volatility forecast with the assumption of normal distribution such Value-at-Risk estimates can be easily computed. Even though the assumption of normality assumption is violated, volatility successfully serves in creating the Value-at-Risk figures in simulation purposes (Pritsker, 1996).

2.1.2. Stylized Facts of Volatility

A number of several salient facts about financial asset prices and financial market volatility have been set up over the last decades. These stylized facts including volatility clustering, mean reversion, asymmetry, and fat tail distributions of volatilities across assets have been confirmed by huge amount of researches. Hence, a qualitative volatility model must reflect all these properties.

2.1.2.1. Volatility Clustering

Often financial asset prices are characterized by the large and small moves in the volatility, such behavior is called volatility clustering. Mandelbrot (1963) and Fama (1965) were one of the first, who documented the evidence of such behavior, particularly, they reported that large changes in the price of an asset are often followed by other large changes, and small changes are often followed by small changes. Further, the feature was confirmed in the studies of Schwert (1989), Chou (1988), Baillie (1996). Thus, volatility occurs in clusters, in other words, volatility swings are not stopped suddenly by shocks or newsbreaks, moreover they tend to persist for many periods. This volatility persistence means that the volatility expectations are influenced by market participants' perception of high volatility (Poterbaand Summers, 1986: 1147). Figure 7, which is described in the chapter four displays the daily squared returns of spot and futures gold volatility and shows evidence that the volatility of squared returns tends to cluster together over time. The family of GARCH class models successfully describes the volatility clustering and usually the estimates of the GARCH coefficients approximates to 0.9.

2.1.2.2. Mean Reversion

The main idea of the mean reversion concept is that periods of high and low prices are temporary and will consequently tend to move to the average price. In terms of volatility mean reversion implies that there is a normal level of volatility to which volatility will eventually return. In turn, the question about normal volatility is quite difficult question, since the markets are permanently transforming. Moreover, analysis of volatility cannot give a certain answer about when the volatility will revert to its mean. In this thesis, the conditional volatility is estimated under FIGARCH approach and conclusion about the mean reversion property is provided using Table 1.

Table 1: Long Memory Parameter and Mean Reversion.

d	Mean reversion
$d=0$	Short-run mean-reversion
$0<d<0.5$	Long-run mean-reversion
$0.5<d<1$	Long-run mean-reversion
$d=1$	No mean-reversion
$d>1$	No mean-reversion

2.1.2.3. Asymmetry

Another volatility characteristic, which is observed in financial markets is asymmetry, or so called leverage effect. The asymmetry is generally inherent to equity markets. Indeed, for the time series of equity markets positive and negative shocks do not have the same impact on the volatility. Many volatility models consider that the conditional volatility is affected symmetrically, the most popular GARCH (1,1) model, for example, allows the variance to be affected only by the square of the lagged innovation, thus, completely ignoring the sign of that innovation, i.e. the sign will be lost of the lagged residuals are squared (Brooks, 2008). Thus, the modeling the conditional volatility under GARCH approach will not be able to capture the asymmetric effects, to overcome this problem there were constructed different extensions of GARCH (1,1) model, such as exponential GARCH (Nelson, 1991: 347) and GJR (Glosten, 1993: 1779) models. In this study, the evidence of leverage effect is tested by the Sign Bias Test (SBT), which examines the model on the asymmetric impact of positive and negative innovations.

2.1.2.4. Tail Probabilities

The feature of the tail probability must be always examined in volatility modeling. Generally, the most common property of many financial data is to have leptokurtic or fat tailed distribution. Especially after the financial crisis of 2008, the importance of fat tails becomes more widely recognized by financial risk management and ignoring of them may lead to the serious errors in the model estimation. Nowadays, it is widely admitted that rather edged shape of the curve compared to a normal bell shaped distribution indicates a leptokurtic distribution. Leptokurtosis – is characterized by fatter tails and a greater peak at the mean than normal distribution, though it still has the same mean and variance (Brooks, 2008). Moreover, the fatter tails suggests the presence of relatively more extreme observations and excess kurtosis.

The kurtosis is a statistic for measuring the peak of the distribution of data. A normal distribution has a kurtosis coefficient equal to three, while the coefficient of leptokurtic distribution is always greater than three indicating thick tails. Although the normal distribution can serve as good fit of financial data, it is still going to underestimate the extreme events such as financial crashes. In order to take into consideration above-mentioned fact, in this thesis the models are estimated under Student t distribution, which is probably the most popular and commonly used fat-tailed distribution for financial time series. Like the normal distribution, classical Student t densities are symmetric and have a single peak. However, Student t densities are more peaked around the center and have fatter tails.

2.2. TYPES OF VOLATILITY

It is impossible to see the volatility in the same way as asset prices or interest rates. Therefore, the best way get the volatility is to measure it statistically and such estimation is necessarily to use past information that is looking backward. This will help if one really wants to know what volatility is going to be in the future. For this reason, financial managers talk about different volatilities, as proxies for the risk measurement. This thesis considers the most usable and debated types of volatilities in the financial literature.

2.2.1. Historical Volatility

There are two popular methods to estimate volatility: historical and implied. Historical volatility, can be also referred to as actual volatility, realized volatility and historical standard deviation, reflects the past price movements of the underlying asset. In other words, historical volatility measures how far price swings over a given period tend to stray from a mean or average value. It is calculated as the standard deviation of an asset's return over a fixed period, such as 30, 60, 90, 120, or 365 days. Return is often defined as the natural logarithm of the closing prices between each interval of time. The return and historical volatility can be calculated as shown in Equations 1 and 2.

$$r_t = P_t \,/\, P_{t-1}. \tag{1}$$

$$HV = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(r_i - \bar{r})^2} \quad (2)$$

where r_t: Return at thei^{th} interval; P_t: Close price of asset at the i^{th} interval.

If one wants to get the annualized volatility, then daily standard deviation must be multiplied by the square root of the number of days in a year. The average number of trading days in a year is 252. Despite the historical volatility is considered in most textbooks there several well-known disadvantages, specifically, when the historical standard deviation is used to calculate future volatility, since it only considers the information of past returns, thereby, not taking into consideration other possible information that might affect the markets. Engle (2004) and Poon (2003) also highlighted another problem that all past squared return deviations back to an arbitrary date are weighted equally in calculating the standard deviation and all observations before that date are ignored.

Moreover, the historical standard deviation is a function of squared return deviations and this creates additional problem since those deviations could be created by extreme values. To overcome this issue it is suggested to use a longer period to measure the historical standard deviation. Thus, returns over the last year are more preferably than over the last month and measuring historical volatility over a long period, such as a year smooth out the clusters and the information loses.

2.2.2. Implied Volatility

In volatility framework, implied volatility is a measure of market expectations regarding the asset's future volatility, or in other words, it is the current volatility of an asset estimated by its option price. Implied Volatility is derived from an option pricing model namely the Black-Scholes model by adding five variables into the formula, the price (P) of the underlying asset, the option's strike price (K), time to maturity (ΔT), the riskless interest rate (r_f), and the volatility. Volatility is the only variable that cannot be directly observed (Hull, 2006: 12). Therefore, if one knows the price of an option and all the above inputs, then the implied volatility can be calculated from modified option-pricing model. This calculated volatility value is called implied volatility. Due to the put-call parity, the implied volatility is the same for both call and put options with the same time to maturity and the same strike price (Poon, 2005: 478).

In practice, the theoretical market price and real price of option may differ from each other, whereas application of implied volatility can make these two prices equivalent (Alexander, 2001). Thus, implied volatility acts as a proxy for option value. It is the only parameter in option pricing that is not directly observable from the market. To compare the relative value of two options one needs only look at their implied volatilities.

2.3. VOLATILITY MODELS

The presence of volatility clustering and persistence dictate that observations that are more recent maintain more information in the near-term future than the older observations. As a rule, any scientific research is accompanied by applying statistical methods. The dynamics of financial markets generates more and more distinctive features each decade. Accordingly, many managers and investors found that traditional statistical methodology have some serious shortcomings, since mostly it implies normal distribution and linear behavior of the models, which in turn make them impossible to capture more sophisticated price dynamics. Campbell (1997) stated that many aspects of today’s world economics have nonlinear nature, for example investors' behavior towards risk, dynamics of price fluctuations. Nowadays, the financial literature proposes more-sophisticated models, such as GARCH and the Riskmetrics, which consider that the weights decay constantly as the observations back in time (Engle, 2004: 405).

2.3.1. Random Walk

One of the first models of volatility proposed in finance literature was the random walk model. The model is coherent with the efficient market hypothesis, where stock price indexes are virtually random. Based on the historical prices, the random walk model uses ordinary least square method to estimate the volatility of stock returns.

$$r_t = \mu + \varepsilon_t \quad (3)$$

where r_t responds for the stock index return at time *t*; μ is the average return under the efficient market hypothesis; ε_t is the error term at time *t*, and its auto-covariance should equal to zero over time.

2.3.2. Exponentially Weighted Moving Average Model

An exponentially weighted moving average approach estimates weighting factors and allows more recent returns to have more influence weight on the variance. The weighting factors are decreasing exponentially for each recent point, at the same time paying attention to older observations.

$$\sigma_n^2 = \lambda\, \sigma_{n-1}^2 + (1- \lambda)\mu_{n-1}^2 \quad (4)$$

where λ is a weighting factor and $0 < \lambda < 1$, σ_n is the volatility on day n , and μ_i is the daily return for a specific day.

2.3.3. GARCH

The generalized autoregressive conditional heteroscedasticity approach was developed by Bollerslev (1986) extends the ARCH model. Thus, the conditional variance in this model becomes also a function of its own lags. Besides, the lag structure of the GARCH model is more flexible than in the ARCH model, which can create problems with negative variance parameter estimates (Bollerslev, 1986: 307).

$$\sigma_t^2 = \alpha_o + \sum_{j=1}^{q} \alpha_j\, \varepsilon_{t-j}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \quad (5)$$

where σ_t^2 can be expressed to AR (q) process for the squared residuals,$\alpha_i > 0$ and $\beta_i > 0$ guarantee that $\sigma_t^2 > 0$. It should be noticed that if p=0, the GARCH (p,q) model becomes an ARCH (q) model.

According to Bera (1995), GARCH model fits the data conditional volatility perfectly and substantially improves the variance forecasts of prices but not the price itself. The long range dependency represents an additional a predictable component in the time series, this feature contributes to increasing forecasting accuracy and improving the effectiveness of risk management. Therefore, modelling long memory in conditional variance gives a significant advantage over the traditional GARCH type models.

2.3.4. Risk Metrics Approach

J.P. Morgan developed in 1992 the extended version of the exponentially weighted moving average approach, RiskMetrics, which can be written in the following equation:

$$\sigma_t^2 = (1-\lambda)\sum_{j=0}^{\infty} \lambda^f \, (r_{t-j} - \bar{r})^2 \tag{6}$$

where $\bar{r}$ denotes the average return estimated by observations and it is assumed to be zero by RiskMetrics model. λ is the weighting factor, which estimates the weights to recent and older observations. The value of λ is generally equal to 0.94 for daily data and 0.97 for weekly data.

2.4. EFFICIENT MARKET AND LONG MEMORY IN VOLATILITY

One of the features of well-organized and functioning country's economy is market efficiency, which may be considered as the core of modern financial economics. The concept of efficient market hypothesis was developed by Fama (1970) and marked the beginning of a new era in theoretical and empirical finance. It is implied that there must no deterministic patterns, which could successfully characterize the efficient financial market. Additionally, there are three conditions dictating an efficient capital market: 1) there are must be large number of competing participants, who analyze and value securities 2) new information coming randomly to the market 3) the participants attempt to regulate security prices quickly to catch the effect of news (Fama, 1970: 374). At the same time, the inefficiency implies new opportunities to the market participants. Therefore, this feature became of high attention to portfolio and risk managers, since the models of asset and derivative pricing impose some statistical assumptions on the data, which meat the hypothesis market efficiency.

The information in the market is categorized into three types as historical information, public information and future (or internal) information. Balaban (1996) found that in the Turkish capital market the aggregate stock prices do not fully reflect publicly available information. On the contrary, Pele (2008) revealed the efficiency in the Romanian capital market, which also suggests that there are no arbitrage opportunities and the usage of historical data becomes invalid (Eoma, 2008: 4631). Sometimes, researchers examine the efficiency by considering the data's ability to generate deterministic or stochastic process. In this relation, the idea of long memory in asset returns would conflict the weak form of the market efficiency hypothesis, which also claims that asset returns cannot be predicted. The conflict lies in the fact that the presence of long memory serves as a perfect indicator of non-linear dependence, which implies that market respond to information flow not immediately but progressively. Lomev (2010) conducted the research about stock indices of East-European countries such as Bulgaria, Croatia, Romania, Russia, Serbia, Turkey, and Ukraine; the findings suggest the presence of long memory for all indices except for ISE100, which implies the rejection of weak form of efficiency. Lim et al. (2008), Alagidede and Panagiotidis (2009) indicated the weak form of market efficiency paying attention to nonlinearities in the data.

Thus, if the data possess long range dependence, the investigated time series are not independent and do not follow a random walk, thereby, distant past values will be engaged in forecasting future returns. Generally, the presence of long memory accompanied by the evidence of significant autocorrelation functions. In addition, if the nonlinearity is detected in the data, this may be also considered as evidence of return predictability. Modeling long memory properties in returns and volatility has become an attractive research challenge in finance, since the presence of it improves the prediction accuracy of market movements, which undoubtedly appeals derivative market participants, risk and portfolio managers.

There are already admitted three types of market efficiency, based on the information set, namely weak, semi-strong and strong form. According to Fama (1970), the weak form of the market efficiency, security prices reflect all the available historical information or the information set consists of past prices and volumes. In this limited version, the assumption of independent and identically distribution of the log-returns is established. Moreover, it also implies a random walk process in the prices, thereby researchers and practitioners began to make conclusions about the weak form market efficiency by modelling the prices series and estimating possible deviations from the random walk approach. In particular, Parto (2004) tested the random walk hypothesis in developed stock markets and found that in most of them are not characterized by random walk process. On the other hand, the findings of Oskoee (2010) suggest the weak form efficiency for the Iran stock market. The current thesis does not test the hypothesis of random walk process directly. However, the series are checked for nonlinearity using Engle (1982) LM test and the long memory property and as it was mentioned, the presence of these features assumes the rejection of weak form efficiency. Additionally the semi-strong form implies that prices include all the publicly available information, which may consist of historical information, annual reports, announcements, etc. The strong form suggests that prices fully reflect all the available and relevant information – public and private (Fama, 1970: 410).

2.5. DERIVATIVE TRADERS

The diversity of derivative instruments attracts many different types of traders. In general, they can be divided into three groups: hedgers, speculators and arbitrageurs. This section provides the description of these traders:

- The first big group of traders represents the hedgers; the main purpose of such traders is to control their risk exposure by using financial derivatives. The incentive of hedgers' activity starts with possible undesirable price fluctuations, thereby if one attempts to provide safety to his investment, he or she can lock the price at a determined time in the future by selling futures that match the delivery of asset similar to his investment at a determined time. This method of neutralizing the price change risks is available for both financial and commodities markets. Another situation in the derivative market is connected with probability of declining in a share price during the next months, here; the investor can shield his asset by buying put options with an exercise price equal to his lowest agreeable price level. Such operation provides a guarantee against the risk of asset downfall below, at the same time keeping the possibility of upward behavior.

The primary distinctive feature of hedging with futures is that futures neutralize risk and price fluctuations by locking the price at a specified level, whereas hedging with options provides insurance as they defend the investor from undesirable price changes while preserving the possibility of auspicious price motions (Hull, 2009: 10). Besides, futures contracts are popular for portfolio management, even though, their application differs from hedging, it still keeping the possibility of risk managing. That is, hedgers and portfolio managers employ derivatives in portfolio with other assets to regulate their composite risk exposure. In addition, mostly it is accepted that the period hedgers and portfolio managers keep their derivatives is much longer than speculators. The most attractive feature of the futures is the presence of low transaction costs and liquidity that is why portfolio managers often consider the futures as tool for managing the beta of portfolio. When the manager knows the beta and weight of the assets, he can easily find the beta of a whole portfolio by summing their weighted betas. The portfolio's beta can be controlled by trading shares, borrowing (lending) at the risk free rate (CAPM framework) and using stock index futures (Sutcliffe, 1993). The first two approaches imply large transaction costs, while index futures have comparatively low transaction cost and margin payments; moreover, regulating the beta becomes easier, that is, portfolio manager buys (sells) index futures without compromising diversification. Thus, index futures gained widespread popularity and applied successfully in managing and controlling beta (Hull, 2009: 11).

- In comparison to hedgers, speculators namely hedge funds, commodity trading advisors, different types of brokers and traders use derivatives in order to make profit by betting on the future direction of market prices of the underlying asset. The thing is that derivative speculators can take advantage of the leverage effect, which allows them to pay only for the options price or futures margin payment, therefore, one gets the same asset exposure as the underlying asset. Thus, the popularity of derivative trading is mainly connected with the opportunity of high exposure for a relatively small initial investment. However, this advantage becomes serious drawback, because in this market the result of bad outcomes bears substantial losses of the total investment. Speculators operate with different time horizons, in the shortest one act scalpers, their time horizon can be even one second. Such traders generally, do not pay too much attention of where the prices are going. The purpose of a speculator or also call like market maker is to purchase contracts at a slightly lower price than the current market price and sell them at a slightly higher price. Moreover, the total profit on each contract may be just cent, but scalpers "win the battle" with the quantity, not quality thus, the amount of trading contracts in a day can be up to thousands (Kolb, 2003: 102). Another type of speculators, day traders set their positions within minutes or hours, whereas trend followers operate in the longest time horizons: days, weeks or months. This type of speculators also supplies the liquidity information to hedgers in futures markets (Hull, 2009: 11).
- The last group of traders represents arbitrageurs, whose activity implies searching the identical or similar mispriced assets in two different markets and fixing them in a risk free profit. For instance, they can profit by purchasing an asset in one market for less than they sell in another market, so arbitrageurs are financial intermediaries, who connect the buyers in one market and sellers in another market. This also may be applied to the shares on different exchanges but denominated in different currencies, since they cannot entirely be in the same with the current exchange rate. Thus, in the

above-mentioned examples arbitrageurs can gain a risk free profit (Yadav, 2006). Arbitrageurs are major market participants in that their aim is maintain the efficiency of the market by giving the prices back to fundamental values. They generally trade the assets, which values depend on the same factors. The asset sold can be physical and the bought may be a derivative of the physical asset, also arbitrageurs can trade the same underlying asset in the derivative market. Although, the arbitrageurs apply sophisticated quantitative tools before taking a position, they still keep in mind that their models can be mistaken (Cetina, 2012: 104).

CHAPTER 3
DATA AND METHODOLOGY

3.1. DATA

In this thesis, daily time series for Turkish and Russian gold spot and three-month futures prices are used. The gold futures are traded on the TURDEX (Turkish Derivatives Exchange Market) in Izmir and FORTS (Futures & Options on RTS) in Moscow. Both the spot and futures prices are denominated in national currencies.

The data employed in this study are continuously compounded daily gold returns. They are calculated by taking a logarithmic difference of the gold spot and futures prices, which is $R_t = \log(p_t/p_{t-1})$, where $p_t$denotes the value of gold price at a time ***t.***

While the spot gold market has a relatively long history, the precious metals futures market is quite new. The Turkish Derivatives Exchange Market was established in 2005 and the first futures gold contracts were traded in March 2006. From 2006 through June 2008, there was no active gold trading on TURDEX. The futures gold market exhibited instable and temporarily trading characteristics. When the world economy has experienced a period of considerable financial volatility during which gold prices increased significantly, gold futures market turned to be an actively traded market. In the light of these facts, the data in Turkey for the years 2006, 2007 and the first half of 2008 was omitted and thus, sample period starts from June 27, 2008 till May 31, 2013. The same procedure was executed for Russian gold futures in order to have comparison with Turkey using the same sample sizes.

The data for the gold spot prices were obtained from the official web page of World Gold Council, www.gold.org. The data for the Turkish and Russian gold futures prices were taken from www.turdex.org.tr and www.finam.ru, respectively.

3.2. METHODOLOGY

This section provides the methodology of the tests and models estimated in this thesis. Before modelling the volatility, the tests of long memory and multiple structural changes are presented. Further, two tests of Shimotsu are offered to distinguish between true and spurious long memory process. Then, FIGARCH model under Chung's specification is considered to account for the long memory in volatility. The multivariate approach is represented in order to estimate the spillovers between spot and futures volatilities. Further, to estimate the hedging abilities of gold futures contracts, the formulas of hedge ratios and hedging effectiveness are proposed. Finally, the methodology of Value-at-Risk calculation and its test on effectiveness is presented.

3.2.1. Long Memory Tests

Among several methods of estimating and testing the fractional differencing parameter *d*, semi-parametric approach by Geweke and Porter-Hudak estimator (GPH) and Gaussian semi-parametric (GSP) approach by Robinson are extensively used in the literature. To detect the presence of long memory, GPH, GSP and modified GPH estimators are used.

The GPH is the most widely used long memory estimator due to its computational simplicity. It is based on a spectral regression of the low frequency near zero, providing a test for estimating the fractionally integrated parameter. GPH estimation procedure starts by calculating the sample periodogram. The next step is to perform a simple linear regression

$$log\{I_y(w_j)\}=\beta_1 + \beta_2 log\left\{4sin^2(\frac{w_j}{2})\right\} + v_j, \quad (7)$$

where $v_j = log\left\{\frac{f_z(w_j)}{f_z(0)}\right\}$ and j=1,…, m (the bandwidth parameter) and

$w_j \frac{2\pi j}{n}$ denotes the j th Fourier frequency based on a sample of n observation. $I(w_j)$indicates the sample periodogram defined as

$$I(w_j) = \frac{1}{2\pi n}\left|\sum_{i=1}^{n} r_t e^{-w_j t}\right|^2$$

where r_t is covariance stationary gold return time series. The estimate of $\hat{d}_{GPH}$ is $-\beta_1$.

GPH estimator has large bias in finite samples in the presence of strongly autoregressive short memory (Agiaklglou et al., 1992: 235; Cheung, 1993: 182). The bias, therefore, is corrected by including additional regressors in the estimation equation. Smith (2005) proposed the modified GPH (mGPH) estimator and like GPH estimator, mGPH is focused on the log periodogram, however the modified version allows for slowly varying structural changes. Indeed, Smith (2005) claims that the results of GHP estimator are biased and they often improperly indicate the presence of long memory when it is applied to a short-memory mean-plus-noise process. Further, mGPH includes supplementary regressor $-\log(p^2 + w_j^2)$ in the log-periodogram regression where p is estimated as $p = kj/n$ for some constant $k > 0$. This would reduce the bias caused by structural changes. Although parameter k cannot be well estimated from the data, Smith (2005) suggests setting $k = 3$. The offered specification of the GPH regression model does not absolutely eliminate bias due to structural breaks, the mGPH estimator with $k = 3$ significantly reduces bias relative to the GPH estimator.

An alternative estimator of the persistence is GSP test constructed by Robinson and Henry (1999). GSP estimator is also based on the periodogram regression and it runs the Gaussian semi-parametric method to estimate the long memory parameter for a covariance stationary series. It is given as:

$$f(w) = Gw^{1-2H} \ as \ w \to 0^+$$

where $\frac{1}{2} < H < 1$, $0 < G < \infty$ and $f(w)$ is the spectral density of r_t. The periodogram with respect to the observations of r_t, $t = 1, \dots, T$ is defined as $I(w_j) = \frac{1}{2\pi n} \left| \sum_{i=1}^{n} r_t e^{itw_j} \right|^2$.

Consequently, the long memory parameter H is determined by

$$H = \arg \min_{\Delta \le H \le \Delta_2} R(H),$$

$$\text{where} \begin{cases} 0 < \Delta_1 < \Delta_2 < 1 \\ R(H) = log\left\{\frac{1}{m}\sum_{j=1}^{m}\frac{I(w_j)}{w_j^{1-2H}}\right\} - (2H-1)\frac{1}{m}\sum_{j=1}^{m}\log(w_j) \\ m \in (0, [n/2]) \\ w_j = 2\pi j/n \end{cases}$$

3.2.2. Tests for Multiple Structural Breaks

The methodology was developed by Bai and Perron (2003), who considered estimating and testing for multiple structural breaks when number and the location of breaks is unknown. Multiple linear regression with m breaks:

$$(m+1 \text{ regimes}): y_t = x_t'\beta + z_t'\delta_j + u_t \text{with} \quad t = T_{j-1}+1, \dots, T_j \qquad (8)$$

where *m* is the number of breaks, y_t is the dependent variable, x_t is the column vector of the explanatory variables at time *t*, whose effects are invariant with time, in such a way that the vector x_t' is a line vector. z_t is the column vector of the explanatory variables at time *t*, whose effects vary over the time, in such a way that the vector z_t' is a line vector. β and δ_j are the corresponding vectors of coefficients and u_t is the disturbance term.

For detecting the breaks, Bai and Perron developed two approaches. In the first approach, each partition *m* is obtained as the one that minimizes the sum of square residuals (SSR). In the second approach, starting with the single break that minimizes the SSR, breaks are determined sequentially. To search for the breaks that minimize SSR is realized regardless of whether these breaks are statistically significant or not.

The authors of the procedure apply a battery of tests such as $supF_t(k)$ test to detect no breaks versus a pre-specified number of changes, that is $supF_t(k;q) = F_t(\hat{\lambda}_1, \dots, \hat{\lambda}_k; q)$, where $\hat{\lambda}_1, \dots, \hat{\lambda}_k$ minimize the global sum of squared residuals.

To test the null hypothesis of no structural breaks against an unknown number of breaks, Bai-Perron proposed the double maximum tests, which are defined as:

$$UD_{max} = \max_{1 \le k \le M} \sup F_t\,(k;q),$$

where M is an upper bound on the number of positive breaks. $WD_{\max}$, that applies weights to sup $F_t(k; q)$ such that marginal p-values are equal across values of m.

To define the corresponding number of breaks in the data, Bai and Perron elaborated a procedure to test the null hypothesis of l changes versus the alternative hypothesis of $l+1$ changes. This test is applied to each segment containing the estimated breaks points $\hat{T}_{i-1}$and $\hat{T}_i$(i=1,…, l+1). Rejection is implemented in favor of a model with (l+1) breaks if the overall minimal value of the sum of squared residuals (over all segments where an additional break is included) is sufficiently smaller than the sum of squared residuals from l break model. The selected breaks, therefore, are those, which associated with this overall minimum.

All these tests allow for different serial correlation in the errors. The model specification consists of constant as regressor, also it accounts for serial correlation and different variances in the residuals, as suggested by Bai and Perron (2003).

3.2.3. Real or Spurious Long Memory

It is a fact that structural breaks can easy cause spurious long memory. Shimotsu (2006) test is applied in order to determine whether the long memory is true or spurious produced by structural breaks.

3.2.3.1. Sample Splitting Test

The logic of the test lies in estimating the long memory parameter over the full sample and over different subsamples under the null of the true long memory. Each subsample follows I (d) process with the same value of the long memory parameter d. This is splitting the sample into b subsamples providing each subsample with T/b observations[1]. Shimotsu (2006) suggests to use m/b periodogram ordinates to compute the local Whittle estimator, m is an integer number of the periodogram ordinates used for the calculating the d in the full sample. Let also $\hat{d}^{i}(i = 1,2,3,\ldots,b)$ be the local estimator of the true long memory parameter d_0 computed from the i^{th} subsample. Then following expressions are defined:

$$\hat{d}_b = \begin{pmatrix} \hat{d} - d_0 \\ \hat{d}^{(1)} - d_0 \\ \vdots \\ \hat{d}^{(b)} - d_0 \end{pmatrix}, A = \begin{pmatrix} 1 & -1 & \cdots & 0 \\ \vdots & \vdots & \cdots & \vdots \\ 1 & 0 & \cdots & -1 \end{pmatrix} \text{ and } \Omega = \begin{pmatrix} 1 & \tau_b \\ \tau_b & bI_b \end{pmatrix}$$

where I_i is a $(b \times b)$ identity matrix and τ_i is a $(b \times 1)$ vector of ones. Following Hurvich and Chen (2000), and Shimotsu (2006), the constancy hypothesis of d $(H_0: d = d^1 = d^2 = \cdots = d^b)$ is tested against structural change hypothesis using the following the Wald tests statistics[2].

$$W = 4m\left(\frac{c_{m/b}}{m/b}\right) A\hat{d}_b (A\Omega A')^{-1} (A\hat{d}_b)' \qquad (9)$$

where $c_m = \sum_{j=1}^{m} v_j^2$; $v_j = logj - \frac{1}{m}\sum_{j=1}^{m} logj$; and m is the number of periodogram ordinates and $m \prec T$. Shimotsu (2006) concludes that larger values of m do not necessarily lead to increases in the power, b=2 and b=4 are chosen in this paper.

[1]T/b is assumed to be integer
[2]The Wald statistics follows a Chi-squared limiting distribution with b-1 degree of freedom

3.2.3.2. Test Using d^{th} Differencing

The second test developed by Shimotsu (2006) considers the fact that if an I(d) process is differenced d times, then the obtained time series are trivially an I(0) process but not in the case when spurious long-memory processes are taken into account. To run the procedure, the data is demeaned firstly and then the Phillips-Perron (Z_t) and the KPSS unit root tests (η_u) are applied to its $\hat{d}^{th}$difference. Assuming that Y_t follows a truncated I (d) process with initialization at t=0:

$$Y_t - \mu = (1 - L)^{-d} u_t I_{t \geq 1}$$

where μ is the mean Y_t when d < 1/2, we have $T^{-1} \sum_{t=1}^{T} Y_t - \mu = O_P(T^{d-1/2})$ and as discussed in Shimotsu (2006) $(1 - L)^{-d}(Y_t - T^{-1} \sum_{t=1}^{T} Y_t) = u_t + O_P(T^{d-1/2} t^{-d})$.

Hence, if $d \geq 1$, the second term on the right has a nonnegligible effect on the sample statistics of the d^{th}differenced demeaned data. Under the assumptions presented in Shimotsu (2006), the two statistics, Z_t and η_u, converge towards $P(W(r, d_o))$ and $K\big(W(r, d_0)\big)$ as $T \to \infty$ where $W(r, d) = W(r) - w(d)\big(\Gamma(2 - d)\Gamma(d + 1)\big)^{-1} r^{1-d} W_{d+1}(1)$.

Note that $P\big(W(r, d_0)\big)$ is the standard Dickey-Fuller distribution when an intercept is included and $K\big(W(r, d_0)\big) = \int_0^1 (r) - rW(1))^2 \, dr$. When d=0, $W(r, d)$ reduces to the standard Brownian bridge. *W (d)* refers to a smooth weight function such that w (d) =1 for d $\leq 1/2$ and w (d) = 0 for d $\geq 3/4$.

3.2.4. FIGARCH Class Model

The FIGARCH model tests the long-memory properties in time series considering the fractionally integrated process I (d) in the conditional volatility. According to Fantazzini (2011), the fractional models show much higher p-values than competing models when tests for conditional heteroskedasticity are of concern; this confirms the importance modelling long memory in the volatility.

Among fractional models, the FIGARCH model by Baillie, Bollerslev, and Mikkelsen (1996) (hereafter denoted BBM) is the one that performs best in terms of numerical convergence, computational time and diagnostic tests. The FIGARCH (p_v, d_v, q_v) specification mathematically can be expressed as follows:

$$\sigma_t^2 = \omega[1-\beta(L)]^{-1} + [1-(1-\beta L)^{-1}\,\alpha(L)(1-L)^d]\varepsilon_t^2, \tag{10}$$

$$\{\omega^*\}\{\lambda(L)\}$$

or

$$\sigma_t^2 = \omega^* + \textstyle\sum_{i=1} \infty\, \lambda_i L^i \varepsilon_t^2 = \omega^* + \lambda(L)\, \varepsilon_t^2, \text{ with } 0 \le d \le 1.$$

where L denotes the lag polynomial so that $L\,\varepsilon_t = \varepsilon_{t-1}$ and d is the long memory parameter in the conditional variance of the series. ω is the constant of the conditional volatility equation and is assumed positive. α and β are reffered to as the ARCH and GARCH parameters.

However, Chung (1999) finds out some shortcomings in the BBM model, since there is a structural problem in the specification, leading to difficult interpretations of the estimated parameters. As a result, Chung (1999) worked out a slightly different process:

$$\alpha(L)(1-L)^d(\varepsilon_t^2 - \sigma^2) = [1-\beta(L)](\varepsilon_t^2 - \sigma_t^2)$$

where σ^2 is the unconditional variance of ε_t.

Keeping the same idea of $\lambda(L)$ as in Equation (10), the conditional variance can be formulated as:

$$\sigma_t^2 = \sigma^2 + \{1-[1-\beta(L)]^{-1}\,\alpha(L)(1-L)^d\}\,(\varepsilon_t^2 - \sigma^2)$$

or

$$\sigma_t^2 = \sigma^2 + \lambda(L)\,(\varepsilon_t^2 - \sigma^2). \tag{11}$$

Chung (1999) proves that $\sigma^2 > 0$ and $0 \leq \alpha_1 \leq \beta_1 \leq d \leq 1$ is sufficient to guarantee the positivity of Equation (11) when *p=q=1*.

Moreover, $\lambda(L)$ is an infinite summation, which must be truncated. Contrary to BBM, Chung (1999) proposes to truncate $\lambda(L)$ at the size of the information set *(T-1)* and to initialize the unobserved $(\varepsilon_t^2 - \sigma^2)$ at zero. Thus, in this study the fractional integration process is estimated under Chung's (1999) specification.

According to Hosking (1981), when the long memory parameter d lies between -0.5 and 0.5, the y_t process is stationary and invertible. Thus, the effect of shocks to ε_t on y_t decays at the slow rate to zero. When d = 0, the process is stationary, the effect of shocks to ε_t on y_t decays geometrically and it is called short memory. If d = 1, the model conforms to a unit root process. For 0 < d < 0.5, there is a positive dependence between distant observations implying long memory. If -0.5 < d< 0, the process exhibits negative dependence between distant observations, so-called anti-persistence or intermediate memory.

3.2.5. Multivariate ARCH-Type Models Framework

One of the sophisticated multivariate GARCH models is dynamic conditional correlation multivariate GARCH model proposed Engle (2002), which can be defined in following way:

$$H_t = D_t R_t D_t,$$

where D_t=diag $(h_{11t}^{1/2} \dots h_{NNt}^{1/2})$ and h_{iit} can be defined as any univariate GARCH model, and

$$R_t = \text{diag}\,(q_{11,t}^{-1/2} \dots q_{NN,t}^{-1/2}) Q_t \text{diag}\left(q_{11,t}^{-1/2} \dots q_{NN,t}^{-1/2}\right),$$

where the $N \times N$ symmetric positive definite matrix $(q_{ij,t})$ is given by:

$$Q_t = (1 - \alpha - \beta)\bar{Q} + \alpha \mu_{t-1} \mu_{t-1}' + \beta Q_{t-1}, \qquad (12)$$

with $\mu_t = (\mu_{1t}\, \mu_{2t} \dots \mu_{Nt})'$ and $\mu_{it} = \epsilon_{it}/\sqrt{h_{iit}}.\bar{Q}$ is the $N \times N$ unconditional variance matrix of μ_t, and α and β are nonnegative scalar parameters satisfying $\alpha + \beta < 1$.

One of the big advantages of the DCC models is the separate estimation of parameters governing the variance and correlation dynamics. To calculate the correlation, $\bar{Q}$ correlation matrix ofμ_t must be estimated firstly. The parameters α and β in (12) are usually estimated by Gaussian quasi-maximum likelihood.

Ailelli (2009) has shown that the estimation of $\bar{Q}$ as the empirical correlation matrix of μ_t is inconsistent because:

$$E[\mu_t \mu_t] = E[E[\mu_t' \mu_t | \Omega_{t-1}] = E[R_t] \neq E[Q_t].$$

Ailelli (2009) solves this problem by the following model:

Let $P_t = \text{diag}\,(q_{11,t}^{1/2} \dots q_{NN,t}^{1/2})$ and μ_t^*. Then, $E[\mu_t^* \mu_t^* | \Omega_{t-1}] = Q_t$. The new model, called corrected DCC (cDCC) is specified as followed:

$$Q_t = (1 - \alpha - \beta)\bar{Q} + \alpha \mu_{t-1}^* \mu_{t-1}^{*'} + \beta Q_{t-1}, \tag{13}$$

with $\bar{Q}$ the unconditional correlation matrix of μ_{t-1}^*.

Diagonal elements $q_{11,t}, \dots, q_{NN,t}$ of $Q_t$are obtained as follows:

$$q_{ii,t} = (1 - \alpha - \beta) + \alpha \mu_{i,t-1}^2 + \beta q_{ii,t-1}, \tag{14}$$

3.2.6. Hedge Ratio and Hedging Effectiveness

The major function of the futures market is hedging, which allows for the investor to minimize the losses of possible cash price changes. Therefore, the hedging is the mechanism of managing the risk. It is accepted that performance of the futures contracts is determined by the hedging effectiveness. Hedge effectiveness is the extent to which changes in the fair value of the hedging instrument offset changes in the fair value of the hedged item. To compare the performances the un-hedged position is established on the spot market and the hedged position is constructed with the combination of both the spot and the futures contracts. Moreover, the calculated hedge ratios respond for the amount of futures contracts to be kept in order to reduce the risk (Ederington, 1979: 157).

The traditional hedging strategy, when the spot position is hedged by taking an equal but opposite position in futures market, that is h = - 1. If the proportional price changes in the spot market correspond to the same changes in the futures market then the price risk will be removed. However, in the real world it is almost impossible to have perfect relation between the spot and futures. The variances of un-hedged and hedged positions can be estimated as follows:

$$\text{Var (u)} = \sigma_s^2 \text{ and Var (h)} = \sigma_s^2 + h^2\sigma_f^2 - 2h * \sigma_{s,f},$$

where Var (u) and Var (h) are variance of un-hedged and hedged positions. Here σ_s, σ_f and $\sigma_{s,f}$ are the standard deviations of spot, futures prices and covariance between spot and futures returns respectively. Johnson (1960) developed a measure of hedging effectiveness as the percentage reduction in variance of the hedged and the un-hedged positions:

$$E = 1 - \frac{VAR\ (H)}{VAR(U)} \qquad (15)$$

The OLS method estimates the hedge ratio by calculating the regression found in Equation (16) using OLS (Coakley, 2008: 1076).

$$\Delta s_t = \beta_0 + \beta_1 \Delta f_t + \varepsilon_t \qquad (16)$$

The estimated value of β_1 is hedge ratio, it is generally accepted that slope parameter β_1 must be in the range of 0.8 and 1.25 and hedging effectiveness equal or greater than 0.8; in these conditions the hedging is considered as highly effective (Lipe, 1996).

3.2.7. Value-at-Risk and Backtesting

According to Jorion (2001), Value-at-Risk method calculates the probability of portfolio assets losing a specific amount over a specified time due to adverse movements in the market factors. Thus, VaR is a single number, which involves the total risk in a portfolio of financial assets. It is widely popular among corporate treasurers and fund managers, as well as bank regulators, who estimate VaR for the purpose of capital bank needed to maintain the risks it is bearing (Hull, 2009: 457). Mathematically it describes as follows:

If q_α is the α^{th} quantile of the distribution of ε_t, i.e. $P\ (\varepsilon_t < q_\alpha) = \alpha$, or $P\ (r_t < \sigma_t q_\alpha \vdots F_{t-1}) = \alpha$, then

$$VaR_{t,\alpha} = \sigma_t q_\alpha \tag{17}$$

where σ_t in this thesis is calculated by FIGARCH, GARCH and Riskmetrics and q_α is quantile of Student distribution.

$VaR_{t,\alpha}$ for long (VaR_L) and short (VaR_S) positions:

$$VaR_L = \hat{\mu}_t + \hat{\sigma}_t . st_{\alpha,v}; \tag{18}$$

$$VaR_S = \hat{\mu}_t + \hat{\sigma}_t . st_{1-\alpha,v} \tag{19}$$

where $st_{\alpha,v,\mathcal{E}}$ and $st_{1-\alpha,v,\mathcal{E}}$ are the left and right quantiles respectively, v, degree of freedom, $\hat{\mu}_t$, forecast of conditional mean, $\hat{\sigma}_t$, forecast of conditional deviation.

The effectiveness of VaR estimates is tested by Backtesting procedure, developed by Kupiec (1995) and can be expressed as follows: Let $N = \sum_{t=1}^{T} l_t$ be the number of exceptions (l_t is an indicator of exceptions).

where $N \sim B\ (T, p), p$ is a pre-specified VaR level. Let $p_o$denote the modeled probability of failure. Hypothesis for testing if failure rate equals expected one:

$$H_0 : p = p_0$$

Likelihood ratio statistics,

$$LR_1 = -2 \log \{p^N(1-p)^{T-N}\} + 2 \log \left\{\left(\frac{N}{T}\right)^N (1-N/T)^{T-N}\right\}; \quad LR_1 \sim \chi^2$$

It was accepted the apparent success of RiskMetrics model in estimating the VaR. The model became standard in the market risk measurement due to its simplicity. RiskMetrics model is an IGARCH (1,1) model, in which the ARCH and GARCH coefficients are fixed. The basic conditional variance model of the RiskMetrics is described as follows:

$$\sigma_t^2 = \omega + (1-\lambda)\varepsilon_{t-1}^2 + \lambda\sigma_{t-1}^2 \quad (20)$$

where ω = 0 and. λ is the weighting factor, which estimates the weights to recent and older observations. λ is set to 0.94 with daily data and to 0.97 with weekly data.

CHAPTER 4
EMPIRICAL FINDINGS

This chapter provides empirical findings of the thesis. Initially the descriptive statistics of the daily returns is discussed, which provides the general characteristics of gold series. After that, the results of the long memory and structural break tests are presented, providing necessary information for the volatility modelling. Then, long memory versus structural breaks tests are performed to identify the most appropriate model specification. Further, the results of the FIGARCH modelling and its misspecification tests are represented, successful passing of which contributed to run the multivariate FIGARCH models. Finally, the forecast performance of FIGARCH model was investigated through the calculation of hedge ratios and value-at-risk estimates. The time series comprise 1285 observations and volatility is assumed as log-squared returns. Calculations were performed using Oxmetrics, Gauss and Matlab software.

4.1. GENERAL CHARACTERISTICS OF GOLD MARKETS

Table 2 presents the descriptive statistics for Turkish and Russian spot and futures gold returns as well as their stochastic properties over the sample period. For Turkey, the average returns for the spot and futures series reported as 0.0631% and 0.066%, respectively. While for Russia, the daily average returns are 0.0564% and 0.0308% for spot and futures, respectively. Notice that the Russian futures series exhibit two times lower average return than Turkish futures.

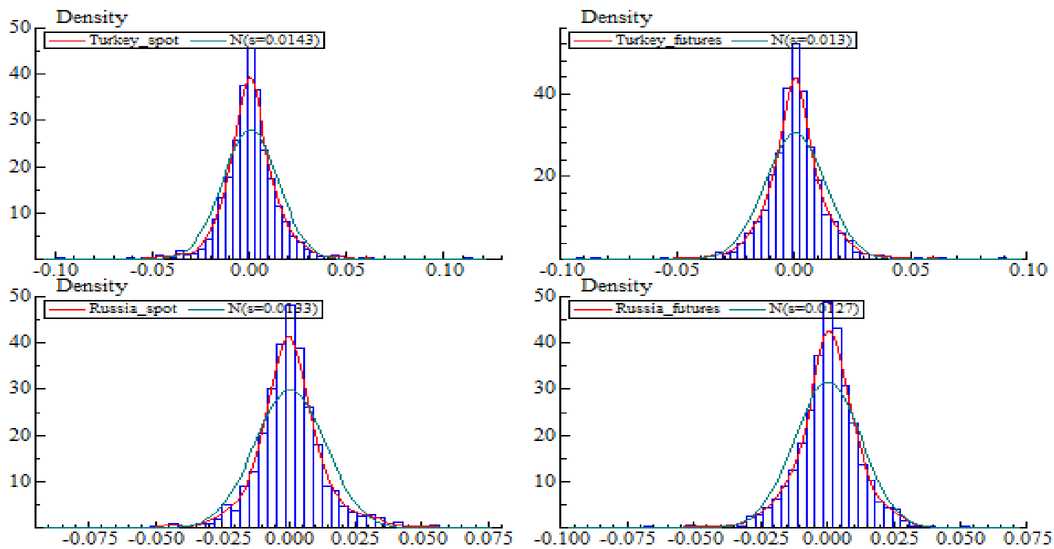
The standard deviation or unconditional volatility of all returns series are very close to each other and lie in the range of 1.26% (Russian futures) to 1.42% (Turkish spot). Further, the findings demonstrate the same results in Normality tests, in which skewness is negative and the excess kurtosis is highly significant. This means that gold returns have fatter and longer right tails than the normal distribution. This is consistent with the results of the Jarque-Bera test (JB), which rejects normality for both Turkey and Russia. Empirical evidence of leptokurtic (fat tails) properties is represented in Figure 6.

Table 2: Descriptive Statistics for Spot and Futures Gold Returns

	Turkish Gold Spot	Turkish Gold Futures	Russian Gold Spot	Russian Gold Futures
Mean (%)	0.0631	0.066	0.0564	0.0308
Min. (%)	-9.7129	-9.2557	-8.5334	-8.9168
Max. (%)	11.331	8.9569	6.7878	6.308
Std. Dev. (%)	1.42	1.29	1.33	1.26
Skewness	-0.0413	-0.1	-0.0432	-0.6349
Excess Kurtosis	8.0588**	7.2926**	5.0321**	5.369**
JB	3477.6***	2849.6**	1356.2***	1629.7***
ARCH(5)	36.674***	20.901***	20.749***	11.477***
Q(5)	9.0701	7.6319	3.6717	13.0344**
$Q^2(5)$	230.869***	152.929***	134.131***	77.2822***
ADF	-21.931***	-21.3903***	-20.7711***	-20.9622***

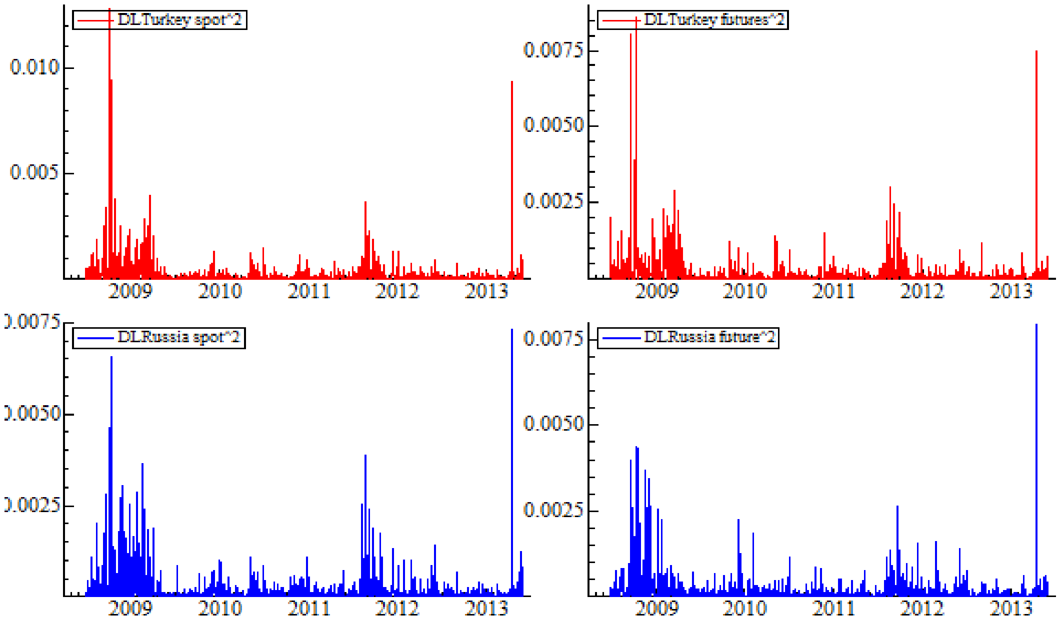
Notes*:* This table reports the descriptive statistics for Turkish and Russian spot and futures gold returns. JB, ARCH, *Q*(5) and $Q^2(5)$ refer to the empirical statistics of the Jarque-Bera test for normality, ARCH test for conditional heteroskedasticity, Ljung-Box test for autocorrelation with five lags applied to raw returns, and Ljung-Box test for autocorrelation with five lags applied to squared returns, respectively. ADF responds for Augmented-Dickey–Fuller test on unit root. *** Significant at 1% level, ** Significant at 5% level

Figure 6: Probability Density Functions



The signs of volatility clustering (i.e., periods of large absolute changes tend to cluster together followed by periods of relatively small absolute changes) and persistence (i.e., volatility stays in the same regime for a long period) can be seen in the Figure 7. The graphs contribute to the first evidence of structural breaks, since the presence of several sudden changes in the return volatilities is observed.

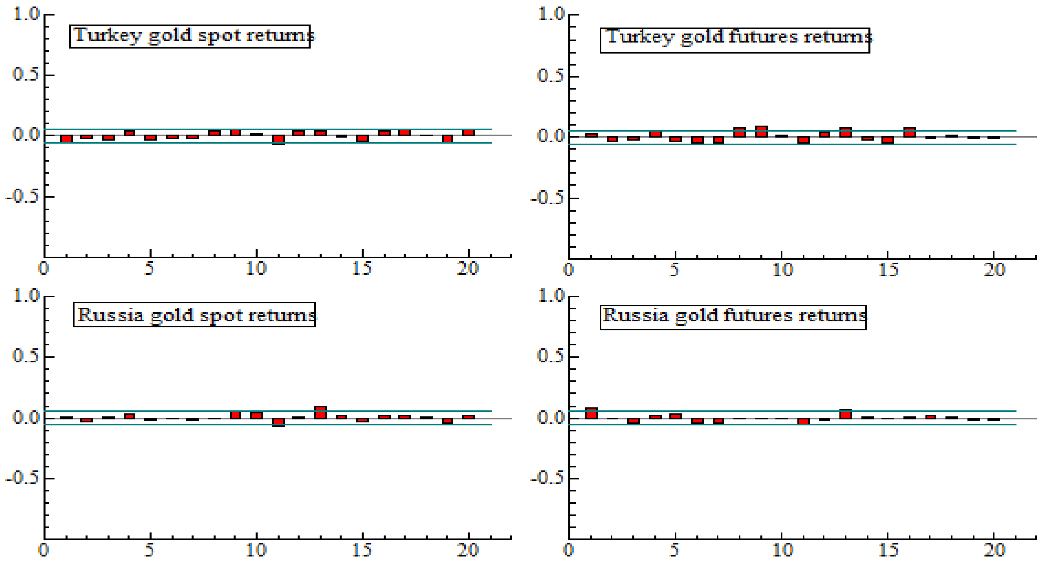
Figure 7: Dynamics of Gold Spot and Futures Squared Returns



The findings of the LM ARCH (5) test for conditional heteroscedasticity provide strong evidence of ARCH effects in all gold return series. This suggests suitability of GARCH – type models for modelling the time varying conditional volatility. The Ljung–Box tests with a lag of 5^{th} order indicate that autocorrelation doesn't present gold returns, except Russian futures. While for the squared returns Ljung–Box test, indicate strong evidence of serial correlation in the Turkish and Russian gold series. The Augmented Dickey–Fuller (ADF) statistics, which test for the null hypothesis of a unit root, show the rejection at 1% significance level indicating that the return series are stationary.

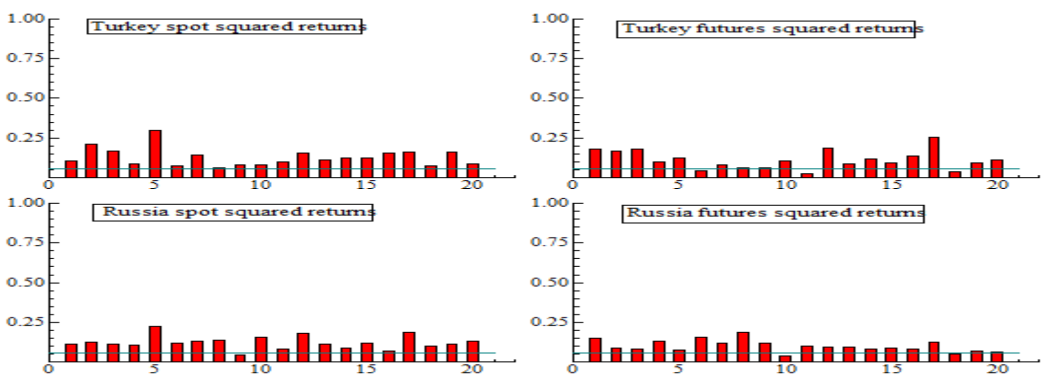
Analyzing the behavior of the autocorrelations functions may represent patterns of long memory in the distribution of gold series. Figure 8 and 9 display the autocorrelation functions of daily returns and volatility up to 20 lag. For the returns, most autocorrelations are small and stay inside the 95% confidence intervals, and some significant autocorrelations die out quickly for both Turkey and Russia.

Figure 8: Autocorrelation Functions for Spot and Futures Returns



Thus, no systemic pattern is found in the return series of gold. However, the autocorrelations for the squared returns series are significantly positive and persistence lasts for many lags. Moreover, the decay of the functions is quite slow and exhibits hyperbolic rate, in general such distinguishing feature possess long memory processes.

Figure 9: Autocorrelation Functions for Spot and Futures Squared Returns



Given the properties of autocorrelation functions, ACF graphs show a very persistent behavior in the volatility of spot and futures series. Such behavior of the functions is suggestive of long memory process; however, it is important to highlight that the presence of long memory does not dictate the general behavior of the autocorrelation function. This means that for a long memory process, it is not necessary for the autocorrelations to remain significant at large lags. One of the reasons of highly significant correlations may be structural breaks, which were no taken into account in modelling financial series. For example, Diebold and Inoue (2001) emphasize that infrequent stochastic breaks can create strong persistence in the autocorrelation structure of financial series.

4.2. ESTIMATION RESULTS OF LONG MEMORY TESTS

In this thesis, semi-parametric GPH and GSP procedures are employed to estimate the fractional differencing parameter for the gold volatility. These tests are implemented using Oxmetrics 6.30 (Doornik, 1999). Student t-statistics is applied to estimate the significance of d parameters. The null hypothesis of the tests is the absence of long memory or $H_0: d = 0$.

Researchers consider several ways to measure the volatility but generally, all of them are derived from returns. For instance, Lobato and Savin (1998) used squared returns, Granger and Ding (1996) used absolute returns, and Breidt, Crato and de Lima (1998) used log-squared returns.

In this study, the long memory tests are applied to log-squared returns, which are good proxy for volatility (Arouri et al, 2012: 207; Choi and Hammoudeh, 2009: 342). Table 3 demonstrates the GPH, and GSP estimates of the d parameter for gold volatility in the spot and futures markets. As shown in Table 3, the estimates of the parameter d in the squared returns range from 0.2868 (Turkish futures) to 0.5071 (Turkish spot) and statistically significant to reject the null of short memory at 1% significance level. The results of GHP and GSP tests are consistent and show stationary long memory characteristics, since the estimates of the d is less than 0.5, except Turkish gold spot (0.5071).

Table 3: Results of Long Memory Tests for Gold Squared Returns

	SPOT		FUTURES	
	GPH	GSP	GPH	GSP
TURKISH GOLD VOLATILITY	0.2974*** [0.0002]	0.5071*** [0.0000]	0.2868*** [0.0003]	0.4979*** [0.0000]
RUSSIAN GOLD VOLATILITY	0.356*** [0.0000]	0.4858*** [0.0000]	0.3557*** [0.0000]	0.458*** [0.0000]

Notes: This table reports the results from two LM tests: Geweke and Porter-Hudak (1983)'s GPH, Robinson and Henry (1999)'s Gaussian Semiparametric (GSP). All tests are employed using a bandwidth of T/16 where T refers to the total number of observations. P-values are given in brackets. *** indicates significance at 1%.

The findings indicate that by using semi-parametric long memory tests, there is found strong evidence of long memory in the gold volatility, whatever the long memory tests used. The presence of long memory in gold spot and futures squared returns is consistent with the findings of Arouri et al. (2012). Motivated by the presence of long memory in the gold volatility, FIGARCH process developed by Chung (1999) can be used to model volatility persistence. Given the possibility of structural breaks, the multiple structural tests of Bai and Perron (2003) are applied.

4.3. STRUCTURAL BREAKS USING BAI-PERRON PROCEDURE

Table 4 reports the results of Bai and Perron tests[3] (2003) which have been widely employed due to its distinct features. The findings indicate that double maximum statistics, $D\max$ and $WD\max$ are statistically significant at the conventional levels. This means that at least one break exists in both spot and futures volatility.

The results of the Bai and Perron procedure reveal the structural breaks in both spot and futures gold volatility. The $\sup F_T(k)$ tests are all significant for k

[3] Statistics are computed using the GAUSS program available from Pierre Perron's home page at http://people.bu.edu/perron/code.html

between 1 and 5; while sup*Ft* (*l* +1| *l*) tests suggest one structural change for all series, since its statistics, which corresponds to multiple structural changes is not significant. The BIC, the modified Schwarz criterion and Sequential procedure select one break; these results are consistent for all gold volatility series.

Table 4: Bai and Perron Statistics of Multiple Structural Breaks tests

	Turkish Spot Volatility	Turkish Futures Volatility	Russian Spot Volatility	Russian Futures Volatility
SUPFt TESTS				
SupFt(1)	27.8798 **	22.9718 **	41.7945**	29.4469**
SupFt(2)	17.7538**	14.2734 **	27.4783**	19.3706**
SupFt(3)	14.4788**	11.1376 **	19.7231**	15.6374**
SupFt(4)	11.7765**	8.9982**	16.5881**	15.2921**
SupFt(5)	8.7798 **	7.9914 **	12.8568**	12.1516**
DOUBLE MAX TESTS				
UDmax	27.8798 **	22.9718 **	41.7945**	29.4469**
WDmax	27.8798**	22.9718**	41.7945**	29.4469**
SUPFt(L+1|L) TESTS				
The supFt(2| 1)	4.9765	3.5596	6.6724	4.2839
The supFt(3| 2)	6.8023	5.0657	6.1892	8.1804
The supFt(4| 3)	1.8870	1.2932	4.2438	8.0831
The supFt(5| 4)	-	-	-	-
LWZ	1	1	1	1
BIC	1	1	1	1
Sequential	1	1	1	1
Break dates	06.04.2009 (01.04.2009–04.08.2009)	06.04.2009 (30.03.2009-28.08.2009)	03.04.2009 (25.03.2009 18.06.2009)	20.03.2009 (02.03.2009 02.07.2009)

Notes: 1. Heteroscedasticity and autocorrelation consistent covariance matrix is constructed following Andrews (1991) and Andrews and Monahan (1992) using a quadratic kernel with automatic bandwidth selection based on AR (1) approximation. 2. 5% size for the sequential test supFt (l+1|l) is used.3. In parentheses are the 95% confidence intervals for T_i(i=1, 2)). ** indicates significance at 5%.

For Turkey, the spot and futures break dates are found to be the same and they occurred in 06.04.2009. The spot break has a 95% confidence interval spanning time between 01.04.2009 and 04.08.2009. A larger confidence interval is obtained for futures volatility, which is between 30.03.2009 and 28.08.2009. Thus, there is no difference of structural break dates between spot and futures in the Turkish gold market.

In comparison to Russian gold market, it is clearly seen that the break dates had appeared before they happened in Turkey; moreover, the Russian volatility of gold futures reacted two weeks earlier than the Russian spot. This means that the various economic factors and negative world news have impact firstly on the Russian futures gold market than spot gold market. While in Turkey, the structural changes on gold volatility were at the same time in both spot and futures.

In spite of the relentless rise in the gold prices, the gold market has undergone significant corrections from time to time, in particular, when the world economy signaled a recovery. However, the corrections were short-term and the given break dates are closely associated with those corrections in the gold prices. The mentioned break date can be attributed to the efforts of international authorities to drive down the gold prices. Since the beginning of the financial crisis in July 2007 to March 2009, the gold prices increased by 42% (Baur et al., 2010: 1886). The surge in the gold prices pushed international authorities to take active role in cooling the commodity prices and healing the economic wounds. In April 2009, gold prices turned to decline not only in Turkey and Russia but also all over the world due to sales fear by International Monetary Fund (IMF). The expectations of international environment towards IMF's role in combating crisis made the gold prices undergo a correction during April 2009. Thus, the presence of structural breaks raises the question of whether evidence of a fractionally integrated volatility implies true long memory. To address this issue Shimotsu (2006) test is deployed to distinguish between true long memory and structural breaks. Moreover, due to the presence of level shifts the results of long memory parameters must be reestimated, this will be done using modified version of GPH test.

4.4. LONG MEMORY VERSUS STRUCTURAL BREAKS TESTS

Lobato and Savin (1998), Granger and Hyung (1999), Liu (2000) consider financial market volatility in which long memory and level shifts provide competing model specifications. Modified GPH estimator can reduce the bias in the GPH estimator due to occasional level shifts. Test[4] is applied to log squared returns. Table 5 reports the findings of modified GPH (hereafter mGPH).

Table 5: The Modified GHP Estimates with Level Shifts

	TURKEY			
	SPOT		FUTURES	
Plug-in	0.6421***	[0.0003]	0.5334***	[0.0002]
J=T/16	0.5773***	[0.0002]	0.6355***	[0.0000]
	RUSSIA			
	SPOT		FUTURES	
Plug-in	0.4677***	[0.0000]	0.4337***	[0.0000]
J=T/16	0.7657***	[0.0000]	0.6027***	[0.0000]

Notes: This table represents the estimates of long memory of Smith's (2005) modified GHP with p values in [ ]. The plug-in method proposed by Hurvich and Deo (1999) is used to select J. k=3 as suggested by Smith (2005). *** indicates significance at 1%.

The results are consistent with the findings of GPH and GSP reported in Table 3 indicating the long-range dependence in volatility. It is however, important to note that the mGPH estimates exceed the GPH estimates. While the GPH estimates range from 0.2974 to 0.356, the mGPH estimates range from 0.4337 to 0.7657. The increased values of d can be explained due to the bias inherent in the GPH and GSP estimators. The Modified GPH estimator suggests whether a short-memory model with level shifts should be considered as an alternative to long memory.

Conducted test confirms the need of modelling the fractional integrated process, all the d estimates are statistically significant and most of them are greater than 0.5, this implies that volatility series are extremely persistent with the non-stationary properties. The process will still have long-run mean reversion and long-lived shock duration, but will also possess an infinite variance.

[4] Gauss code is available from Aaron Smith webpage athttp://agecon.ucdavis.edu/people/faculty/aaron-smith/gauss-code-page/

As was mentioned before, the evidence of long memory in the volatility of spot and futures gold series may be overstated due to the presence of structural breaks. Several recent studies, including Diebold and Inoue (2001), Bhardwaj and Swanson (2006), Choi and Zivot (2007) and Granger and Hyung (2004), show that structural breaks or regime switching can generate spurious long memory behavior.

Table 6: Test of Long Memory versus Structural Breaks

SHIMOTSU TESTS							
		$\bar{d}$		W		Z_t	η_u
	$\hat{d}$	b=2	b=4	b=2	b=4		
Turkish Spot	0,7355	0.7488	0.7708	0.0117	0.1825	-1.5954 (-2.844)	0.1605 (0.4552)
Turkish Futures	0.7884	0.807	0.8231	0.1438	0.9229	-1.7508 (-2.853)	0.1183 (0.4616)
Russian Spot	0,7569	0,7461	0,7606	0,432	0,7921	-1.9622 (-2,8476)	0.154 (0,4578)
Russian Futures	0,6703	0,6743	0,6725	0,0174	0,3261	-1.1306 (-2,8169)	0.1704 (0,4414)

Notes: b denotes the number of subsamples, W represents the Wald statistics, () are the critical values for the Philips–Perron (Z_t) and KPSS (η_u) tests at 5% level. $\chi^2_{0.95}(1)$=3,84 and $\chi^2_{0.95}(3)$ =7,82 are the critical values of Wald test.

In the presence of spurious long memory, the estimate of d is biased and the autocovariance function exhibits a slow rate of decay, akin to a long memory process. Hence, it is important to distinguish between true and spurious long memory. The test of Shimotsu (2006) is applied to assess whether the data exhibit true long memory. Long memory is examined using both the split sample and d^{th} differencing approaches. The results of these tests[5] are presented in Table 6.

Two and four subsamples are considered for the sizes of sample splitting. Specifically, the subsample uses the periodogram ordinates $2\pi/n/b\,, \ldots, 2\pi\,(m/b)/(n/b)$. This mitigates the effect of short-run dynamics on the test statistic; value of m is set as in previous tests.

[5]Matlab code for the test can be obtained from Katsumi Shimotsu's webpage at http://shimotsu.web.fc2.com/Site/Matlab_Codes.html

Table 6 exhibits the results of sample splitting statistics for long memory parameter ($\bar{d}$) and the Wald statistic (W). Further, the differenced series are tested for stationarity using the unit root test Phillips-Perron (Phillips, 1988: 335) and the KPSS test (Kwiatkowski et al., 1992). Wald test indicate that the constancy of the long memory parameter d cannot be rejected for both spot and futures in Turkey and Russia. This means that volatility of spot and futures gold series has real long memory.

Moreover, the results provided by d^{th}differencing tests are in the same line with the split sample tests results. It is evident that for all series, the Philips-Perron test (Z_t) does not reject the null hypothesis of I (d), while the hypothesis of stationarity cannot be rejected by KPSS test (η_u) for all cases. The findings suggest that the persistence found in the squared returns of gold is not caused by the presence of structural changes. Thus, the evidence of long memory in volatility is not spurious for Turkish and Russian Gold markets.

4.5. MODELING LONG MEMORY IN VOLATILITY: FIGARCH MODEL

ARMA-FIGARCH class models are used to reproduce the long memory characteristics in the conditional variance of spot and futures gold volatility dynamics. Zero parameters are used in the mean equation and the estimation results are provided in Table 7. The degrees of freedom of the Student-t distribution are highly significant and it is found to outperform the normal distribution. However, for the Russian futures GED distribution is used, since the LM ARCH test statistics was significant when running FIGARCH under Student distribution. The Ljung – Box statistics Q (10) indicate no serial correlation for all series, except Turkish gold futures. After modelling FIGARCH in the conditional variance all arch effects were eliminated.

The FIGARCH (1, d, 1) based on CHUNG's specification seems to be an adequate specification to take long run dependence into consideration. Indeed, the fractionally differencing coefficient is significantly different from 0 and 1 at standard levels for all series; therefore the long memory property is prevalent in the Turkish and Russian Gold markets.

Table 7: Evidence of Long Memory from the ARMA-FIGARCH Class Model

	TURKISH SPOT	TURKISH FUTURES	RUSSIAN SPOT	RUSSIAN FUTURES
μ_m	0.0003	0.0004*	0.0001	0.0007***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
μ_v	10.7958	10.1691*	4.9351	3.0096*
	(7.4033)	(6.1333)	(4.1373)	(1.6614)
d_v	0.7264***	0.656***	0.6423***	0.5051***
	(0.1123)	(0.1012)	(0.1744)	(0.0942)
α	0.1868**	0.324***	0.2011***	0.2021**
	(0.0915)	(0.1113)	(0.0743)	(0.1021)
β	0.81***	0.8107***	0.7886***	0.6313***
	(0.06)	(0.0657)	(0.1182)	(0.1168)
Student(DF)	5.993***	4.7599***	5.2904***	1.1***(GED)
AIC	-6.0486	-6.2224	-6.1453	-6.1942
SIC	-6.0245	-6.1983	-6.1212	-6.1701
Q(10)	11.5863	20.8243**	9.0251	15.865
ARCH (10)	0.33163	0.64537	0.11148	1.4517
SBT	0.78809	0.95956	1.64228	1.2779
Nyblom test	2.193	1.9597	1.8227	1.3773
P (18)	7.6241	11.9385	17.5416	24.685
P(36)	23.6350	26.0444	44.6467	41.7891
P(54)	35.5837	40.9626	57.1837	60.3774

Notes: This table reports the results of the ARMA-FIGARCH class model for daily gold spot and futures squared returns. μ_m, μ_v, d_v refer to the constant terms and LM parameters of the variance equation, respectively. Robust standard errors are given in parenthesis. Q (10) and ARCH (10) are the empirical statistics of the Ljung-Box and Engle (1982)'s tests for autocorrelation and conditional heteroscedasticity, respectively. AIC and SIC are the Akaike and Scwartz Information criterions. SBT denotes as Sign Bias test which examines the presence of asymmetry in the time series. Nyblom test represents the Joint statistics of Nyblom test to check the model for stability, the critical value of the Nyblom test at 1% level equals to 2.8 (Nyblom 1989). P (18), P (36), P (54)are the Pearson Goodness-of-fit with 18, 36, 54 cells respectively.*** indicates significance at 1%, ** indicates significance at 5%, * indicates significance at 10%.

The long memory parameters (d_v) in the conditional volatility processes are all positive and highly significant. The d_v values range from 0.5051 (Russian futures) to 0.7264 (Turkish spot). The FIGARCH results are consistent with the findings of modified GPH and suggest that gold volatility display long memory and non-stationary properties. Thus, ARMA-FIGARCH class model appropriately captures the price dynamics of the gold.

The Sign Bias Test (SBT) examines the asymmetric impact of positive and negative innovations on the volatility, which cannot be predicted by the estimated models. The null hypothesis for SBT is strongly rejected, indicating no leverage effects in four models. This means that the possible current shocks will not effect on predicting the conditional volatility.

The null hypothesis of Nyblom Joint test about stability of the model cannot be rejected either since the all the statistics are lower than the critical value of 2.8, meaning that the constructed models are stable.

Goodness of fit of the model is estimated by Adjusted Pearson Chi-square test, which compares the empirical distribution of the innovations with the theoretical one. The null hypothesis of this test is a correct distribution of the estimated model. König and Gaab (1982) suggest that the number of cells must be increased at a rate equal to $T^{0,4}$, where T is the number of observations. Thus, in this case the cells are equal to 18, 36 and 54. The results of the test point out correct specification of the overall conditional distribution for all models, since the null hypothesis about true specification cannot be rejected. Thus, the results of misspecification tests suggest that volatility in Turkish and Russian Gold markets can be captured by applying FIGARCH[6] class model.

4.6. VOLATILITY SPILLOVER

In this section, our focus is on the volatility spillover coefficients of the multivariate FIGARCH model, which is implemented using corrected dynamic conditional correlation model. The results will give an insight into the degree of volatility spillover and the dynamics of volatility co-movement between spot and futures both inside the countries and between them.

Table 8 presents the results of modelling the multivariate volatility using Turkish and Russian time series. The estimated coefficients for the conditional correlation equation (alpha and beta) of cDCC–FIGARCH model are significant and their sum is less than one, which implies that the dynamic conditional correlations are mean reverting.

[6]Choi and Zivot (2007) suggest that taking into consideration structural breaks in the model reduces the volatility persistence. To check those possibilities, ARMA- FIGARCH model accommodating structural breaks in the variance equation was estimated. Confidence intervals of estimated structural breaks were taken as dummy variables. The results show that considering structural breaks in the model did not improve the quality of the model, moreover in some cases, the results were even worse. However, it is worth mentioning that the dummies were significant enough in all series.

Table 8: Volatility spillover using cDCC approach

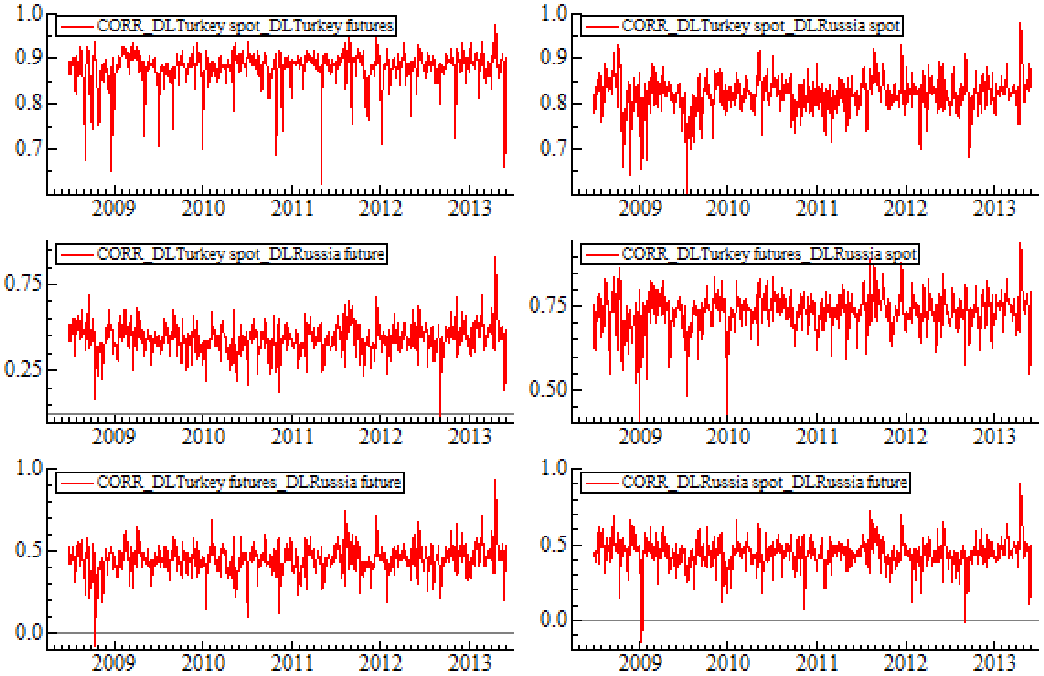
	Turkish gold spot	Turkish gold futures	Russian gold spot	Russian gold futures
Turkish gold spot	1	---	---	---
Turkish gold futures	$q_{21} = 0.8$**	1	---	---
Russian gold spot	$q_{31} = 0.8$**	$q_{32} = 0.7$**	1	---
Russian gold futures	$q_{41} = 0.4$**	$q_{42} = 0.4$**	$q_{43} = 0.4$**	1
	Coefficient	Std.Error	t-value	t-prob
Alpha	0.0866	0.0169	5.113	0.0000
Beta	0.6266	0.1057	5.928	0.0000

Notes: The table presents the cDCC estimates using FIGARCH. Volatility spillover in the model is measured by $q_{i,j}$ for *i*, *j*= 1,2,3,4. Alpha and Beta are scalar parameters of the cDCC model. ** indicates significance at 1%

The $q_{i,j}$ coefficient measures the spillover effects of gold volatility. For example, q_{21} measures the volatility spillover from the Turkish gold spot market to the Turkish futures market. According to the Table 8, significant volatility spillover effects are observed between the Turkish gold spot market and Russian gold spot market.

Moreover, it is not surprise that Turkish gold spot has the strongest volatility spillover impact on Turkish futures. This finding suggests that the information flow between spot and futures markets has intensified in the past 5 years, due to high degree of interdependence. Although the dynamic conditional correlation between Russian spot and futures is equals to 0.44. This would suggest that persistence in the transfer of information between spot and futures markets is relatively low, suggesting that volatility shocks do not tend to persist and affect futures and spot prices for a long period.

Figure 10: Conditional Correlations between Spot and Futures



Since the Turkish and Russian spot have volatility transmission, there is also significant and high volatility spillover between Russian spot and Turkish futures markets. In addition, there are no significant volatility spillovers from Russian futures to any other market (q_{41},q_{42},q_{43}).

Thus, the findings suggest evidence of volatility transmission between Turkish and Russian gold spot markets. As for the interdependence between spot and futures inside the countries, such relationship was found only in Turkey, which means a more efficient transmission of information and improved hedging opportunities. Graphical evidence of obtained results represented in Figure 10.

4.7. HEDGE RATIO CALCULATION AND HEDGING EFFECTIVENESS

This section explores the hedging effectiveness in Turkish and Russian gold markets. Table 9 reports the results from the OLS regression model, GARCH and FIGARCH models in Turkey. The slope coefficient equals to the hedge ratio and hedging effectiveness is calculated using Equation (16). The obtained hedge ratios are 0.9287, 0.989, and 0.9889 for the OLS, GARCH and FIGARCH respectively.

This reveals that hedge ratios are high and hedgers will be able to substantially reduce their risk. Hedging effectiveness results are also high and close to each other 0.817, 0.8142, 0.8142 and therefore, risk reduction is about 81%. Thus, the analysis reveals that Turkish gold futures contracts are suitable for hedging and minimizing the gold spot price risk by 81%. However, there is no difference in the performance of the hedging effectiveness between OLS and GARCH – type models in Turkish gold markets.

Table 9: Comparisons between Hedging Models, Turkey

	OLS	GARCH (1,1)	FIGARCH (1,d,1)
Hedge Ratio	0.9287	0.989	0.9889
Var (U)	0.0002	0.0002	0.0002
Var(H)	0.000036	0.000037	0.000037
Hedging Effectiveness	0.817	0.8142	0.8142

Table 10 presents the performance of in sample forecasting, RMSE, MAE and MAPE serve as performance criteria. The findings suggest that the FIGARCH model outperforms all the proposed models, since it has the smallest values in most cases. Although the GARCH model has relatively similar results with FIGARCH model, it is clearly seen from the Table 10 that in the long forecasts FIGARCH model successfully beats the GARCH model. Thus, it may be claimed that for Turkey, the FIGARCH model fits the data well and forecast adequately.

Table 10: In-Sample Forecasting Performance, Turkey

	OLS			GARCH (1,1)			FIGARCH (1,d,1)		
	5-day	10-day	20-day	5-day	10-day	20-day	5-day	10-day	20-day
RMSE	**0.005**	**0.003**	0.003	0,027	0,043	0.02	0,014	0,016	**0.0001**
MAE	-	-	-	0,021	0,036	0,090	**0,013**	**0,014**	**0,044**
MAPE	201.89	115.41	107.65	9.9	**5.25**	61.1	**3.527**	6.443	**28.44**

Notes: bold values indicate significance at 5 % level

Table 11: Comparisons between Hedging Models, Russia

	OLS	GARCH (1,1)	FIGARCH (1,d,1)
Hedge Ratio	0.5073	0.4295	0.4491
Var (U)	0.00017	0.00017	0.00017
Var(H)	0.000135	0.000136	0.00013
Hedging Effectiveness	0.2392	0.2326	0.2353

Relatively different results were obtained investigating the Russian hedging models. Table 11 exhibits the results of proposed three models, in comparison to Turkish findings, the hedge ratios in Russia are quite low and its effectiveness is about 23% that is almost four times lower than in Turkey. This also can interpreted as changes in the value of gold futures offset only 23% of the value of gold spot.

The results also indicated no difference in the performance of the hedging effectiveness between OLS and GARCH – type models. However, in forecasting performance FIGARCH model again is the best in most cases that consistent with the findings in Turkey. Overall, it is suggested that hedgers and portfolio managers can use Turkish gold futures contracts in order minimize their spot risk exposure, since the hedging effectiveness is substantially bigger than in Russian gold markets. A possible explanation of inefficiency of hedging in Russia may be attributed to limited liquidity and low quality of information (Thompson, 1996: 697). Increase of futures trading may contribute to more effective risk transfer in these markets.

Table 12: In-sample forecasting performance, Russia

	OLS			GARCH (1,1)			FIGARCH (1,d,1)		
	5-day	10-day	20-day	5-day	10-day	20-day	5-day	10-day	20-day
RMSE	**0.003**	**0.003**	**0.004**	0,046	0,043	0,090	0,036	0,034	0,090
MAE	-	-	-	0,046	0,040	0,062	**0,035**	**0,033**	**0,057**
MAPE	111.4	108.3	86.21	16.46	18.14	39.11	**12.85**	**13.8**	**28.53**

Notes: bold values indicate significance at 5 % level

4.8. VALUE-AT-RISK ANALYSIS: A COMPARISON OF VOLATILITY MODELS

As a rule, VaR can be represented as a function of volatility and the higher the variability, the more investor may lose (WCG, 2010). The purpose of this section is to compare the conditional volatility models for gold spot and futures series. Value-at-Risk is one of the popular methods widely employed to measure the market risk. The VaR models became very beneficial, since their ability to make quite accurate forecast of the risks. However, no matter how successful and recognized was the model; it must be always tested on the possible errors and shortcomings. The aim of such tests is to examine the model for the forecast quality of the risks. The financial literature proposes various estimators of testing the model, one of which is Backtesting. According to Jorion (1997), Backtesting is a powerful statistical test, which enables to verify whether forecasted losses are consistent with actual losses.

Kupiec (1995) proposed the most applied technique for Backtesting. This procedure checks the effectiveness of VaR estimates, relying on the number of failures in forecasting the market risk, and then conducts a comparison with already known confidence interval.

Table 13, 14, 15 and 16 exhibits the results of the Kupiec LR Test used to examine the performance of the Value-at-Risk estimates by running the GARCH (1,1), FIGARCH (1,d,1), and Riskmetrics models. The procedure allowed to conclude about the best volatility model in forecasting the Value-at-Risk estimates for the gold time series, one of the assumptions of the test is that investor takes both long and short positions in the market. The established confidence intervals are 95%, 99% and 99.75% for short positions and 5%, 1% and 0.25% for long positions.

Results in Table 13, 14, 15, and 16 clearly show that FIGARCH models were best in estimating gold spot and futures VaR, whereas Riskmetrics and GARCH exhibit poor results of VaR estimates. The idea of the test is that the percentage of returns being outside the VaR border must be equal to the established confidence level, for instance if the confidence value equals to 95%, this implies that VaR model can miss only 5% of returns.

Table 13: VaR failure rate results (Kupiec test), Turkish gold spot

	VaR for short positions			VaR for long positions		
	0.95000	0.99000	0.99750	0.050000	0.010000	0.0025000
GARCH	**0.282** **[0.5953]**	4.5005 [0.0338]	3.8823 [0.0487]	**0.4419** **[0.506]**	**1.2261** **[0.268]**	7.8152 [0.0051]
FIGARCH	**1.3743** **[0.241]**	**0.0836** **[0.7724]**	**0.3773** **[0.539]**	**0,4388** **[0.994]**	**0.8242** **[0.363]**	**1.8028** **[0.1793]**
RISKMETRICS	4.1850 [0.0407]	8.0478 [0.0045]	10.132 [0.001]	**0.4363** **[0.5088]**	**2.6372** **[0.1043]**	10.132 [0.0014]

Notes: bold values indicate significance at 5 % level. P-values are in brackets.

Table 14: VaR failure rate results (Kupiec test), Turkish gold futures

	VaR for short positions			VaR for long positions		
	0.95000	0.99000	0.99750	0.050000	0.010000	0.0025000
GARCH	**0.282** **[0.59535]**	8.0478 [0.004]	**15.354** **[0,891]**	**2.2393** **[0.1345]**	**5.5874** **[0.018]**	3.8823 [0.0487]
FIGARCH	**3.6963** **[0.0545]**	**1.8719** **[0.1712]**	**0.3039** **[0.5814]**	**0.0159** **[0.8995]**	**0.7069** **[0.4004]**	**0.1759** **0.6748]**
RISKMETRICS	2.4023 [0.1211]	14.006 [0.0001]	**15.354** **[0,8913]**	**0.4419** **[0.5061]**	8.0478 [0.0045]	10.132 [0.0014]

Notes: bold values indicate significance at 5 % level. P-values are in brackets.

If the model losses exceed 5%, the model is considered to have weak forecasting quality and if not, the null hypothesis is accepted. In other words, Backtesting procedure helps to estimate the quality of the forecast of a risk model by comparing the actual results to those generated with VaR model. According to the obtained results VaR model based on the FIGARCH (1,d,1) specification is found to be both a good volatility estimator and an excellent market risk predictor. Therefore, the usefulness of VaR method is connected to its capability to predict possible price down falls and rises in financial markets, that in turn contributes to the improvement of controlling over the capital gained and to protect from unexpected losses.

Table 15: VaR failure rate results (Kupiec test), Russian gold spot

	VaR for short positions			VaR for long positions		
	0.95000	0.99000	0.99750	0.050000	0.010000	0.0025000
GARCH	**2.0295**	6.7713	21.252	**0.88111**	**1.8719**	5.7226
	[0.1542]	[0.009]	[0,0402]	**[0.3479]**	**[0.1712]**	[0.0167]
FIGARCH	5.2464	**2.6372**	**0.30397**	**0.07300**	**0.08364**	**0,020897**
	[0.0219]	**[0.1043]**	**[0.5814]**	**[0.787]**	**[0.772]**	**[0.998]**
RISKMETRICS	4.1850	14.006	24.424	**0.15524**	3.5154	5.7226
	[0.0407]	[0.0001]	[0,0077]	**[0.6935]**	[0.0608]	[0.0167]

Notes: bold values indicate significance at 5 % level. P-values are in brackets.

Table 16: VaR failure rate results (Kupiec test), Russian gold futures

	VaR for short positions			VaR for long positions		
	0.95000	0.99000	0.99750	0.050000	0.010000	0.0025000
GARCH	5.5723	6.7713	5.7226	**1.6867**	6.7713	12.651
	[0.018]	[0.0092]	[0.0167]	**[0.194]**	[0.0092]	[0.0003]
FIGARCH	**1.8379**	**0,08422**	**0.37731**	4.1850	4.5005	**1.1149**
	[0.175]	**[0.9976]**	**[0.539]**	[0.0407]	[0.0338]	**[0.2910]**
RISKMETRICS	**1.1596**	6.7713	7.8152	**2.4023**	12.395	**18.225**
	[0.2815]	[0.0092]	[0.005]	**[0.1211]**	[0.0004]	**[0,1962]**

Notes: bold values indicate significance at 5 % level. P-values are in brackets.

CONCLUSION

Gold has a unique place in financial markets. Of all the precious metals, gold is the most popular as an investment. People who invest to gold often consider it as a hedge or safe haven against economic (investment market declines, burgeoning national debt, inflation), political (war), social (social unrest) or currency-based (currency failure) crises. Generally, the price of commodity must be directly dependent on its supply and demand. However, unlike other commodities the price formation of gold is mostly influenced on hoarding and disposal. For example, national central banks and professional investors can make a deal that is sufficient for instant changes in market prices, therefore other market participants are carefully monitoring their activities.

This thesis investigates the modelling the spot and futures gold volatility in Turkey and Russia. The data is used from 27 June 2008 to 31 May 2013. The empirical findings show that Turkish and Russian gold volatility properties exhibit long memory in both spot and futures series. This process is adequately modelled by a fractionally integrated process, which is implemented using FIGARCH model under Student and GED distributions.

Gold is considered as a safe haven and it is viewed as a store of value. However, large spikes in the gold prices forced investors to question gold as safe haven. This contributed to an increasing number of papers concentrated on the gold market volatility. This thesis contributes to the literature in several aspects. First, compared to the numerous studies on volatility modelling, mostly focused on equity and commodity markets, this thesis provides a pioneering study on the gold volatility of the emerging countries like Turkey and Russia; moreover, these countries gain more and more attention on the world arena. Booming of gold investment and gold reserves of the countries became noticeable and recognized in the world. High risk and uncertainty became inherent to the world economy. Economic bubbles and financial crisis strengthened the importance of forecasting volatility behavior. The history of gold volatility starts with cancellation of the Bretton Woods system, which allowed gold to have wider swings of volatility. Therefore, the potential losses and risks even for such reliable asset as gold have increased. Moreover, the high probability of gold bubble also gained a wide discussion. Generally, the nature of any bubble is based on the greediness and fear of the people. In this connection, analysts and experts predict the next gold bubble will be due to the fear of uncertainty in the world economy. Thus, nowadays the study of gold volatility is very essential and especially for the emerging economies, whose central banks started to act as net gold buyers. The above-mentioned facts determined the choice of the thesis research.

Second, the volatility of any asset may suffer from various characteristics; one of such features is the long memory phenomenon, which has been discussed by many researchers. Although their studies are concentrated only on developed countries, the thesis fills this gap by examining the presence of long memory in gold volatility of the emerging markets. The evidence of long memory also implies rejection of weak form of the market efficiency hypothesis. Moreover, fractionally integrated GARCH models, which easily reproduce the long memory in the conditional volatility, are widely used by the researchers, since they exhibit better forecasting performance. The second interesting feature of the volatility can be attributed to structural breaks. Indeed, considering structural breaks, leads to improvement of model estimation as whole. The problem related to presence of the structural changes lies in competing with long memory process, which can be spuriously generated by these breaks. Thus, third contribution checks the presence of multiple structural breaks by using Bai and Perron (2003) approach. After that, Shimotsu test is applied to overcome the issue of distinguishing between structural breaks and long memory.

The time-varying volatility, as a measure of risk has attracted big attention among researchers and portfolio managers. Volatility spillover effect provides practical conclusions on the implication of gold volatility for risk management and hedging capabilities in futures markets. Thus, the fourth contribution of in this thesis related to cDCC multivariate model, which proposed to explore the volatility transmission between spot and futures gold markets in Turkey and Russia. Fifth contribution of this work related to the Value-at-Risk methodology, specifically the accuracy of VaR estimates is compared between proposed conditional volatility models. The obtained results can be useful for the banks, risk and portfolio managers. Additionally, the thesis estimates the hedge ratios and hedging effectiveness presenting the valuable information for hedgers.

Preliminary data analysis show that gold spot and futures series have significant serial correlation in the squared residuals. Moreover, the Engle's ARCH test found the signs of heteroscedasticity in the returns series. This problem is solved by estimating the GARCH – type models in the variance equation. All the series have non-normal distributions, since the Jarque - Bera tests are strongly rejected the null hypothesis.

The Augmented Dickey–Fuller statistics show the rejection at 1% significance level indicating that all the return series are stationary. Graphical analysis of autocorrelations functions indicate that autocorrelations of the all volatility series are significantly positive and persistence lasts for many lags. Consequently, this additionally reveals the long memory pattern of the data indicating the dependence among distance observations.

The first major finding is that the gold volatilities of Turkey and Russia exhibit the long memory in both spot and futures return volatility series. The results of GPH and GSP estimators are consistent and show stationary long memory characteristics, since the estimates of the *d* is less than 0.5, except Turkish gold spot (0.5071).

Before running the estimation of FIGARCH models, the study investigates the multiple structural breaks through a sophisticated technique suggested by Bai and Perron (2003). The evidence suggests that each of the spot and futures gold volatility series had undergone structural changes in both countries. The break dates are associated with the global corrections in the gold prices, which exhibited an upward trend since the beginning of global financial crisis. The short-term corrections can be attributed to efforts of international authorities and the signs of slight progress in the world economy. Thus, the presence of structural breaks in the gold volatility may cause spurious long memory process and substantially shift the GPH estimates.

To address this issue, the modified version of GPH test was applied to the gold volatility series. The results are consistent with the findings of GPH and GSP that is all the long memory parameters are highly significant. However, the results of the modified GPH test exceed the GPH estimates. While the GPH results range from

0.2974 to 0.356, the modified GPH estimates range from 0.4337 to 0.7657. Thus, taking into account structural breaks in the GHP test gives noticeable shift of the parameters and concludes in a favor of non-stationary long memory processes. The findings of Shimotsu tests suggest that the persistence, which was found in the squared returns of gold, is not due to the presence of structural change. Taken together, the findings suggest the evidence of long memory in volatility is not spurious for Turkish and Russian Gold markets.

The FIGARCH (1, d, 1), based on CHUNG's specification, seems to be an adequate specification to take long memory into consideration. After estimating the FIGARCH models all ARCH effects were disappeared. Sign bias test reveals no presence of asymmetry effects in the models. Nyblom Joint test shows the stability of the constructed models and the Adjusted Pearson Chi-square test concludes about correct specification of the models. Thus, the results of misspecification tests suggest that volatility in Turkish and Russian Gold markets can be captured by applying FIGARCH class model.

The establishment of futures market facilitated to substantial development of the news transmission mechanism by allowing a more rapid correction of prices to new information (Antoniou, 1998). To evaluate the possible volatility transmission between spot and futures, a multivariate approach was implemented to analyze volatility in the four markets as a whole system. The corrected dynamic conditional correlations model is based on FIGARCH specifications since they showed a good fitting. The results of dynamic conditional correlations between countries show the strong evidence of volatility spillover. However, the low conditional correlation of 0.44 between Russian spot and futures indicates that volatility shocks will not tend to persist and affect futures and spot prices for a long period. Attracting additional gold traders may stimulate the increase of information flow between cash and futures markets (Cox, 1976: 1215). Further, Bohl (2011) states that futures and spot markets will correlate increasingly as institutional investors become more active. Therefore, the presence of low correlation between Russian gold markets may be due to the small proportion of institutional investors, which also implies the reduced arbitraged activity. The information flow between Turkish spot and futures is very high, indicating the interdependence of these markets. The empirical findings of gold volatility transmission across spot and futures may be also beneficial for international investors and professional hedgers, whose direct interest lies in a high correlation between futures and assets.

One of the important roles of futures markets is hedging of risks. The thesis sheds light on the hedging effectiveness of using the gold futures. The results are of importance to gold hedgers and jewelry producers who require taking futures positions to eliminate significant portion of risk. The findings presented in this thesis strongly suggest that the Turkish gold futures contract is an effective tool for hedging risk, since its hedging effectiveness is greater than 0.8 and the hedge ratio lies in the range of 0.8 and 1.25. The effectiveness of the hedging is dependent on how well new information is reflected in price, thus, obtained results are consistent with the findings of significant volatility spillovers between Turkish spot and futures. Hence, the results have introduced new opportunity of reducing the risk without liquidating spot positions or changing portfolios composition. On the other hand, the results show that Russian gold futures are not as effective as a means of reducing spot price risk. A potential reason of such weak performance may be the low trading volume of the gold futures contracts as well as limited liquidity and low quality of information. In turn, limited liquidity may be the result of small amount of speculators operating with gold futures contracts, since they provide high liquidity to the derivative markets. Additionally, FIGARCH models confirmed their superiority in the long-term forecast.

Gold, like all financial assets exposes to market risk. In financial literature it is accepted that gold have relatively small correlations to majority of assets; thus, serving as good portfolio diversifier and this fact remains the main reason why investors are attracted to this yellow metal. The research from the WCG (2010) illustrated that gold is able to reduce the potential loss suffered from inauspicious outcomes, or tail risk. Particularly, it was concluded that even small allocation to gold (from 2.5% to 9.0%) could reduce the Value-at-Risk of a portfolio. As it was stated, volatility is a good indicator of market risk. The importance of Value-at-Risk method as an approach for risk measurement brought up the question of estimating the accuracy of VaR (Blanco, 2004). Therefore, to address this question this thesis conducts the Backtesting procedure. Haas (2001) highlights the importance of

Backtesing for banks from regulatory point of view. Moreover, financial institutions other than banks also employ VaR for their internal risk management. In this study, Backtesting is implemented using three volatility models, namely GARCH, FIGARCH and Riskmetrics model, which was proposed by the J.P. Morgan Bank and became well known among risk managers. The Backtesting findings suggest that Riskmetrics and GARCH models do not respond to the requirements of the test and therefore, are not suitable to control the risk of gold price fluctuations. However, according to the Kupiec test statistics (Backtesting procedure) the model, which take into account the evidence of long-term memory, specifically the FIGARCH (1,d,1) model exhibited the best fitting and forecasting quality to calculate the market risk. The implications of these findings are important for risk-adverse investors and portfolio managers, who may prefer to manage their risk by allocating gold into the portfolio. Thus, evaluation of potential losses based on VaR forecasts of FIGARCH models let the investors effectively protect their capital. Furthermore, the VaR computation of long and short positions in these markets allows portfolio managers to compute optimal margin levels (Kan, 2009: 25).

Overall, the results of this thesis have important implications for understanding the Turkish and Russian gold volatility properties, which is of great interest for investors, portfolio and risk managers as volatility is an important input for asset valuations, hedging, and risk management. Especially, for the people, who work in the futures trading obtained results may have important implications if they rely on the persistence of gold's tendencies (ascending or descending). Long memory tests results suggest that gold spot and futures volatilities were long-range-dependent, indicating the predictability of the volatilities and rejection of weak form of the market efficiency hypothesis. That is, speculators, who bet on where the price of the commodity will go, can improve the predictability of the spot and futures volatilities and realize profit using FIGARCH specification.

From a forecasting perspective, use of the long-range dependence property should lead to an improvement in gold volatility forecasts and provide better understanding of higher profits by considering past information. Since volatility is a key input in value at risk formulas, gold price risk is predictable and the methods of risk management are of use especially when extreme events occur. This point is of great importance for gold-related asset investors. Volatility is also a major factor influencing option prices. The presence of long memory suggests that pricing options with martingale methods may not be appropriate. Therefore, calculation of implied volatility using Black-Scholes methodology without considering long memory may become misleading.

The surprising absence of hedging opportunities of Russian futures contracts raises questions for future research. In addition, the volatility spillover effects may be investigated among four main precious metals, such as gold, platinum, silver and palladium. The seasonal features, like autumn effect of gold as well as day of the week effects can also contribute to better understanding the features of gold market. In addition, possible implications for the arbitrageurs may be investigated using high frequency data as well as spot commission, futures transactions, and riskless interest rate.

REFERENCES

Agiakloglou, C., Newbold, P., and Wohar, M. (1993). Bias in an Estimator of the Fractional Difference Parameter. *Journal of Time Series Analysis*, 14: 235-246.

Aielli, G. (2009). *Dynamic conditional correlations: on properties and estimation*. Technical report, Department of Statistics, University of Florence.

Akgiray, V. (1989). Conditional Heteroscedasticity in Time Series of Stock Returns: Evidence and Forecasts. *The Journal of Business*, 62(1): 55-80.

Alagidede Paul and Theodore Panagiotidis. (2009). Modelling stock returns in Africa's emerging equity markets. *International Review of Financial Analysis*, 18: 1−11.

Alexander, C. (2001). *Market Models: A guide to financial data analysis.* John Wiley&Sons, Ltd.

Antoniou, A. Holmes, P., and Priestley R. (1998). "The effects of stock index futures trading on stock index volatility: an analysis of the asymmetric response of volatility to news. *Journal of Futures Markets*, 18: 151-166.

Bai,Jushan., Perron,Pierre. (2003). Computation and analysis of multiple structural change models. *Journal of Applied Econometrics*, 18(1): 1-22.

Baillie, R. T., T. Bollerslev, and H. O. Mikkelsen. (1996). Fractionally Integrated Generalized Autoregressive Conditional Heteroskedasticity. *Journal of Econometrics*, 74: 3–30.

Baker S.A. and Van-Tassel, R.C. (1985). Forecasting the price of gold: A fundamentalist approach. 12(4): 43-51.

Balaban, E., Kandemir, H., Kunter K. (1996). *Stock market efficiency in a developing economy: evidence from Turkey*. The Central Bank of Republic of Turkey: DP/ 9612/1996.

Batten, J. A., Ciner, C., & Lucey, B. M. (2010). The macroeconomic determinants of volatility in precious metals markets. *Resources Policy,* 35: 65-71.

Baur, D. G., Thomas, K., McDermott. (2010). Is Gold a Safe Haven? International Evidence. *Journal of Banking & Finance,* 34: 1886-1898.

Bazhanov, S.V, Burtsev S.V, Bukato V.I, Lapidus M.H, Lvov Y.I, Mescheryakov G.U, Nikitin V.P, Khokhlov A.S. (2004). *Modern gold market:* 46. Moscow: Finances and Statistics.

Bera, A and Higgins, M. (1995). *On ARCH Models, Properties, Estimation, and Testing, In Survey in Econometrics,* ed L Oxley, D A R George, C J Roberts and S Sayer, Blackwell Press, Oxford of UK and Cambridge of USA.: 171 – 215.

Bhardwaj, G., and Swanson, N. R. (2006). An empirical investigation of the usefulness of ARFIMA models for predicting macroeconomic and financial time series. . *Journal of Econometrics*, 131: 539–578.

Blanco, C. &. (2004). Backtesting VaR models: Quantitative and Qualitative Tests. *Financial Engineering Associates, Risk Desk, 1(4).*

Bohl, M.T., Salm, C. A., y Schuppli, M. (2011). Price discovery and investor structure in stock index futures. *Journal of Futures Markets,* 31: 282-306.

Bollerslev, T. (1986). Generalized Autoregressive Conditional Heteroskedasticity. *Journal of Economics,* 31: 307-327.

Bollerslev, T. (1987). A Conditionally Heteroskedastic Time Series Model for Speculative Prices and Rates of Return. *Review of Economics and Statistics,* 69(3): 542-547.

Bollerslev, T., Wooldridge, J.M. (1992). Quasi-maximum Likelihood Estimation and Inference in Dynamic Models with Time-Varying Covariances. *Econometric Reviews*, 11(2): 143-172.

Breidt, F.J., N. Crato and P.de Lima. (1998). The detection and estimation of long memory in stochastic volatility. *Journal of Econometrics,* 83: 325-348.

Brooks, C. (2008). *Introductory Econometrics for Finance.* Cambridge University Press.:

Cai, J., Cheung, Y. -L., & Wong, M. C. S. (2001). What moves the gold market? *Journal of Futures Markets,* 21(3): 257–278.

Campbell, J.Y., A. W. Lo and A. C. MacKinlay. (1997). *The Econometrics of Financial Markets*, Princeton University Press, Princeton, NJ.

Canarella, G., & Pollard, S. K. (2008). Modelling the volatility of the London gold market fixing as an asymmetric power ARCH. *The Journal of Applied Finance,* 14(5): 17-43.

Capie, F., T. C. Mills and G. Wood. (2005). Gold as a Hedge against the Dollar. *Journal of International Financial Markets, Institutions and Money,* 15(4): 343-352.

Cheung, Y. (1993). Long memory in foreign exchange rates. *Journal of Business & Economic Statistics,* 11 (1): 93-101.

Cheung, Y.W., Lai, K.S. (1993). Do gold market returns have long memory. *The Financial Review,* 28 (2): 181-202.

Choi, K., and Zivot, E. (2007). (n.d.). Long memory and structural changes in the forward discount: An empirical investigation. *Journal of International Money and Finance*, 26: 342-363.

Choi, K.,& Hammoudeh, S. (2009). Long memory in oil and refined products markets. *Energy Journal,* 30: 97-116.

Chou, R. Y. (1988). Volatility persistence and stock valuations: some empirical evidence using GARCH. *Journal of Applied Econometrics*, 3: 279–94.

Chung, C. (1999). Estimating the Fractionally Integrated GARCH Model. National Taïwan University working paper.

Coakley, J. D. (2008). The role of long memory in medging effectiveness. Computational Statistics and Data Analysis: 3075-3082.

Coakley, Jerry., Dollery, Jian., Kellard, Neil. (2011). Long memory and structural breaks in commodity futures markets. 31(11): 1076–1113.

Conover, C. M., G. R. Jensen, R. R. Johnson and J. M. Mercer. (2009). Can Precious Metals Make your Portfolio Shine? *Journal of Investing,* 18: 75-86.

Cox, C. (1976). Futures trading and market information. *Journal of Political Economy*, 84: 1215-1237.

Cutbertson, K., Nitzsche, D. (2001). *Financial Engineering, Derivatives and Risk Management*, John Wiley & Sons, New York.

Diebold and Inoue. (2001). Long memory and regime switching. *Journal of Econometrics*, 105: 131-159.

Ding, Z.,C.W J.Granger, and R.F Engle. (1993). A long memory property of stock Market Returns and a New Model. *Journal of Emprical Finance,* 1: 83-106.

Doornik, J. (1999). *Object-orientated matrix programming using Ox (3rd ed.)*. London: Timberlake Consultants Press and Oxford.

Ederington, L. (1979). The Hedging Performance of the New Futures Markets. *Journal of Finance:* 157-170.

Engle, R. (2002). Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. *Journal of Business & Economic Statistics,* 20(3): 339–350.

Engle, Robert. (2004). Risk and volatility: econometric models and financial practice. *American Economic Review,* 94(3): 405-420.

Eoma, C., Choi, S., Oh, G. and Jung, W.S. (2008). Hurst Exponent and Prediction Based on Weak-form Efficient Market Hypothesis of Stock Markets. *Physica A*, 387: 4630–4636.

Ewing, B.T., Malik, F. (2013). Volatility transmission between gold and oil futures under structural breaks. *International Review of Economics and Finance,* 25: 113-121.

Fama, E. F. (1965). The behavior of stock-market prices. *Journal Business,* 38: 34–105.

Fama, Eugene . (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *Journal of Finance*, 25: 383-417.

Fantazzini, D. (2011). Fractionally Integrated Models for Volatility: A Review. *Nonlinear Financial Econometrics: Markov Switching Models, Persistence and Nonlinear Cointegration,* Palgrave-MacMillan.

Geweke, J. P., & Porter-Hudack, S. (1983). The estimation and application of long memory time series models. *Journal of Time Series Analysis*, 4: 221–238.

Glosten, L. R., Jagannathan, R., and Runkle, D. E. (1993). On the relation between the expected value and the volatility of nominal excess return on stocks. *Journal of Finance*, 48: 1779-1801.

Gourko S.P, Tselehovich E.P, Primachenok G.A. (2005). *The World Economy: Textbook*: 122-124. Moscow: "Ekoperspektiva".

Granger, C. W. J., & Hyung, N. (2004). Occasional structural breaks and long memory with an application to the S&P500 absolute stock returns. *Journal of Empirical Finance*, 11: 399-421.

Granger, C.W.J. and Hyung, N. (1999). *Occasional Structural Breaks and Long Memory*, Discussion Paper: 99-14 , Department of Economics, University of California, San Diego.

Granger, Clive W.J. &Ding, Zhuanxin. (1996). Varieties of long memory models. *Journal of Econometrics*, 73(1): 61-77.

Grouard, M; Levy, S; Lubochinsky, C. (2003). *Stock market volatility: from empirical data to their interpretation*. Banque de France. FSR.

Haas, M. (2001). New methods in backtesting. Mimeo. *Financial Engineering Research Center Caesar, Friedensplatz, Bonn*.

Hammoudeh, S., & Yuan, Y. (2008). Metal volatility in presence of oil and interest rate shocks. *Energy Economics*, 30: 606–620.

Hany, A. Shawky1., Achla, Marathe., Christopher, L. Barrett. (2003). A first look at the empirical relation between spot and futures electricity prices in the United States. *Journal of Futures Markets*, 23(10): 931–955.

Hosking, J.R.M. (1981). Fractional Differencing. *Biometrica,* 68: 165-176.

Hull, J. (2006). *Options, Futures and Other Derivatives 6th edition*, Prentice Hall.

Hull, J. C. (2009). *Options, futures and other derivatives, Seventh edition*; Pearson Prentice Hall: 10-11.

Hurvich, C.M., Deo, R., and Brodsky, J. (1998). The Mean Squared Error of Geweke and Porter-Hudak's Estimator of the Memory Parameter of a Long-Memory Time Series. *Journal of Time Series Analysis,* 19: 19-46.

IGE. (2012). *IGE Book*. Istanbul: Gold Exchange Book.

Jarque, C. M., & Bera, A. K. (1980). Efficient tests for normality, homoskedasticity and serial independence of regression residuals. *Economics Letters,* 6(3): 255-259.

Johnson, L. (1960). The theory of speculation in commodity futures. *Review of Economic Studies*, 27: 139–151.

Jorion, P. (1997). *Value-at-Risk: The new benchmark for controlling market risk*. MacGraw-Hill, New York.

Jorion, P. (2006). *Value at Risk.* McGraw-Hill, New York.

Kan Sang Hoon, Yoon Seong-Min. (2009). Value-at-risk analysis for Asian emerging markets: asymmetry and fat tails in returns innovation. *The Korean Economic Review, 25*.

Karin Knorr Cetina, Alex Preda. (2012). *The Oxford Handbook of the Sociology of Finance*. Oxford University Press.

Kiohos, A., and Sariannidis, N. (2010). Determinants of the asymmetric gold market. *Investment Management and Financial Innovations, 7(4)*.

Knight, F. (1921). "Risk Uncertainty and Profit" Reprint Chicago . *The Chicago University Press 1971*.

Kolb, R. W. (2003). *Futures, Options and Swaps, Forth edition*; Blackwell Puplishing.

König, H., and W. Gaab. (n.d.). *The Advanced Theory of Statistics, vol. 2 of Inference and Relationships.*, Haffner: New York.

Koutsoyiannis, A. (1990). A short-run pricing model for a speculative asset, tested with data from the gold bullion market. *Applied Economics*, 15: 563–581.

Kozhogulov, B. (2005). *The global gold market and its features*. Novosibirsk: Institute of Economics.

Kupiec, P. H. (1995). Techiques for verifying the accuracy of risk measurement models. *The Journal of Derivatives*.

Kwiatkowski, D., P. C. B. Phillips, P. Schmidt and Y. Shin. (1992). Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root: How sure are we that economic time series have a unit root? *Journal of Econometrics*, 54: 159-178.

Levin, E.J., P. Macmillan, R.E. Wright and D. Ghosh. (2004). Gold as an Inflation Hedge? *Studies in Economics and Finance*, 22(1): 1-25.

Levin, E.J., Wright R.E. (2006). *Short run and long run determinants of the gold price*. London: World Gold Council.

Lim, Kian Ping, Robert Brooks and Jae H. Kim. (2008). Financial crisis and stock market efficiency: Empirical evidence from Asian countries. *International Review of Financial Analysis,* 17(3): 571−591.

Lipe, R. C. (1996). *Current Accounting Projects,* presentation at the 1996 Twenty-Fourth Annual National Conference on Current SEC Developments, Office of the Chief Accountant, U.S Securities and Exchange Commission, Washington, DC.

Liu, M. (2000). Modeling Long Memory in Stock Market Volatility. *Journal of Econometrics*, 99: 139-171.

Livshits, A.Y, Nikulina I.N, Gruzdeva O.A. (1994). *The introduction to the market economy: Handbook for Economic Universities:* 19-21. Moscow: Graduate School of Economics.

Lobato I.N. and Savin N.E. (1998). Real and Spurious Long Memory Properties of Stock Market Data. *Journal of Business &Economic Statistics*, 16(3): 261-268.

Lobato, I. N., & Savin, N. E. (1998). Real and spurious long memory properties of stock market data. *Journal of Business and Economic Statistics*, 16: 261-268.

Lomev, B., Ivanov, I., Bogdanova, B. (2010). *Investigation of market efficiency of emerging stock markets from the East-European region through discrete wavelet transform.* Economics and Management ,University of Ruse. 49: 194-198.

Longin, F. (2000). From value at risk to stress testing: The extreme value approach. *Journal of Banking & Finance*, 24: 1097-1130.

Mandelbrot, B. (1963). The variation of certain speculative prices. *Journal Business,* 36: 394–419.

Mandelbrot, B. B. (1971). When can price be arbitraged efficiently? A limit the validity of the random walk and martingale models. *Review of Economics and Statistics,* 53: 225-236.

Mark, J. (September 2011). Gold and the US dollar: Hedge or haven?, Finance Research Letters. *Elsevier,* 8(3): 120-131.

Mateeva, T. (2005). *Introduction to Macroeconomics*: 510. Moscow: Graduate school of economics, 3rd edition.

Mohamed El Hedi Arouri., Shawkat Hammoudeh., Amine Lahiani., Duc Khuong Nguyen. (2012). Long memory and structural breaks in modeling the return and volatility dynamics of precious metals. *The Quarterly Review of Economics and Finance*, 52(2): 207–218.

Mohamed El Hédi Arouria., Amine Lahianib., Aldo Lévyc., Duc Khuong Nguyend. (2012). Forecasting the conditional volatility of oil spot and futures prices with structural breaks and long memory models. *Energy Economics*, 34(1): 283–293.

Morales, L. (2008). European Applied Business Research Conference (EABR). *Volatility spillovers on precious metals markets: the effects of the Asian crisis.* Salzburg, Austria.

Narayan, P. K., S. Narayan and X. Zheng. (2010). Gold and Oil Futures Markets: Are Markets Efficient. *Applied Energy,* 87: 3299-3303.

Nelson, D. (1991). Conditional heteroskedasticity in asset returns: a new approach. *Econometrica,* 59(2): 347-370.

Nyblom, J. (1989). Testing for the Constancy of Parameters Over Time. *Journal of the American Statistical Association,* 84(405): 223–230.

Oskoee, S. A. P., Li, H., Shamsavari, A. (2010). The Random walk hypothesis in emerging stock market. *International Research Journal of Finance and Economics,* 50: 51-61.

Palm, F. C., and P. J. G. Vlaar. (1997). Simple Diagnostics Procedures for Modelling Financial Time Series. *Allgemeines Statistisches Archiv,* 81: 85–101.

Parkinson, M. (1980). The Extreme Value Method for Estimating the Variance of the Rate of Return. *Journal of Business,* 53(1): 61-65.

Parrenas, J. C. (2003). *Report of a Collaborative Survey Undertaken by the Pacific Economic.*

Parto, D.K., Wu, Y. (2004). Predictability of short-horizon returns in international equity markets. *Journal of Empirical Finance*, 11: 553-584.

Pele, D., Voineagu, V. (2008). Testing market efficiency via decomposition of stock return. Application to Romanian capital market. *Romanian Journal of Economic Forecasting*, 63-79.

Phillips, P. C. B. and P. Perron. (1988). Testing for a unit root in time series regression. *Biometrika,* 75: 335-46.

Poon, Ser-Huang and Clive Granger. (2003). Forecasting Volatility in Financial Markets: A Review. *Journal of Economic Literature,* 41(2): 478-539.

Poterba,J., and Summers, L. (1986). The Persistence of Volatility and Stock Market Fluctuations. *America Economic Review*, 76: 1142-1151.

Prime, M. (2009). Investing in gold - how to measure in grams? *Metal mining news*.

Pritsker, M. (1996). *Evaluating Value at Risk Methodologies: Accuracy versus Computational Time*. The Wharton Financial Institutions Center.

Robinson, P. M. (1994b). Semiparametric analysis of long memory time series. *Annals of Statistics,* 22: 515-539.

Robinson, P. M. (1995a). Gaussian semiparametric estimation of long range dependence. *Annals of Statistics,* 23: 1630-1661.

Robinson, P. M. (1995b). Log periodogram regression of time series with long range dependence. *Annals of Statistics,* 23: 1048-1072.

Robinson, P. M., & Hendry, D. (1999). Long and short memory conditional heteroscedasticity in estimating the memory parameter of levels. *Econometric Theory,* 15: 299-336.

Sang Hoon Kanga., Seong-Min Yoon. (2013). Modeling and forecasting the volatility of petroleum futures prices. *Energy Economics,* 36: 354–362.

Sari, R., Hammoudeh, S., & Soytas, U. (2009). Dynamics of oil price, precious metal prices, and exchange rate: Are there relationships. *Energy Economics,* 32: 351–362.

Schwartz, F. (2002). *West exchange activity*: 95. Moscow: IQ.

Schwert, G. W. (1989). Why does stock market volatility change over time? *Journal Finance,* 44: 1115–1153.

Shimotsu, K. (2006). *Simple (but effective) tests of long memory versus structural breaks*. Working Paper, Department of Economics, Queen's University.

Shimotsu, K. (2010). Exact local Whittle estimation of fractional integration with unknown mean and time trend. *Econometric Theory,* 26: 510–540.

Shimotsu, K. and Phillips, P. C. B. (2005). Exact local Whittle estimation of fractional integration. *Annals of Statistics,* 33: 1890-1933.

Smith, A. (2005). Level Shifts and the Illusion of Long Memory in Economic Time Series. *Journal of Business & Economic Statistics*, 23(3): 321-335.

Soytas, U., Sari, R., Hammoudeh, S., & Hacihasanoglu, E. . (2009). The oil prices, precious metal prices and macroeconomy in Turkey. *Energy Policy*, 37: 5557–5566.

Steven, Clark.,& T, Coggin. (2011). Are U.S. stock prices mean reverting? Some new tests using fractional integration models with overlapping data and structural breaks. *Empirical Economics,* 40: 373-391.

Suetin, A. (2004). The international gold market. *Auditor,* 1: 38-44.

Sumner, S., Johnson, R. & Soenen, L. (2013). Spillover effects among gold, stocks, and bonds. *Journal of Centrum Cathedra,* 3(2): 106-120.

Sutcliffe, C. M. (1993). S*tock Index Futures. Theories and international evidence. First edition*. Chapman& Hall.

Sutcliffe, Charles, Board, John, Sandman, Gleb. (2001). The Effect of Futures Market Volume on Spot Market Volatility. *Journal of Business Finance & Accounting,* 28: 799 – 819.

Thompson, S.R., P. Garcia, and L.K. Dallaflor. (1996). The Demise of the High Fructose Corn Syrup Futures Contract: A Case Study. *Journal of Futures Markets ,* 16: 697-724.

Trück, Stefan., Liang, Kevin. (2012). Modelling and forecasting volatility in the gold market. *International Journal of Banking and Finance,* 9(1): 48-80.

Tully, E., & Lucey, B. M. . (2007). A power GARCH examination of the gold market. *Research in International Business and Finance,* 21: 316–325.

WCG. (2002). *Gold Demand Trend*s. London: World Gold Council.

WCG. (2010). *Gold: Hedging Against Tail Risk.* London: World Gold Council.

WCG. (2012, Q1). *Gold Demand Trends. London*: World Gold Council.

WCG. (2012, Q2). *Gold Demand Trends. London*: World Gold Council.

Xekalaki, E. and S. Degiannakis. (2010). *ARCH Models for Financial Applications,* Wiley.

Xu, X., and Fung, H. (2005). Cross-market linkages between U.S and Japanese precious metals futures trading. *International Financial Markets,* 15(2): 107-124.

Yadav. (2006). *Foreign Exchange Markets (Understanding Derivatives and Other Instruments),* Macmillan India Ltd., Delhi.

Yalama, Abdullah., Sibel, Celik. (2013). Real or spurious long memory characteristics of volatility: Empirical evidence from an emerging market. *Economic Modelling,* 30: 67–72.

Zharkov, I. (2009). What happens in the Turkish jewelry industry? *Jewelry news*.