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HEDGING BENEFITS OF GOLD FUTURES: A REGIME SWITCHING MODEL APPROACH

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ABSTRACT

Using a regime switching model, this study analyzes the nature of gold hedging benefits from the perspective of an individual investor who may choose to invest in a portfolio of: a) Index Futures, b) T-note Futures, c) Oil Futures and d) Gold Futures. Empirical findings support the argument that two distinctive identifiable regimes of gold futures returns exist: 1) a negative return with higher volatility regime and 2) a positive return with lower volatility regime. Between the two regimes, hedging benefits of gold are more pronounced during the higher volatility regimes when compared with the index-futures that represent the overall market. When other T-bond future, AAA Bond and CCC Bond index returns are considered as benchmarks, we find similar evidence consistent with this argument.

We also compare the hedge benefits for the gold futures during the 2008 financial crisis; results suggest that hedge benefits for gold futures are more pronounced in both the regimes during the financial crisis when compared with futures returns in other non-financial crisis sample.

I. INTRODUCTION

The recent revival of research interest in Gold Futures as hedging tool is largely contributed by the increasing gold futures prices over the last decade[see: Cai *et al.* (2001), Bertus and Stanhouse (2001), Liu and Chou (2003), Hillier *et al.* (2006), Figuerola and Gonzalo (2010), among others].Although extant studies provide empirical analysis on hedge benefit of gold futures by using diversified tools and methodologies, the persistence of rather exorbitant gold price still remains a puzzle that may not be rationally justified.

Apart from this economic justification, this study has methodological motivation as well. In this paper, we analyze whether Gold Futures provide hedging benefits to the futures market investors by using a Regime Switching Model.The use of regime switching model is motivated to address the structural break issues and excess kurtosis in futures returns and higher trading volumes leading to futures maturity. Although the regime switching approach is often used in financial economics literature, this technique is yet to be used in analyzing the hedging benefits of gold futures.

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As such, this study deviates from the existing literature in three important ways.First, unlike the other studies (see: Bertus and Stanhouse (2001), Liu and Chou (2003), among others) that provide empiric evidence on: (a) Gold Futures prices themselves and (b) comparing with other precious metals (like: silver); this study analyzes the hedging benefit of Gold futures within a larger set of assets. We compare gold hedging benefits from the perspective of an individual investor who chooses to invest in a portfolio of: (a) Index Futures, (b) T-note Futures, (c) Oil Futures and (d) Gold Futures. We argue that such approach allows us to emulate a more diversified set of investment possibilities from the perspective of an investor. Index fund futures, T-notes futures and oil futures can be considered as proxies for the stock market, bonds and consumption commodities; respectively.

Second, this study uses the Regime Switching Model that dynamically identifies changes in regimes and allows both means and variances to vary across the regimes. Although the Regime Switching Model is used recently in researches on index futures, bond futures and interest rate term structure (Ang and Bekaert (2002), Kasuya (2005), and others), it is yet to be used in analyzing Gold Futures returns. We argue that this technique may be relevant because of the inherent structure of gold futures trading patterns that exhibit higher trading and return volatility after a certain point of time towards approaching the maturity.

Third, this study considers financial crisis as a possible source of additional breakpoints in addition to the inherent nature of the commodity futures that bears high trading and return volatility regimes and low trading and return volatility regimes.We define financial crisis as per United States business cycle identifier data (a binomial variable of +1 and 0 for financial crisis and no financial crisis respectively) as defined in Federal Reserve of St. Louis Economic Database. Referring to the business cycle identifier, futures are classified into: a) during crisis, b) crisis only and c) no crisis period data panels.

Accordingly, this paper may contribute to the existing literature in three different ways. First, it may provide better insight to the nature and extent of hedging benefits that gold futures may provide to the investors when compared to a larger and more comprehensive set of assets that includes: index futures, bond futures and oil futures.Second, the use of Regime Switching Model may allow us to analyze inherent trading and return volatility nature of the gold futures and compare the same for other three types of futures: index futures, bond futures and oil futures. Third, acknowledging financial crisis breakpoints, in addition to the inherent regime changes within the futures, may provide better understanding about the nature of hedging benefits of gold futures use during the financial crisis periods and normal business conditions.

1.1. Literature Review

Cai *et al.* (2001) is one of the early studies in recent literature on gold futures that analyzes what factors explains movements in the gold market. They use ARCH (Auto-Regressive Conditional Heteroskedasticity) model to model intraday return volatility in gold futures traded on New York Mercantile Exchange. A contemporaneous study by Bertus and Stanhouse (2001) also uses a dynamic factor analysis approach to investigate rational speculative bubbles in the gold futures market. They argue that exchange of gold futures does only entail changes in accounting entry and a negligible carrying and storage cost. Given the nature of gold futures, spot market is the plausible source of such bubbles.

Later, Liu and Chou (2003) provide empirics on parities and spread trading in gold and silver markets by using a fractional cointegration technique. They suggest that precious metal markets may provide investors arbitrage profit because of the slow adjustment of long-memory process that has a time varying risk premium component. Hillier *et al.* (2006)analyze the investment role of three precious metals in financial markets based on daily data for gold, platinum and silver futures for 1976 to 2004 period. They find all three precious metals to have low correlations with market index as an evidence of diversification benefits for the investors. They report that precious metals have some hedging capability during the high stock market volatility.

Figuerola and Gonzalo (2010) is a much recent study to use a non-linear price discovery equilibrium model to capture the long term hedging properties of gold and silver futures. They find that price discovery is regime dependent and is also determined by the relative number of participants in gold and silver markets. Gold and silver are cointegrated only under weak dollar and high volatility conditions and gold dominates silver in terms of hedging benefits. In another recent study, Baur and McDermot(2010) discuss whether gold can be treated as a safe haven in a global financial system. They argue that gold may play a key role in stabilizing the financial system by reducing losses during extreme negative market shocks. Baur and McDermot(2010) use a GARCH (1,1) model with mean equation where return on gold is dependent in market model and financial crisis dummies are embedded into the market risk beta. Using the model, they also show that gold plays the role of safe haven during the peak of the recent financial crisis.

Although Hamilton (1989) lays down the basic premises of theoretical and econometric framework for regime switching models, existing literature shows an interest in using the technique to analyze a set of well-diversified issues in finance very recently. Ang and Bekaert (2002) use a regime switching model to analyze interest rates behaviors of United States, Germany and the United Kingdom. They find that regime switching model provides better forecast and regimes in interest rates correspond reasonably well with US business cycles. Later, among others, Kasuya (2005) analyzes monetary policy effects by using regime switching approach.

Chiang and Wang (2008) uses a regime shifting cointegration technique to analyze long run relationship between stock index and stock index futures of MSCI Taiwan, Nikkei 225, Hong-Kong Hang-Seng, and Singapore Exchange (SGX) Straits Times indices. They show that cointegration system with regime shifts performs is a better model compared to usual cointegration system that does not accommodate for regime shift.Bansal et. al. (2010) is one of the recent studies to use a regime switching model that allows the return means, volatilities and correlations to vary across different regimes to analyze diversification benefit of holding stock index and T-note futures during high stress and low stress regimes. They conclude that stock market stress have material influence on treasury bond pricing and diversification benefit of holding stock index future and T-note future is greater during high stock market stress regimes.

Remainder of the study is organized as follows. Following this section, the paper provides a brief description of the data and methodology in section two. Next, section three presents descriptive statistics and time series properties of the futures returns. In section four, I report the empirical evidence from regime switching models and discuss the implications. And finally, section five summarizes major findings and concludes with the contributions of this study to the existing literature.

2. DATA AND METHODOLOGY

2.1. Data

Daily return data on index fund future, T-notes futures, oil futures and Gold futures from 2006 to 2011 are collected from *www.wikiposit.com* website. Futures are matched by their maturity dates beginning 2006 March to 2011 December maturing on quarterly intervals. For example, "March 2006 dataset" represents returns data for the four types of futures matched by transaction days.As futures maturing on the month March and September exhibit lower number of observations because of shorter time horizon, only matched futures datasets for maturing on month of June and December are used for analysis. Accordingly, 12 panels of matching datasets are identified from the initial 24 panels. Table 1 summarizes sample selection.

Return information on investment grade bond (AAA) index and non-investment grade bond (CCC) index, SNP 500, and United States business cycle data are obtained from Federal Reserve of St. Louis database. Data panels are defined as: (a) crisis only if the business cycle dummy series is although +1, (b) no crisis if the business cycle dummy series is although 0 and (c) during crisis if business cycle dummy variable is both +1 and 0 over the time period. All futures return data and market data are in daily frequency.

2.2. Econometric Techniques

Descriptive statistics and time series plots of gold futures and other futures and benchmark returns in Figure 01 provide some important insights. Although, returns are generally stationary, return distributions generally have excess kurtosis compared to normal distribution. Existence of such excess kurtosis commends for GARCH model approach. Section four of this paper summarizes regression results and significance of GARCH models. Although, GARCH effect is generally significant for most of the benchmark models, the mean regression models still suffer from low power of test even GARCH affects are included in mean equations.As a plausible alternative, Regime switching regression models may provide better estimates as such models account for the possibility of either or both of the mean and variance of a distribution to vary.

The use of regime switching models is being motivated from the criticism of Pedoroni (2004)criticism that regular co-integration estimates may be inconsistent when used in time series with shorter time span. As a remedy to that, a panel cointegration approach may provide more consistent estimates by drawing information from additional cross-section of similar time series. However, if both mean and variance vary across different regimes in a given time series, panel co-integration estimate may not be consistent.

2.3. Regime Switching Model Approach

Using a bi-variate two state regime switching model, Bansal et. al. (2010) analyze mean reversion in daily futures-contract returns for the US stock index and ten-year Treasury notes over the

Table 1
Sample Selection criteria

Financial Crisis is defined as per US Business cycle Variable as defined in FED St. Louis Dataset * Futures data set matched by maturity denoted by year and month of maturity

Panel A: Initial Sample

Dataset	*Begin Date*	*Ending Date*	*No. of observation*	*Financial Crisis Description*
2008Jun	3/23/2007	5/20/2008	283	during
2008Dec	9/21/07	11/20/08	275	during
2008Mar	1/2/08	2/20/08	34	crisis only
2011Dec	3/24/11	9/23/11	127	no crisis
2011Jun	9/22/2010	5/20/2011	164	no crisis
2011Mar	12/31/2010	2/22/2011	36	no crisis
2011Sep	6/30/2011	8/22/2011	36	no crisis
2009Dec	9/23/2008	11/20/2009	288	during
2009Jun	3/24/2008	5/19/2009	288	crisis only
2009Mar	1/2/2009	2/20/2009	34	crisis only
2009Sep	7/1/2009	8/20/2009	36	no crisis
2007Dec	9/22/2006	11/16/2007	284	no crisis
2007Jun	3/24/2006	5/22/2007	287	no crisis
2007Mar	1/3/2007	2/21/2007	34	no crisis
2007Sep	7/2/2007	8/22/2007	37	no crisis
2006Dec	10/26/2005	11/17/2006	264	no crisis
2006Jun	8/2/2005	5/23/2006	200	no crisis
2006Mar	1/3/2006	2/21/2006	34	no crisis
2006Sep	7/5/2006	8/22/2006	35	no crisis
2010Dec	3/24/2010	11/19/2010	165	no crisis
2010Jun	3/24/2009	5/20/2010	287	during
2010Mar	1/4/2010	2/19/2010	32	no crisis
2010Sep	6/30/2010	8/20/2010	37	no crisis

Panel B: Final Sample

Dataset	*Begin Date*	*Ending Date*	*No. of observation*	*Financial Crisis Description*
2008Jun	3/23/2007	5/20/2008	283	during
2008Dec	9/21/07	11/20/08	275	during
2011Dec	3/24/11	9/23/11	127	no crisis
2011Jun	9/22/2010	5/20/2011	164	no crisis
2009Dec	9/23/2008	11/20/2009	288	during
2009Jun	3/24/2008	5/19/2009	288	crisis only
2007Dec	9/22/2006	11/16/2007	284	no crisis
2007Jun	3/24/2006	5/22/2007	287	no crisis
2006Dec	10/26/2005	11/17/2006	264	no crisis
2006Jun	8/2/2005	5/23/2006	200	no crisis
2010Dec	3/24/2010	11/19/2010	165	no crisis
2010Jun	3/24/2009	5/20/2010	287	during

crisis-rich 1997–2005 period. In a contemporaneous study, Baur and McDermot (2010) use market model as mean equation in a GARCH model framework with recession dummies embedded in the market beta itself.

In this study, I follow the simple two state regime switching model (originally introduced by Hamiltion (1989) and later used by Bansal et. al. (2010), among others) in a market model set up as shown in Baur and McDermot (2010). Besides, as gold futures exhibit higher trading volatility approaching their maturity, I introduce a dummy variable for "trading" to analyze whether trading volumes higher than mean trading volume have any significant impact on the gold hedging benefit in two different regimes.

In following set up, the regime switching setup combines; a) two separate market model equations with a volatility response component for two different regimes; and b) a third equation that is probitregression that assigns probability weights to the two regimes. Equation (1) , (2) and (3) represent the basic regime switching setup.

Regime Switching Set up with Market Model

Regime 01 : $r_s = c_s^j + \beta_s * (r_{market\_indext} - r_f) + \gamma_s * tradingdummy_s^j + \eta_s * \sigma_s^j$ (1)

Regime 02 : $r_b = c_b^j + \beta_b * (r_{market\_index} - r_f) + \gamma_b * tradingdummy_s^j + \eta_b * \sigma_b^j$ (2)

Trading dummy is: +1 if trading volume of gold future at time t is greater than mean trading volume 0 if trading volume of gold future at time t is greater than mean trading volume

Probit Regression : Yt = p * y1 + (1-p) * y2 (3)

Summary of Hypotheses

		Hyp.: I		*Hyp. II*		*Hyp. III*		*Hyp. IV*
Null Hypothesis:	H_o:	$c_s^j = c_b^j$	H_o:	$\beta_s = \beta_b$	H_o:	$\eta_s = \eta_b$	H_o:	$\gamma_s = \gamma_b$
Alternate Hypothesis:	H_a :	$c_s^j \neq c_b^j$	H_a :	$\beta_s \neq \beta_b$	H_a :	$\eta_s \neq \eta_b$	H_a :	$\gamma_s \neq \gamma_b$

Where, *s* and *b* are indexes for regime one and regime two respectively; and: a) c_s and c_b are intercept terms; b) β_s and β_b are market risk coefficient; c) γ_s and γ_b are trading dummy coefficient; and d) η_s and η_b are coefficient for volatility. Table 03 reports the regime switching model estimates computed by SAS programming language that also reports whether these coefficient estimates are individually significant (as shown in t-statistics) and whether each pair of coefficient estimates are different from one another (as shown in LM- test statistics.)

Hypothesis I: Difference in intercept terms reveals that mean returns of gold futures in two regimes are significantly different from each other. Sign of intercept terms are also of interest as in two different regimes, intercept terms may possess two different signs. In that regimes can also capture the asymmetric impact during positive return regime and negative regime.

Hypothesis II: Difference in market risk coefficient estimates return reveals that asymmetric relationship between gold future return and market return. Besides, signs of market coefficient and their individual significance may explain whether gold future exhibit hedging benefit or not. A negative and significant market risk coefficient explains gold futures possess hedge benefits during a specific regime, otherwise not. Accordingly, empirical evidence of Hypothesis II is of special interest as it explains the basic essence of the paper.

*Hypothesis III:*Difference in effect of trading dummy in two regimes explains whether the trading volumes higher than average volume have asymmetric impact on gold futures during two different regimes.

Hypothesis IV: Difference in coefficient of return volatility captures the variance of return distribution in the two regimes being different or not.As such, Hypothesis IV and Hypothesis I in combination explain the validity of using a regime switching model as they analyze existence of significantly different mean and variance during two different regimes.

2.4. Robustness Issues: Using other Benchmark

As a measure of robustness, I also use SNP-futures, oil futures, T-bond futures, AAA bonds index and CCC bond index returns as benchmark instead of market model in a similar regime switching model set up, as reported in equation (4) to (6).

Regime Switching Set up with other Benchmark Model

Regime 01 : $$r_s = c_s^j + \beta_s * r_{benchmark\_index} + \gamma_s * tradingdummy_s^j + \eta_s * \sigma_s^j \quad (4)$$

Regime 02 : $$r_b = c_b^j + \beta_b * r_{benchmark\_index} + \gamma_b * tradingdummy_s^j + \eta_b * \sigma_b^j \quad (5)$$

Probit Regression : $$Yt = p * y1 + (1-p) * y2 \quad (6)$$

Interpretations of coefficient estimates for these benchmark models are similar to the same of market model with only di0066ference in coefficient estimates for the benchmark returns (i.e. β_s and β_b) as they correspond to respective benchmark models.

3. DESCRIPTIVE STATISTICS

Figure 01 provides the time series plots of (a) returns, (b) trading volumes, and c) Index/Settle Price level of Gold, T-Bond, SNP500 and Oil futures; and the benchmarks (SNP500, AAA Bond and CCCBond) for the 12 matching panels of futures dataset.

Trading volumes and Index price or Settlement prices of the futures and benchmark indexes are generally non-stationary at their level.[1]However, once first differences are considered, all of these time series variables are rather stationary.Plots of returns in different panels of Figure 01 also reveal additional fact that although futures returns are stationary, they are not random noise because of the presence of excess kurtosis.

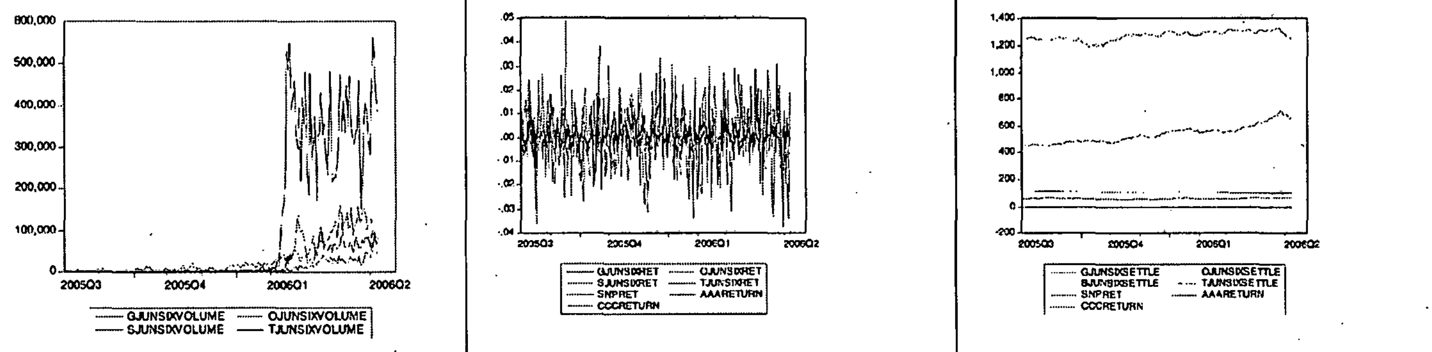
4. GARCH (1, 1) MODEL ESTIMATES

As futures returns exhibit excess kurtosis, using a GARCH(1,1) may be the most obvious econometric choice. In a GARCH (1,1) set up, the basic motivation is to analyze to what extent

Figure 1: Plot of Trading volume, Future and Index returns and Future and Index price level

Panel A through Panel L reports Plot of Trading volume, Future and Index returns and Future and Index price level of 12 data panels used in the study to summarize the time series patterns of the variables.

Panel A: 2006Jun: 8/2/2005 to 5/23/2006: No. of Obs. 200: no crisis



Panel B: 2006Dec: 10/26/2005 to 11/17/2006 No. of Obs. 264 : no crisis

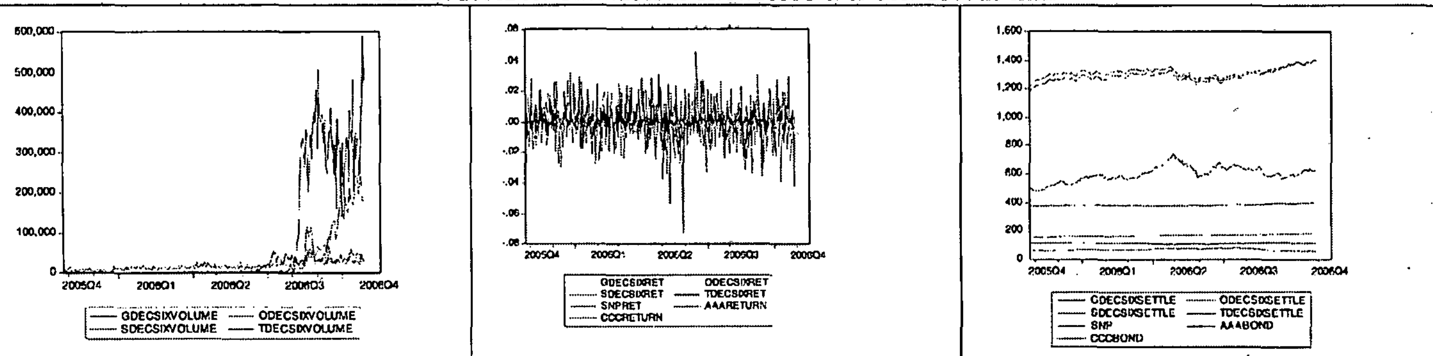
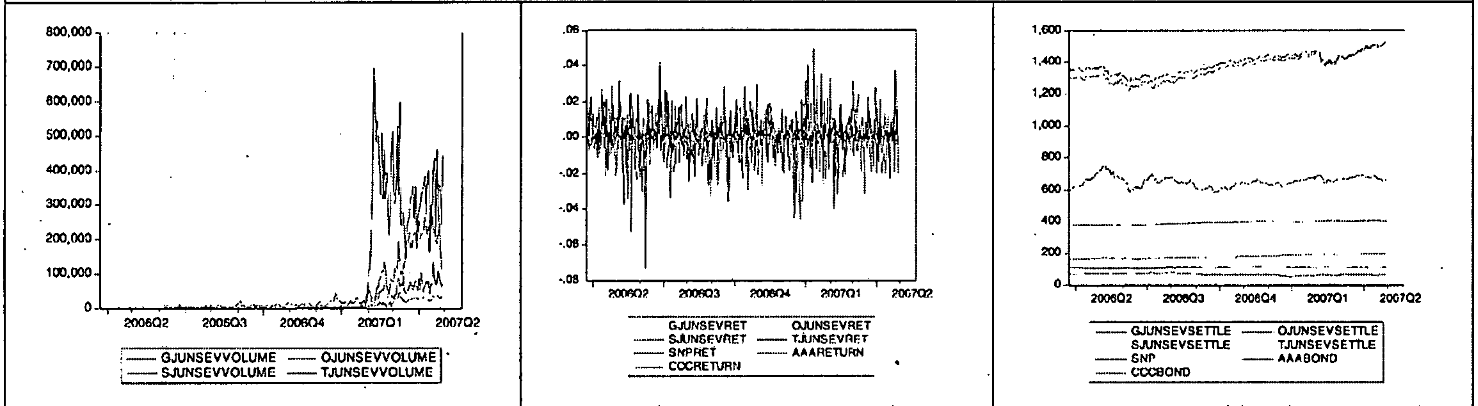


Figure 1: Plot of Trading volume, Future and Index returns and Future and Index price level (continued)

Panel C: 2007Jun: 3/24/2006 to 5/22/2007: No. of Obs. 287 : no crisis



Panel D: 2007Dec: 9/22/2006 to 11/16/2007: No. of Obs. 284 : no crisis

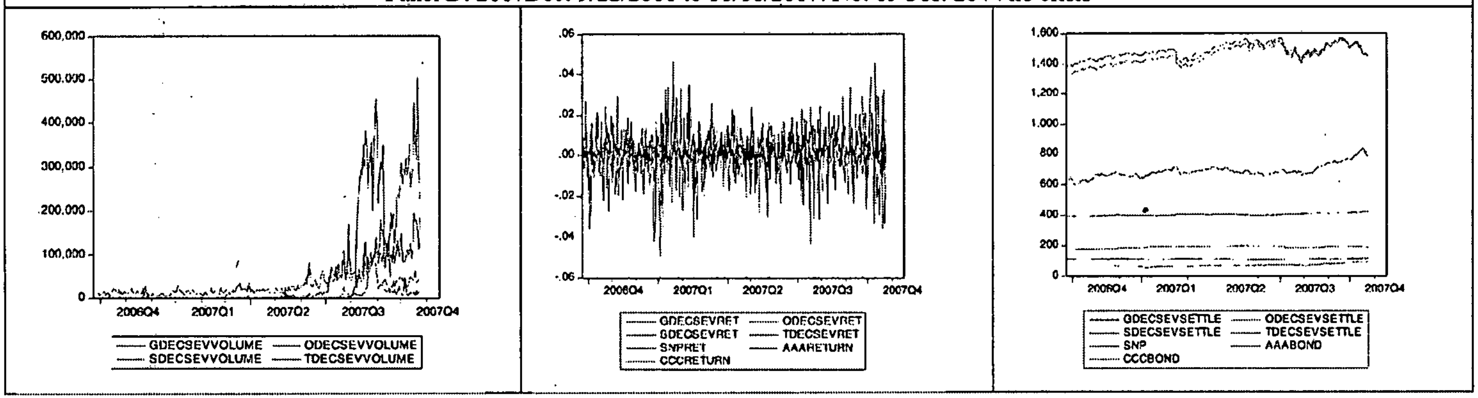
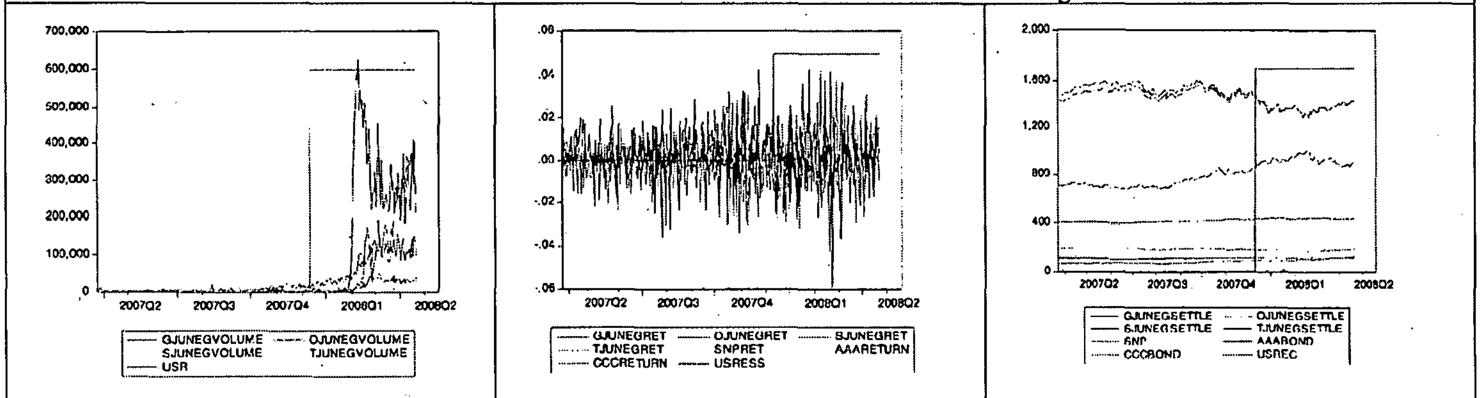


Figure 1: Plot of Trading volume, Future and Index returns and Future and Index price level (continued)

Panel E: 2008Jun: 3/23/2007 to 5/20/2008: No. of Obs. 283: during



Panel F: 2008Jun: 3/23/2007 to 5/20/2008: No. of Obs. 283: during

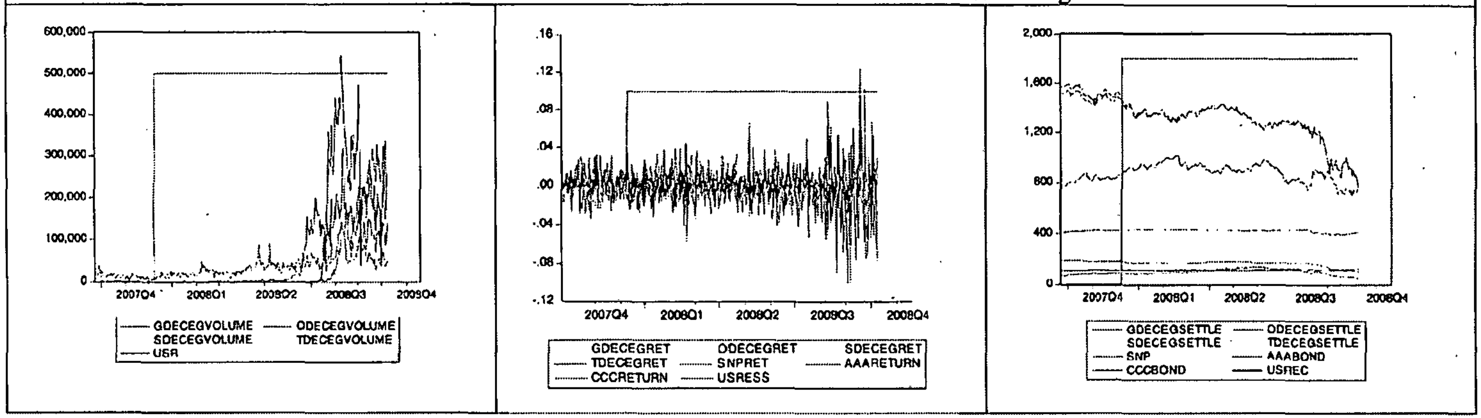


Figure 1: Plot of Trading volume, Future and Index returns and Future and Index price level (continued)

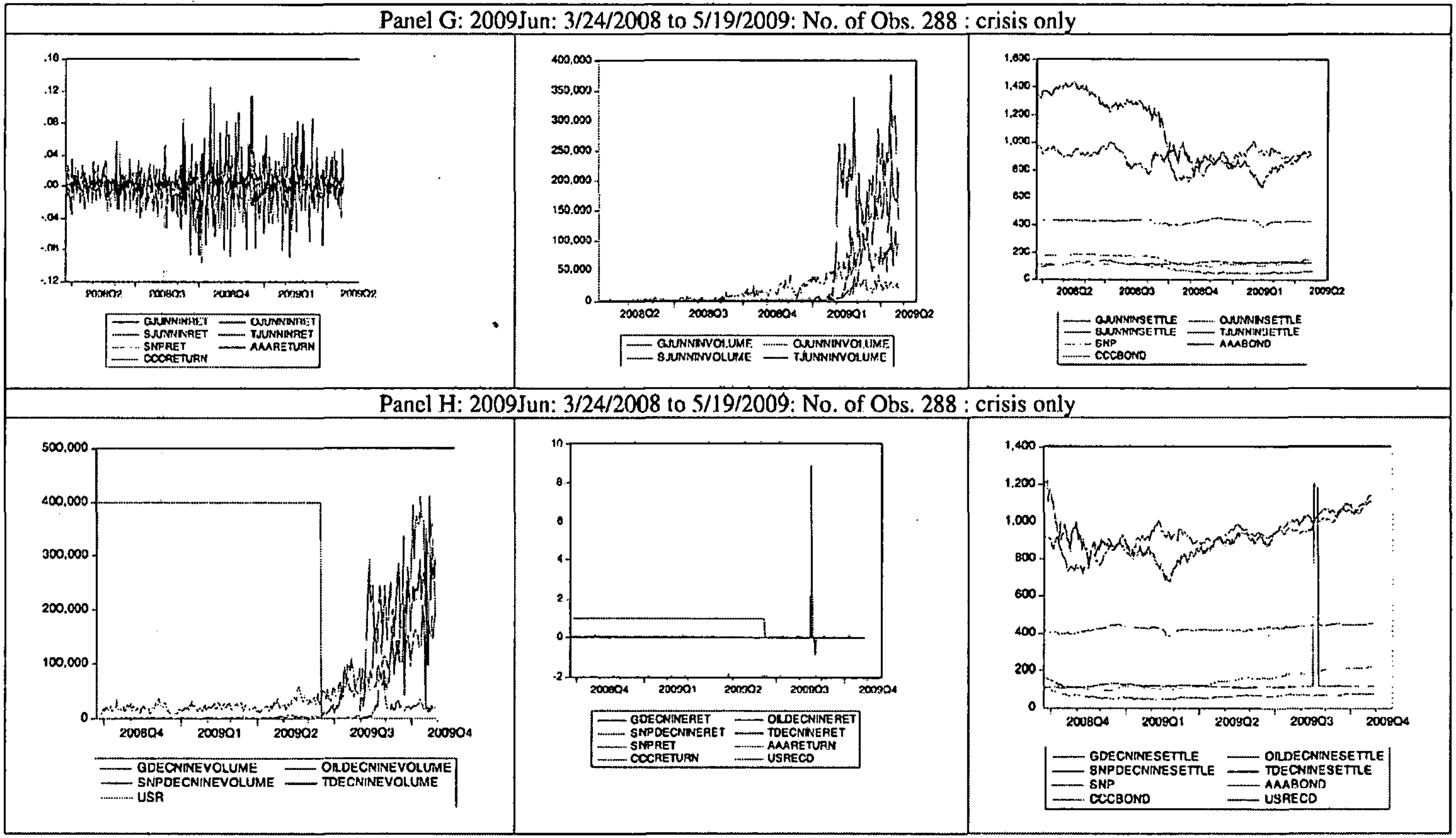
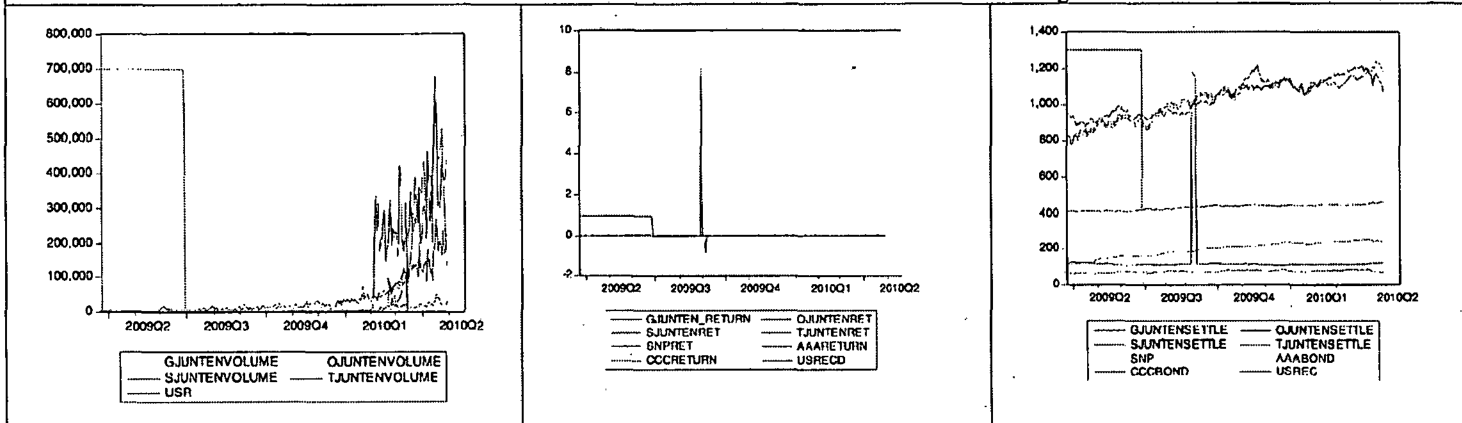


Figure 1: Plot of Trading volume, Future and Index returns and Future and Index price level (continued)

Panel I: 2010Jun: 3/24/2009 to 5/20/2010: No. of Obs. 287: during



Panel J: 2010Jun: 3/24/2009 to 5/20/2010: No. of Obs. 287: during

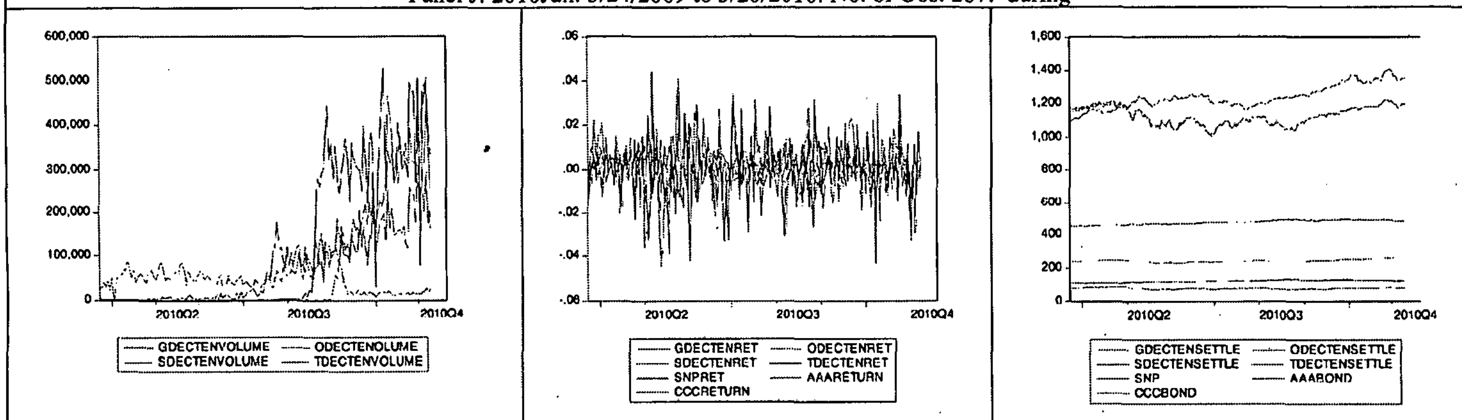
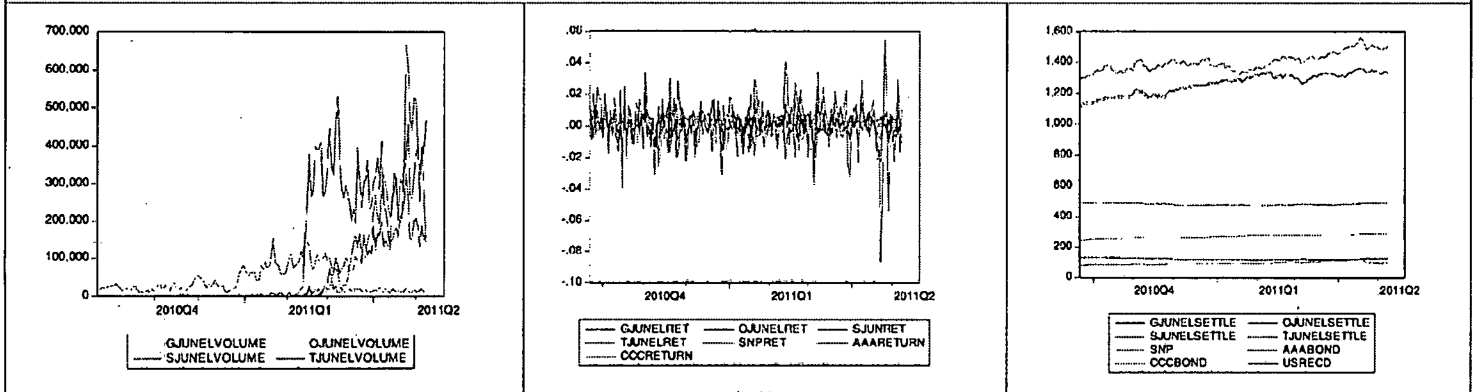
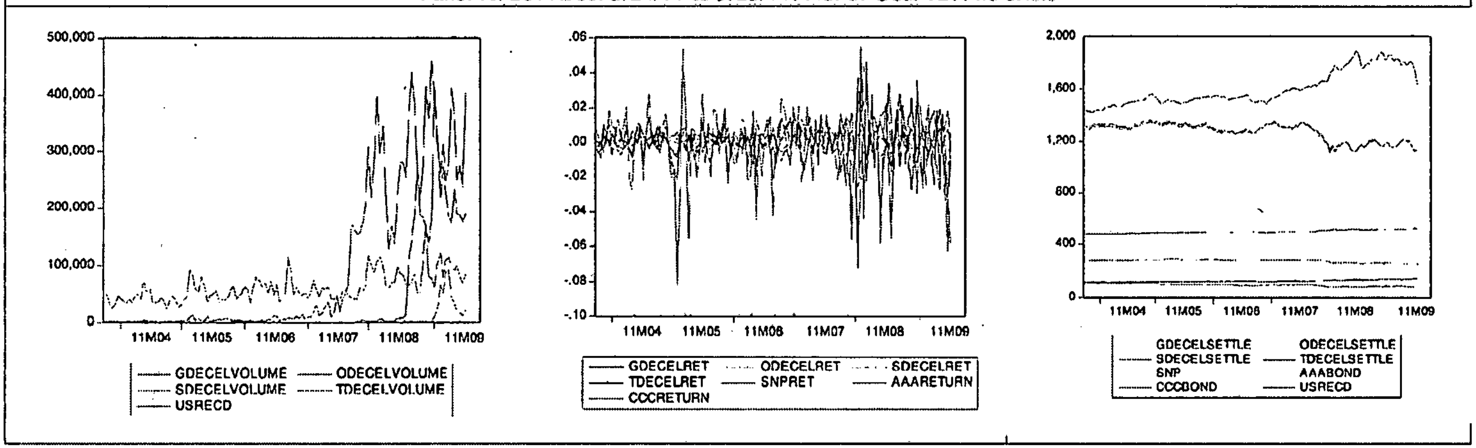


Figure 1: Plot of Trading volume, Future and Index returns and Future and Index price level (continued)

Panel K: 2011Jun: 9/22/2010 to 5/20/2011: No. of Obs. 164: no crisis



Panel K: 2011Dec: 3/24/11 to 9/23/11: No. of Obs. 127: no crisis



residuals of the benchmark models can be explained in terms of information contents revealed through prior volatilities. Panel A through Panel E of Table 2 reports a set of GARCH (1,1) models estimated for 12 data panels for five possible alternate specification. First, a market model is considered as the mean equation for GARCH (1,1) regression. Later, SNP500 futures, T-Bond futures, Oil futures, Investment grade AAA Bond and Non-Investment grade CCC Bond indices as individually considered as benchmark in the mean equations to analyze the existence of hedging benefits for Gold Futures.

Implications of empirical evidence from GARCH model are two-folds. First, GARCH effects are generally significant for all of benchmark models as reported in different panels in Table 02. However, the only otherwise insignificant GARCH effect persist for market model, T-bond futures and AAA Bonds benchmark models during 2007 December panel. One explanation of such insignificant GARCH effect may be the structural break occurred during the beginning of the financial crisis that may essentially impart an unpredictable jump in return volatility.

Second, although GARCH effects are generally significant, inclusion of conditional heteroskedasticity in estimation of gold futures return with respect to other benchmarks does not contribute to additional explanatory power of the mean models. The low power of the regression models and significant GARCH effect suggest otherwise a different concern that the distribution of volatility may not be constant over the time period for the sample data panels.The following section provides discussion of regime switching models that essentially account for the possibility of mean and variance of returns to vary across two different regimes.

5. REGRESSION RESULTS FOR REGIME SWITCHING MODELS

5.1. Regime Switching with Market Model

Table 3 reports the regression results for the regime switching set up with model. Among the 12 data panels, for nine occasions intercept terms are significantly different from each other at 1% level as evident the LM Test statistics "Test (0)". In all 12 panels intercepts are individually significantly different from zero and possess opposite signs. Volatility coefficients are generally individually significant across these panels with a few exceptions. These findings are consistent with the Hypothesis I and Hypothesis II that analyze if the mean and variance of the gold future returns are different in two regimes or not. Results also suggest that regimes with negative mean returns generally exhibit higher volatility.

Results show that for negative return and high volatility regime, market risk coefficients are positive and significant for "2008 Jun" and "2008 Dec" panels that are essentially "during crisis panels" and also for "2011 Dec" that is rather "no-crisis" panel. For other panels of negative return and high volatility regimes, market risk coefficients are generally positive but not significant. Results for positive return and low volatility regime suggest that market risk coefficients are otherwise positive and significant for "2008 Dec", "2011 Dec" and other three panels but positive and not significant for other panels.

Combining these findings for two regimes, it is noticeable that hedging benefit of gold exists in both negative return high volatility and positive return low volatility regimes, especially during financial 2008 financial crisis and the recent 2011 period.

Table 2

GARCH Estimation of Market Model and other benchmark models

Table 02 reports GARCH (1,1) regression estimates for Market Model, as well as T-bond futures, Oil futures, AAA Bond Index and CCC Bond Index as benchmark models in the Equation of : (a) GoldFutureReturn = C(1) + C(2)* (R_m – R_f) and (b) GoldFutureReturn = C(1) + C(2)* ($R_{benchmark}$) respectively for Panel A through Panel E where the GARCH Equations are : GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Panel A: Estimation of Market Model

	2006Jun	2006Dec	2007Jun	2007Dec	2008Jun	2008Dec	2009Jun	2009Dec	2010Jun	2010Dec	2011Jun	2011Dec
						Mean Equation						
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
C	0.00184	0.00096	0.00000	0.00114	0.00113	0.00065	0.00042	0.00147	0.00062	0.00131	0.00072	0.00124
	(0.0095)	(0.2866)	(0.9969)	(0.0763)	(0.0000)	(0.4999)	(0.7009)	0.06000	0.32840	0.08230	0.37170	0.19820
SNPFuture	0.13917	0.11790	0.16121	0.11456	0.04326	-0.11313	-0.10505	0.14707	0.27388	0.04911	0.23225	-0.15270
	(0.2575)	(0.4101)	(0.1602)	(0.0871)	(0.4546)	(0.0281)	(0.0301)	(0.0000)	(0.0000)	0.40770	0.00260	0.00050
						Variance Equation						
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
C	0.00000	0.00001	0.00000	0.00010	0.00000	0.00001	0.00001	0.00000	0.00001	0.00000	0.00004	0.00001
	0.12210	0.15340	0.53730	0.14930	0.44340	0.01450	0.28110	0.42860	0.11400	0.49880	0.39870	0.22010
Resid(-1)^2	-0.03710	0.03779	0.03684	0.07456	-0.02081	0.03546	0.07140	0.06313	-0.00253	0.04806	-0.06448	0.33988
	0.14020	0.05240	0.00550	0.13570	0.08790	0.00300	0.02080	0.03030	0.86690	0.23900	0.22420	0.01750
GARCH(-1)	1.04211	0.93941	0.95606	0.00367	1.02984	0.94658	0.91335	0.92851	0.93913	0.90900	0.59672	0.67837
	0.00000	0.00000	0.00000	0.99540	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.25970	0.00000
R^2	0.00707	0.00177	-0.00057	0.00937	0.00269	0.01949	0.00005	-0.01193	0.08210	0.00518	0.03042	0.05113
Adj. R^2	-0.01330	-0.01365	-0.01476	-0.00483	-0.01166	0.00497	-0.01424	-0.02623	0.06912	-0.01970	0.00603	0.02002
No. of Obs.	200	264	287	284	283	275	288	288	287	165	164	127
Sample Period	8/2/2005 to 5/23/2006	10/26/2005 to 11/17/2006	3/24/2006 to 5/22/2007	9/22/2006 to 11/16/2007	3/23/2007 to 5/20/2008	9/21/2007 to 11/20/2008	3/24/2008 to 5/19/2009	9/23/2008 to 11/20/2009	3/24/2009 to 5/20/2010	3/24/2010 to 11/19/2010	9/22/2010 to 5/20/2011	3/24/11 to 9/23/11
Crisis Def.	no crisis	no crisis	no crisis	no crisis	during	during	crisis only	during	during	no crisis	no crisis	no crisis

• First row provides the coefficient estimates and the following row provides p-values

Table 2
GARCH Estimation of Market Model and other benchmark models (continued)

Panel B: T-Bond Futures Benchmark Model

	2006Jun	2006Dec	2007Jun	2007Dec	2008Jun	2008Dec	2009Jun	2009Dec	2010Jun	2010Dec	2011Jun	2011Dec
						Mean Equation						
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
C	0.00163	0.00104	0.00012	0.00121	0.00115	0.00071	0.00060	0.00152	0.00073	0.00124	0.00130	0.00100
	0.01610	0.24520	0.87410	0.06140	0.11070	0.43400	0.56820	0.04930	0.27550	0.10070	0.10620	0.28630
TBondFut	0.24346	0.14563	-0.05995	-0.07457	0.06604	0.23189	0.39791	0.00202	0.00213	0.18691	0.16656	0.36586
	0.14300	0.51850	0.80540	0.57780	0.58620	0.07630	0.00000	0.97640	0.97550	0.07250	0.11050	0.00070
						Variance Equation						
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
C	0.00000	0.00001	0.00000	0.00010	0.00000	0.00001'	0.00001	0.00000	0.00004	0.00000	0.00015	0.00001
	0.05880	0.14290	0.50510	0.15070	0.59430	0.01560	0.36370	0.49780	0.30690	0.44150	0.00170	0.21000
RESID(-1)^2	-0.03967	0.03949	0.03638	0.07526	-0.02348	0.03620	0.10383	0.05951	-0.02801	0.05599	-0.07806	0.32577
	0.11060	0.05790	0.00640	0.15610	0.03750	0.00260	0.00370	0.01580	0.43540	0.21720	0.00490	0.02150
GARCH(-1)	1.04271	0.93590	0.95567	0.01489	1.03086	0.94654	0.88468	0.93384	0.65974	0.90361	-0.49015	0.67525
	0.00000	0.00000	0.00000	0.98110	0.00000	0.00000	0.00000	0.00000	0.05900	0.00000	0.28490	0.00000
R^2	-0.00357	-0.00117	0.00016	0.00180	0.00055	0.01604	0.01187	0.00288	0.01021	0.01701	0.00597	0.05850
Adj. R^2	-0.02416	-0.01663	-0.01403	-0.01251	-0.01383	0.00146	-0.00225	-0.01122	-0.00378	-0.00757	-0.01904	0.02763
No. of Obs.	200	264	287	284	283	275	288	288	287	165	164	127
Sample Period	8/2/2005 to 5/23/2006	10/26/2005 to 11/17/2006	3/24/2006 to 5/22/2007	9/22/2006 to 11/16/2007	3/23/2007 to 5/20/2008	9/21/2007 to 11/20/2008	3/24/2008 to 5/19/2009	9/23/2008 to 11/20/2009	3/24/2009 to 5/20/2010	3/24/2010 to 11/19/2010	9/22/2010 to 5/20/2011	3/24/11 to 9/23/11
Crisis Def.	no crisis	no crisis	no crisis	no crisis	during	during	crisis only	during	during	no crisis	no crisis	no crisis

• First row provides the coefficient estimates and the following row provides p-values

Table 2

GARCH Estimation of Market Model and other benchmark models (continued)

Panel C: Oil Futures Benchmark Model

	2006Jun	2006Dec	2007Jun	2007Dec	2008Jun	2008Dec	2009Jun	2009Dec	2010Jun	2010Dec	2011Jun	2011Dec
						Mean Equation						
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
C	0.00215	0.00119	0.00006	0.00043	0.00041	0.00048	0.00014	0.00141	0.00083	0.00127	0.00062	0.00163
	0.00000	0.15680	0.93260	0.41990	0.11030	0.53350	0.89970	0.05280	0.21100	0.11360	0.33280	0.00010
OilFuture	0.21093	0.39182	0.25706	0.23465	0.35205	0.32241	0.15005	0.17257	0.06191	0.16804	0.28280	0.19026
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.09320	0.00000	0.00000	0.00000
						Variance Equation						
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
C	0.00000	0.00001	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000	0.00002	0.00001	0.00000	0.00000
	0.55990	0.19970	0.62430	0.88870	0.64420	0.01340	0.18820	0.35970	0.19440	0.57150	0.66320	0.04060
RESID(-1)^2	-0.03216	0.04390	0.02487	-0.02045	-0.01898	0.05370	0.07917	0.06800	-0.00920	0.03927	0.02886	-0.02050
	0.18070	0.19200	0.01480	0.02200	0.20220	0.00240	0.00710	0.02290	0.73640	0.32170	0.23760	0.49740
GARCH(-1)	1.04499	0.91448	0.96790	1.02382	1.02576	0.93739	0.89835	0.92318	0.86118	0.90178	0.95495	1.07702
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
R^2	0.13468	0.19581	0.12675	0.11623	0.23936	0.14046	0.05030	0.04003	0.01320	0.08263	0.26919	-0.00623
Adj. R^2	0.11693	0.18339	0.11436	0.10356	0.22842	0.12772	0.03673	0.02646	-0.00080	0.05969	0.25080	-0.03922
No. of Obs.	200	264	287	284	283	275	288	288	287	165	164	127
Sample Period	8/2/2005 to 5/23/2006	10/26/2005 to 11/17/2006	3/24/2006 to 5/22/2007	9/22/2006 to 11/16/2007	3/23/2007 to 5/20/2008	9/21/2007 to 11/20/2008	3/24/2008 to 5/19/2009	9/23/2008 to 11/20/2009	3/24/2009 to 5/20/2010	3/24/2010 to 11/19/2010	9/22/2010 to 5/20/2011	3/24/11 to 9/23/11
Crisis Def.	no crisis	no crisis	no crisis	no crisis	during	during	crisis only	during	during	no crisis	no crisis	no crisis

• First row provides the coefficient estimates and the following row provides p-values

Table 2

GARCH Estimation of Market Model and other benchmark models (continued)

Panel D: AAA Bond Benchmark Model

	2006Jun	2006Dec	2007Jun	2007Dec	2008Jun	2008Dec	2009Jun	2009Dec	2010Jun	2010Dec	2011Jun	2011Dec
						Mean Equation						
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
C	0.00188	0.00097	0.00014	0.00125	0.00090	0.00091	0.00061	0.00167	0.00091	0.00121	0.00128	0.00104
	0.00000	0.28640	0.85480	0.05490	0.00000	0.32040	0.56320	0.03510	0.18290	0.11090	0.10500	0.25730
AAARETURN	0.63302	0.39289	-0.08527	-0.34017	-0.13451	0.00409	0.47567	-0.09062	-0.11770	0.41257	0.41997	0.65181
	0.06540	0.41150	0.85980	0.20440	0.52390	0.98550	0.00230	0.39260	0.36810	0.05620	0.07610	0.03350
						Variance Equation						
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
C	0.00000	0.00001	0.00000	0.00010	0.00000	0.00001	0.00001	0.00000	0.00001	0.00000	0.00015	0.00001
	0.03980	0.13860	0.50100	0.22360	0.41450	0.01310	0.35530	0.48940	0.17240	0.43790	0.00110	0.21350
RESID(-1)^2	-0.04409	0.04005	0.03661	0.06367	-0.01758	0.03384	0.11571	0.04914	-0.00389	0.05716	-0.08230	0.27993
	0.08070	0.05740	0.00690	0.21770	0.14460	0.00290	0.00250	0.02260	0.87390	0.22140	0.00170	0.03960
GARCH(-1)	1.04570	0.93521	0.95537	0.03649	1.02718	0.95153	0.87185	0.94299	0.87589	0.90173	-0.50193	0.72095
	0.00000	0.00000	0.00000	0.96050	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.25390	0.00000
R^2	0.00068	-0.00066	-0.00005	0.00776	0.00025	-0.00152	-0.00909	-0.00515	0.00098	0.01690	0.01323	0.06258
Adj. R^2	-0.01981	-0.01611	-0.01424	-0.00647	-0.01414	-0.01635	-0.02350	-0.01936	-0.01315	-0.00768	-0.01159	0.03185
No. of Obs.	200	264	287	284	283	275	288	288	287	165	164	127
Sample Period	8/2/2005 to 5/23/2006	10/26/2005 to 11/17/2006	3/24/2006 to 5/22/2007	9/22/2006 to 11/16/2007	3/23/2007 to 5/20/2008	9/21/2007 to 11/20/2008	3/24/2008 to 5/19/2009	9/23/2008 to 11/20/2009	3/24/2009 to 5/20/2010	3/24/2010 to 11/19/2010	9/22/2010 to 5/20/2011	3/24/11 to 9/23/11
Crisis Def.	no crisis	no crisis	no crisis	no crisis	during	during	crisis only	during	during	no crisis	no crisis	no crisis

• First row provides the coefficient estimates and the following row provides p-values

Table 2
GARCH Estimation of Market Model and other benchmark models (continued)

Panel E: AAA Bond Benchmark Model

	2006Jun	2006Dec	2007Jun	2007Dec	2008Jun	2008Dec	2009Jun	2009Dec	2010Jun	2010Dec	2011Jun	2011Dec
						Mean Equation						
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
C	0.00183	0.00035	-0.00138	0.00074	0.00101	0.00085	0.00056	0.00132	0.00067	0.00132	-0.00055	0.00130
	0.00000	0.72340	0.08600	0.19510	0.14080	0.38320	0.60990	0.09880	0.34320	0.03730	0.47950	0.17250
CCCRETURN	0.31767	1.31461	1.92359	0.80240	0.37349	-0.05781	-0.03073	0.10557	0.08010	0.29620	1.42620	-0.37683
	0.39370	0.02660	0.00010	0.00020	0.03850	0.68810	0.78580	0.19130	0.49960	0.00970	0.00000	0.00510
						Variance Equation						
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
C	0.00000	0.00001	0.00000	0.00019	0.00000	0.00001	0.00001	0.00000	0.00002	0.00013	0.00002	0.00001
	0.14040	0.22470	0.79770	0.00000	0.37470	0.01350	0.29150	0.46330	0.16500	0.00610	0.13700	0.08480
RESID(-1)^2	-0.04212	0.03345	0.02800	0.02858	-0.01386	0.03495	0.07770	0.05394	-0.00231	-0.09785	-0.06985	0.37779
	0.09290	0.11050	0.03050	0.06520	0.16350	0.00300	0.01860	0.01740	0.92860	0.00000	0.04340	0.00420
GARCH(-1)	1.04720	0.94175	0.96715	-0.96315	1.02277	0.94995	0.90363	0.93858	0.87014	-0.35294	0.81601	0.64254
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.45370	0.00000	0.00000
R^2	0.00637	0.03547	0.04978	0.05032	0.00827	-0.00262	-0.00115	0.00828	0.00002	0.01023	0.09253	-0.03051
Adj. R^2	-0.01401	0.02057	0.03630	0.03670	-0.00600	-0.01747	-0.01545	-0.00574	-0.01412	-0.01452	0.06970	-0.06430
No. of Obs.	200	264	287	284	283	275	288	288	287	165	164	127
Sample Period	8/2/2005 to 5/23/2006	10/26/2005 to 11/17/2006	3/24/2006 to 5/22/2007	9/22/2006 to 11/16/2007	3/23/2007 to 5/20/2008	9/21/2007 to 11/20/2008	3/24/2008 to 5/19/2009	9/23/2008 to 11/20/2009	3/24/2009 to 5/20/2010	3/24/2010 to 11/19/2010	9/22/2010 to 5/20/2011	3/24/11 to 9/23/11
Crisis Def.	no crisis	no crisis	no crisis	no crisis	during	during	crisis only	during	during	no crisis	no crisis	no crisis

• First row provides the coefficient estimates and the following row provides p-values

Table 3
Regime Switching Setup with Market Model

The regime switching setup combines: a) two separate market model equations with a volatility response component for two different regimes; and b) a third equation that is probit regression that assigns probability weights to the two regimes. Equation (1) , (2) and (3) represent the basic regime switching setup.

Regime Switching Set up with Market Model

Regime 01 :	$r_s = c_s^j + \beta_s * (r_{market\_indext} - r_f) + \gamma_s * tradingdummy_s^j + \eta_s * \sigma_s^j$	(1)
Regime 02 :	$r_b = c_b^j + \beta_b * (r_{market\_index} - r_f) + \gamma_b * tradingdummy_s^j + \eta_b * \sigma_b^j$	(2)
Trading dummy is:	+1 if trading volume of gold future at time t is greater than mean trading volume 0 if trading volume of gold future at time t is greater than mean trading volume	
Probit Regression :	$Y_t = p * y_1 + (1-p) * y_2$	(3)

Summary of Hypotheses

	Hyp.: I		Hyp. II		Hyp. III		Hyp. IV	
Null Hypothesis:	H_o:	$c_s^j = c_b^j$	H_o:	$\beta_s = \beta_b$	H_o:	$\eta_s = \eta_b$	H_o:	$\gamma_s = \gamma_b$
Alternate Hypothesis:	H_a:	$c_s^j \neq c_b^j$	H_a:	$\beta_s \neq \beta_b$	H_a:	$\eta_s \neq \eta_b$	H_a:	$\gamma_s \neq \gamma_b$

Where, *s* and *b* are indexes for regime one and regime two respectively; and: a) c_s and c_b are intercept terms; b) β_s and β_b are market risk coefficient; c) γ_s and γ_b are trading dummy coefficient; and d) η_s and η_b are coefficient for volatility. Test (0), Test(1), Test(2) and Test(3) represent LM test of coefficient restrictions and reports test statistics under the null hypothesis that coefficient estimates are not different during the two regimes.

Table 3: Regime Switching Setup with Market Model (Continued)

	2006Jun	2006Dec	2007Jun	2007Dec	2008Jun	2008Dec	2009Jun	2009Dec	2010Jun	2010Dec	2011Jun	2011Dec
	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
η_s	1.096 [c]	1.516 [c]	1.382 [c]	0.975 [c]	0.314 [c]	0.513 [c]	2.056 [c]	1.637 [c]	0.068 [c]	0.130 [c]	0.033	0.098 [c]
η_b	0.910 [c]	1.207 [c]	1.130 [c]	0.901 [c]	0.080 [c]	0.124	1.822 [c]	1.613 [c]	0.198 [c]	0.048	0.122 [c]	0.045 [c]
p	0.470 [c]	0.209 [c]	0.241 [c]	0.385 [c]	-0.030 [c]	0.007 [c]	-0.127 [c]	0.181 [b]	0.012 [c]	0.012 [c]	-0.006 [c]	0.006 [c]
c_s	-1.254 [c]	-3.140 [c]	-2.741 [c]	-1.609 [c]	-5.576 [c]	-17.230 [c]	-5.345 [c]	-3.673 [b]	-10.010 [c]	-8.301 [b]	-13.645 [c]	-13.043 [c]
c_b	1.591 [c]	3.426 [c]	3.028 [c]	1.762 [c]	5.611 [c]	17.283 [c]	5.079 [c]	3.700 [b]	9.986 [c]	8.318 [c]	13.632 [c]	13.052 [c]
β_s	0.058	0.387	0.477	0.082	0.078 [c]	0.210 [c]	0.218 [a]	0.025	0.003	0.014	-0.011	0.035 [b]
β_b	0.091	-0.588 [a]	-0.594 [a]	-0.110	-0.036	-0.213 [c]	-0.292 [b]	-0.032	-0.002	-0.018	0.008	-0.042 [c]
γ_s	-0.256	0.023	-0.066	-0.260	0.567 [c]	-2.158 [c]	1.159	0.167	1.230 [c]	0.475 [c]	0.941 [c]	1.795 [c]
γ_b	0.503	-0.095	-0.208	0.502 [a]	-0.603 [c]	2.170 [c]	-0.650	0.203	-1.206 [c]	-0.504 [c]	-0.918 [c]	-1.792 [c]
	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.
Test0:	110.9 [c]	1893 [c]	2327 [c]	601 [c]	2254 [c]	0.0	1197 [c]	6002 [c]	25201 [c]	0.0	0.0	25992 [c]
Test1:	6.9 [c]	142.9 [c]	311 [c]	999 [c]	3.7E+06 [c]	557331 [c]	14450 [c]	399285 [c]	8.7E+10 [c]	0.9	1199 [c]	1.5E+08 [c]
Test2:	2.0	0.0	0.0	2.6	39.8 [c]	50.4 [c]	1.7	0.0	144.4 [c]	0.0	53.4 [c]	21.7 [c]
Test3:	23178 [c]	4175 [c]	13739 [c]	10686 [c]	4.9E+08 [c]	4.24E+06 [c]	242.4 [c]	20.6 [c]	1.2E+08 [c]	0.0	3.9E+06 [c]	4.3E+08 [c]
R^2	0.537	0.514	0.518	0.504	0.968	0.974	0.477	0.462	0.989	0.995	0.995	0.998
Adj R^2	0.517	0.499	0.504	0.489	0.968	0.973	0.461	0.446	0.989	0.995	0.995	0.998
Obs.	199	263	286	283	282	274	284	287	287	164	163	126
	no crisis	no crisis	no crisis	no crisis	during	during	crisis only	during	during	no crisis	no crisis	no crisis

[a] Represents statistically significant at 10%
[b] Represents statistically significant at 5%
[c] Represents statistically significant at 1%

Table 4
Regime Switching Setup with other Benchmark Models

The regime switching setup combines: a) two separate market model equations with a volatility response component for two different regimes; and b) a third equation that is probit regression that assigns probability weights to the two regimes. Equation (4) , (5) and (6) represent the basic regime switching setup.

Regime Switching Set up with other Benchmark Model

Regime 01 :	$r_s = c_s^j + \beta_s * r_{benchmark\_index} + \gamma_s * tradingdummy_s^j + \eta_s * \sigma_s^j$	(4)
Regime 02 :	$r_b = c_b^j + \beta_b * r_{benchmark\_index} + \gamma_b * tradingdummy_s^j + \eta_b * \sigma_b^j$	(5)
Trading dummy is:	+1 if trading volume of gold future at time t is greater than mean trading volume 0 if trading volume of gold future at time t is greater than mean trading volume	
Probit Regression :	$Y_t = p * y_1 + (1-p) * y_2$	(6)

Summary of Hypotheses

		Hyp.: I		Hyp. II		Hyp. III		Hyp. IV
Null Hypothesis:	H_0:	$c_s^j = c_b^j$	H_0:	$\beta_s = \beta_b$	H_0:	$\eta_s = \eta_b$	H_0:	$\gamma_s = \gamma_b$
Alternate Hypothesis:	H_a:	$c_s^j \neq c_b^j$	H_a:	$\beta_s \neq \beta_b$	H_a:	$\eta_s \neq \eta_b$	H_a:	$\gamma_s \neq \gamma_b$

Where, *s* and *b* are indexes for regime one and regime two respectively; and: a) c_s and c_b are intercept terms; b) β_s and β_b are coefficients corresponding to respective benchmark indexes; c) γ_s and γ_b are trading dummy coefficient; and d) η_s and η_b are coefficient for volatility. Test (0), Test(1), Test(2) and Test(3) represent LM test of coefficient restrictions and reports test statistics under the null hypothesis that coefficient estimates are not different during the two regimes. Panel A through Panel E of this table report results for: SNP Futures, T-Bond Futures, Oil Futures, AAA Bond Index and CCC Bond Index respectively.

Table 4
Regime Switching Setup with other Benchmark Models (continued)

Panel A: SNP Model

	2006Jun Estimate	2006Dec Estimate	2007Jun Estimate	2007Dec Estimate	2008Jun Estimate	2008Dec Estimate	2009Jun Estimate	2009Dec Estimate	2010Jun Estimate	2010Dec Estimate	2011Jun Estimate	2011Dec Estimate
η_s	1.098[c]	1.509[c]	1.380[c]	0.974[c]	0.314[c]	0.518[c]	2.049[c]	1.589[c]	0.003	0.130[c]	0.118[c]	0.036[b]
η_b	0.915[c]	1.214[c]	1.119[c]	0.891[c]	0.074[c]	0.119	1.831[c]	1.613[c]	0.207[c]	0.038	0.136[c]	0.092[c]
p	-0.037	-0.210[c]	0.263[c]	-0.405[c]	-0.029[c]	-0.007[c]	-0.133[c]	-0.226[c]	-0.013[c]	-0.012[c]	0.031[c]	0.006[c]
c_s	0.508[a]	-3.107[c]	-2.534[c]	-1.551[c]	-5.764[c]	-17.871[c]	-5.292[c]	-2.907[c]	-9.794[c]	-8.451[c]	-3.181[c]	-13.143[c]
c_b	1.604[c]	3.399[c]	2.838[c]	1.708[c]	5.799[c]	17.928[c]	5.035[c]	2.930[c]	9.782[c]	8.468[c]	3.131[c]	13.145[c]
β_s												
β_b	-1.269[c]	0.254	0.339	0.153	0.097[b]	0.199[c]	0.230	0.139[b]	0.116[c]	0.006	-0.021	0.073[c]
γ_s	0.191	-0.605	-0.569[a]	-0.160	-0.035	-0.206[c]	-0.288[b]	-0.078	-0.116[c]	-0.010	0.056[a]	-0.072[c]
γ_b												
	-0.454[c]	-0.015	-0.036	-0.223	0.597[c]	-2.302[c]	1.225	0.293	1.276[c]	0.496[c]	0.230[c]	1.818[c]
Test0:	-0.258	-0.018	-0.236	0.476[a]	-0.630[c]	2.318[c]	-0.713	0.110	-1.255[c]	-0.525[c]	-0.230[c]	-1.818[c]
Test1:	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.
Test2:	105[c]	1378[c]	1053[c]	601[c]	1877[c]	0	1944[c]	939[c]	0	0	88140[c]	0
Test3:	82[c]	41[c]	120[c]	999[c]	667300[c]	168331[c]	6359[c]	18264[c]	2.7E+06[c]	1	56668[c]	2.6E+07[c]
R^2	2.21	0.03	0.11	2.55	39.13[c]	49.03[c]	1.71	0.02	1.40	0.00	59.50[c]	56.32[c]
Adj R^2	22763[c]	5332[c]	21357[c]	10686[c]	4.4E+08[c]	3.6E+06[c]	272[c]	28[c]	2.1E+08[c]	0	6.4E+07[c]	9.2E+08[c]
Obs.	0.537	0.512	0.510	0.503	0.969	0.974	0.473	0.456	0.989	0.995	0.988	0.998
	0.518	0.496	0.496	0.489	0.968	0.973	0.457	0.440	0.989	0.995	0.987	0.998
	199	263	286	283	282	274	284	287	287	164	163	126
	no crisis	no crisis	no crisis	no crisis	during	during	crisis only	during	during	no crisis	no crisis	no crisis

[a] Represents statistically significant at 10%
[b] Represents statistically significant at 5%
[c] Represents statistically significant at 1%

Table 4

Regime Switching Setup with other Benchmark Models (continued)

Panel B: T Bond

	2006Jun Estimate	2006Dec Estimate	2007Jun Estimate	2007Dec Estimate	2008Jun Estimate	2008Dec Estimate	2009Jun Estimate	2009Dec Estimate	2010Jun Estimate	2010Dec Estimate	2011Jun Estimate	2011Dec Estimate
η_s	1.096 [c]	1.513 [c]	1.373 [c]	0.979 [c]	0.324 [c]	0.504 [c]	2.039 [c]	1.621 [c]	0.070 [c]	0.130 [c]	0.091 [c]	0.101 [c]
η_b	0.918 [c]	1.222 [c]	1.134 [c]	0.898 [c]	0.067 [b]	0.156 [a]	1.852 [c]	1.603 [c]	0.198 [c]	0.065	0.092 [c]	0.042 [c]
p	0.456 [c]	0.219 [c]	-0.270 [c]	-0.382 [c]	0.029 [c]	0.007 [c]	-0.123 [b]	0.205 [c]	0.012 [c]	-0.013 [c]	-0.020 [c]	0.006 [c]
c_s	-1.282 [c]	-2.922 [c]	-2.450 [c]	-1.627 [c]	-5.721 [c]	-18.013 [c]	-5.790 [c]	-3.314 [c]	-10.069 [c]	-7.776 [c]	-4.819 [c]	-12.146 [c]
c_b	1.605 [c]	3.191 [c]	2.738 [c]	1.771 [c]	5.752 [c]	18.074 [c]	5.532 [c]	3.352 [c]	10.047 [c]	7.791 [c]	4.792 [c]	12.154 [c]
β_s												
β_b	-0.271	-0.794	-0.710	0.124	-0.104	-0.812 [c]	-0.503	-0.004	0.001	-0.039	-0.046	-0.068
γ_s	0.144	0.614	0.414	0.007	0.069	0.778 [c]	0.812 [a]	0.009	-0.000	0.055	0.049	0.087 [b]
γ_b												
	-0.290	-0.028	-0.051	-0.279	0.614 [c]	-2.677 [c]	1.309	0.277	1.234 [c]	0.459 [b]	0.391 [c]	1.590 [c]
Test0:	0.553 [b]	-0.072	-0.252	0.518 [a]	-0.641 [c]	2.687 [c]	-0.797	0.064	-1.211 [c]	-0.489 [b]	-0.366 [c]	-1.592 [c]
Test1:	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.
Test2:	114.0 [c]	970.6 [c]	1074.9 [c]	671.8 [c]	0.0	0.8	3159.9 [c]	2594 [c]	54561 [c]	0	158 [c]	2373.5 [c]
Test3:	15.0 [c]	8.5 [c]	12.1 [c]	1.2	40492 [c]	2442.6 [c]	69.0 [c]	93901 [c]	1.1E+10 [c]	1.4	58458 [c]	1.0E+06 [c]
R^2	2.43	0.00	0.02	2.89 [a]	44.66 [c]	69.76 [c]	2.35	0.02	278.91 [c]	0.0	16.1 [c]	54.5 [c]
Adj R^2	19714 [c]	5073.6 [c]	18182 [c]	14146 [c]	5.3E+08 [c]	3.8E+06 [c]	147.5 [c]	6.2 [b]	1.2E+08 [c]	0.0	620491 [c]	3.5E+08 [c]
Obs.	0.537	0.506	0.506	0.501	0.966	0.975	0.473	0.456	0.989	0.995	0.994	0.998
	0.518	0.490	0.492	0.487	0.965	0.974	0.458	0.440	0.989	0.995	0.994	0.997
	199	263	286	283	282	274	284	287	287	164	163	126
	no crisis	no crisis	no crisis	no crisis	during	during	crisis only	during	during	no crisis	no crisis	no crisis

[a] Represents statistically significant at 10%
[b] Represents statistically significant at 5%
[c] Represents statistically significant at 1%

Table 4
Regime Switching Setup with other Benchmark Models (continued)

Panel C: Oil Futures Model

	2006Jun Est.	2006Dec Est.	2007Jun Est.	2007Dec Est.	2008Jun Est.	2008Dec Est.	2009Jun Est.	2009Dec Est.	2010Jun Est.	2010Dec Est.	2011Jun Est.	2011Dec Est.
η_s	1.057 [c]	1.271	1.127 [c]	0.968 [c]	0.325 [c]	0.507 [c]	2.052 [c]	1.566 [c]	0.196 [c]	0.196 [c]	0.0921 [c]	0.0460 [c]
η_b	0.895 [c]	1.304	1.314 [c]	0.866 [c]	0.067 [b]	0.130	1.797 [c]	1.601 [c]	0.075 [c]	0.075 [c]	0.1030 [c]	0.0947 [c]
ρ	0.447 [c]	-0.206 [c]	-0.258 [c]	0.402 [c]	0.029 [c]	-0.008	0.133 [c]	0.219 [c]	-0.013 [c]	-0.013 [c]	0.0167 [c]	-0.0067 [c]
c_s	-1.205 [c]	-2.948 [c]	-2.351 [c]	-1.479 [c]	-5.792 [c]	-16.762	-5.362 [c]	-3.003 [c]	-9.372 [c]	-9.372 [c]	-5.6151 [c]	-12.4651 [c]
c_b	1.559 [c]	3.250 [c]	2.691 [c]	1.623 [c]	5.820 [c]	16.800	5.130 [c]	3.033 [c]	9.350 [c]	9.350 [c]	5.5947 [c]	12.4776 [c]
β_s												
β_b	0.176 [b]	0.590 [c]	0.341 [c]	0.096	-0.005	-0.188	0.009	0.123 [a]	0.009	0.009	0.0045	0.0519 [c]
γ_s	0.082	-0.116	-0.031	0.094	0.009 [b]	0.165	0.128	0.029	-0.008	-0.008	0.0032	-0.0565 [c]
γ_b												
	-0.287	0.326	-0.110	-0.185	0.640	-2.308	1.034	0.540	1.138 [c]	1.138 [c]	0.4487 [c]	1.6641 [c]
Test0:	0.495 [a]	-0.295	-0.208	0.373	-0.667	2.312	-0.469	-0.134	-1.117 [c]	-1.117 [c]	-0.4283 [c]	-1.6549 [c]
Test1:	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.
Test2:	136 [c]	1280 [c]	1032 [c]	544.4 [c]	0	0.0	2768 [c]	1154 [c]	12861 [c]	12861 [c]	746.2 [c]	7729.8 [c]
Test3:	3186 [c]	5249 [c]	4108 [c]	45.6 [c]	3.59 [a]	1.7E+06 [c]	2227 [c]	4979 [c]	48611 [c]	48611 [c]	1.30E+06 [c]	1.18E+08 [c]
R^2	1.70	0.48	0.24	1.84	108585 [c]	184.70 [c]	0.79	0.14	113.65 [c]	113.6 [c]	21.30 [c]	34.65 [c]
Adj R^2	12599 [c]	79.2 [c]	8300 [c]	21748 [c]	6.7 [c]	4.6E+06 [c]	311 [c]	58.6 [c]	1.3E+08 [c]	1.3E+08 [c]	8.42E+05 [c]	4.51E+08 [c]
Obs.	0.576	0.579	0.543	0.520	0.966	0.974	0.478	0.468	0.989	0.989	0.9949	0.9983
	0.559	0.566	0.530	0.506	0.965	0.974	0.463	0.453	0.989	0.989	0.9946	0.9981
	199	263	286	283	282	274	284	287	286	286	163	126
	no crisis	no crisis	no crisis	no crisis	during	during	crisis only	during	during	no crisis	no crisis	no crisis

[a] Represents statistically significant at 10%
[b] Represents statistically significant at 5%
[c] Represents statistically significant at 1%

Table 4
Regime Switching Setup with other Benchmark Models (continued)

Panel D: AAA Bond Model

	2006Jun Estimate	2006Dec Estimate	2007Jun Estimate	2007Dec Estimate	2008Jun Estimate	2008Dec Estimate	2009Jun Estimate	2009Dec Estimate	2010Jun Estimate	2010Dec Estimate	2011Jun Estimate	2011Dec Estimate
η_s	1.095 c	1.508 c	1.376 c	0.979 c	0.317 c	0.492 c	2.020 c	1.617 c	0.130 c	0.919 c	0.942 c	1.3369 c
η_b	0.917 c	1.208 c	1.127 c	0.906 c	0.076 c	0.221 b	1.873 c	1.589 b	0.053	0.752 c	0.729 c	0.7909 c
p	-0.453 c	0.226 c	0.272 c	0.389 c	0.030 c	-0.008 b	0.136 c	0.211 b	0.013 c	0.395 a	0.516 c	0.5067 c
c_s	-1.272 c	-2.882 c	-2.385 c	-1.617 c	-5.572 c	-15.578 b	-5.322 c	-3.204 b	-7.943 c	-1.519 c	-1.244 c	-1.3744 c
c_b	1.583 c	3.134 c	2.685 c	1.767 c	5.606 c	15.635 b	5.089 c	3.251 b	7.957 c	1.789 c	1.513 c	1.5796 c
β_s												
β_b	-0.852	-2.187	-1.182	0.198	-0.390 c	0.148	-0.668	-0.213	-0.056	-1.070 a	-0.364	0.9141 a
γ_s	0.668	1.994	0.871	-0.105	0.226 c	-0.140	0.939 a	0.598	0.096	0.948 a	0.281	0.3072
γ_b												
	-0.289	0.044	-0.039	-0.277	0.592 c	-2.263 b	1.121	0.413 b	0.483 c	-0.008	-0.061	-0.2501
Test0:	0.564 b	-0.116	-0.266	0.515 a	-0.622 c	2.307 b	-0.580	-0.065 b	-0.511 c	-0.021	0.027	0.5480
Test1:	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.
Test2:	108.62 c	1785.1 c	742.34 c	845.01 c	1492 c	229547 c	1881 c	229547 c	0	399.41 c	349.93 c	38 c
Test3:	1.80	0.95	0.77	0.16	19328 c	21.9 c	8.38 c	21.9 c	1.21	69.46 c	18.27 c	3.91 b
R^2	2.50	0.02	0.10	2.91	48.2 c	260.0 c	1.10	260.0 c	0.00	0.00	0.03	1.07
Adj R^2	19399 c	4665.9 c	20220 c	13922 c	5.5E+08 c	3.6E+06 c	144.63 c	3.6E+06 c	0	25920 c	57531 c	35214 c
Obs.	0.539	0.510	0.505	0.500	0.968	0.973	0.465	0.973	0.995	0.532	0.491	0.5316
	0.519	0.495	0.491	0.486	0.967	0.972	0.450	0.972	0.995	0.508	0.464	0.4996
	199	263	286	283	282	274	284	274	164	164	163	126
	no crisis	no crisis	no crisis	no crisis	during	during	crisis only	during	during	no crisis	no crisis	no crisis

[a] Represents statistically significant at 10%
[b] Represents statistically significant at 5%
[c] Represents statistically significant at 1%

Table 4
Regime Switching Setup with other Benchmark Models (continued)

Panel E: CCC Bond Model

	2006Jun Estimate	2006Dec Estimate	2007Jun Estimate	2007Dec Estimate	2008Jun Estimate	2008Dec Estimate	2009Jun Estimate	2009Dec Estimate	2010Jun Estimate	2010Dec Estimate	2011Jun Estimate	2011Dec Estimate
η_s	1.116^{c}	1.127^{c}	1.076^{c}	0.279^{c}	0.322^{c}	0.496^{c}	2.118^{c}	1.609^{c}	0.080^{c}	0.899^{c}	0.904^{c}	0.094^{c}
η_b	0.898^{c}	1.568^{c}	1.379^{c}	0.085^{c}	0.075^{c}	0.208^{a}	1.817^{c}	1.605^{c}	0.193^{c}	0.729^{c}	0.722^{c}	0.046^{c}
ρ	-0.458^{c}	0.216^{c}	0.270^{c}	-0.046^{c}	-0.029^{c}	-0.008^{c}	0.112^{b}	0.217^{c}	0.013^{c}	-0.473^{c}	-0.492^{c}	-0.006^{c}
c_s	-1.252^{c}	-2.889^{c}	-2.470^{c}	-4.367^{c}	-5.657^{c}	-15.723^{c}	-6.316^{b}	-3.112^{c}	-9.708^{c}	-1.390^{c}	-1.325^{c}	-12.465^{c}
c_b	1.571^{c}	3.058^{c}	2.636^{c}	4.336^{c}	5.685^{c}	15.781^{c}	6.108^{b}	3.164^{c}	9.681^{c}	1.719^{c}	1.413^{c}	12.477^{c}
β_s												
β_b	-0.405	0.033	1.109	-0.078	-0.074	0.265	0.429	0.297	-0.113	0.040	1.007^{a}	0.051^{c}
γ_s	0.687	2.118^{a}	1.349	0.114	0.115	-0.266	-0.476	-0.133	0.127	0.587^{b}	0.820	-0.056^{c}
γ_b												
	-0.246	-0.118	-0.065	0.523^{c}	0.638^{c}	-2.100^{b}	1.212	0.243	1.143^{c}	0.163	-0.021	1.664^{c}
Test0:	0.520^{a}	-0.059	-0.349	-0.463^{c}	-0.661^{c}	2.137^{b}	-0.712	0.086	-1.120^{c}	-0.252	0.091	-1.654^{c}
Test1:	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.	Stats.
Test2:	112.95^{c}	746.67^{c}	928.98^{c}	1445.5^{c}	2061.9^{c}	177295^{c}	5654.9^{c}	2305^{c}	23064^{c}	347.7^{c}	365.18^{c}	45.9^{c}
Test3:	0.74	0.13	0	720.8^{c}	1891^{c}	2388.5^{c}	43.59^{c}	426.4^{c}	4088.2^{c}	48.48^{c}	0.35	563.61^{c}
R^2	1.98	0.07	0.08	37.4^{c}	57.01^{c}	168.8^{c}	1.37	0.01	149.48^{c}	1.03	0.1	0.94
Adj R^2	24255^{c}	6218.5^{c}	17384^{c}	1.2E+09^{c}	5.4 E+08^{c}	3.9E+06^{c}	299.9^{c}	12.6^{c}	1.0E+08^{c}	48932^{c}	28108^{c}	58072^{c}
Obs.	0.539	0.516	0.527	0.966	0.966	0.973	0.467	0.456	0.99	0.529	0.539	0.516
	0.519	0.501	0.513	0.965	0.965	0.972	0.452	0.440	0.989	0.505	0.515	0.483
	199	263	286	283	282	274	284	287	287	164	163	126
	no crisis	no crisis	no crisis	no crisis	during	during	crisis only	during	during	no crisis	no crisis	no crisis

[a] Represents statistically significant at 10%
[b] Represents statistically significant at 5%
[c] Represents statistically significant at 1%

Impact of trading volume on gold future return is generally significant after 2008 financial crisis in both the regimes. For positive mean and low volatility regime trading volume has negative impact of gold futures price that generally explains rational behavior for most of the data panels other than "2008 Dec" and "2007 Dec". Such pattern explains investors fear during the market crisis at the end of 2007.

To summarize, results show that Hedging benefits of gold vary significantly across two regimes (as evident in the LM statistics) although hedging benefits during a single regime may not be significant all the time. Besides, the regression results exhibit higher explanatory power of more than 90% during "2008 Jun" and "2008 Dec" (during two "during crisis panels") and from "2010 Jun" till 2011 compared to other time periods. Such pattern also explains that generally around the financial crisis, investors consider gold as a hedging tool. Although, United States business cycle definition does not account for a recession notation for third quarter of 2010 and onward, the persistence of higher explanatory power shows that investors still consider during this period. Comparing with lower power of non-dynamic GARCH (1,1) results as reported in Table 2, regime switching regression models provide higher explanatory power.

5.2. Robustness Issues: Regime Switching with other Model

Results for SNP 500 index as benchmark are similar to market model results in terms of coefficient estimates and explanatory power that represent both results to be consistent with each other. Results from T-bond benchmark model however provides additional insight as risk-free rate embedded into the market risk premium may not explain hedge benefit of gold compared to a rather safe investable security.

Coefficient estimates for T-bond futures during negative mean and high volatility regime is only significant and negative during "2008Dec" panel during the peak of financial crisis and however in general negative but not significant in other panels. For positive mean and low volatility regime, T-bond futures coefficients are generally positive but only significant for "2008Dec" and "2011Dec" panels. These results confirm the fact that during financial crisis or anticipated financial crisis, gold futures may indeed play the role of save haven as a complement to other safe securities. However, in the following panel such effect goes away as evident in statistically insignificance of the T-bond futures coefficients.

Results from AAA bond and CCC bond also consistent with T-Bond futures results and their interpretations. However, oil futures benchmark reveals some interesting insights. Although the coefficients for oil futures are generally insignificant across the panels, they are positively related with gold future prices for "2006 Jun" to "2007 Jun", "2009 Dec" and "2011Dec" panels during negative mean and higher volatility regime.

6. CONCLUSION

This study analyzes gold hedging benefits from the perspective of an individual investor who may choose to invest in a portfolio of: a) Index Futures, b) T-note Futures, c) Oil Futures and d) Gold Futures by using a regime switching setup. Results suggest that two regimes of gold futures returns can be distinctly identifiable: a) a negative return with higher volatility regime and b) a positive return with lower volatility regime. Results from market model show that Hedging benefits of gold vary significantly across two regimes although hedging benefits during a single regime may not be significant all the time. During the financial crisis, hedging benefit is more pronounced during for both the regimes. Such finds are consistent with the recent set of literature (see: Baur and McDermot(2010), among others).

Results from other benchmark (T-bond future, AAA Bond and CCC Bond index) models are also consistent with the argument that gold may indeed play the role of a complementary safe investment security, especially during financial crisis or anticipated crisis.

Note

1. I do not present the Partial Autocorrelation Function (PACF) and stationarity properties of these variables in the report due to space constrains.

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