VOL. 2, NO. 2, April 2013

International Journal of Economics, Finance and Management

http://www.ejournalofbusiness.org

Information Flow and Causality between Price Change and Trading Volume in Silver and Platinum Futures Contracts

[1] Sazali Abidin, [2] Azilawati Banchit, [3] Ruilin Lou, [4] Qian Niu

[1] Department of Finance, Waikato Management School, University of Waikato, Private Bag 3105, Hamilton 3240, New Zealand,
[2] Faculty of Business Management, Universiti Teknologi Mara (UiTM), 94300, Kota Samarahan, Sarawak, Malaysia
[3, 4] Waikato Management School, University of Waikato, Private Bag 3105, Hamilton 3240, New Zealand
Email:{[1]drsazali@gmail.com,[1]sazali@waikato.ac.nz,[2]azila@sarawak.uitm.edu.my,[3]r178@waikatoac.nz,[4]qn3@waikato.ac.nz}

ABSTRACT

This study examines the joint relationship between the percentage price change and the trading volume of silver and platinum futures contracts traded on Commodity Exchange, Inc. (COMEX) using the daily time series which covering a period of ten years. We adopt the two-step procedures proposed by Cheung and Ng (1996) to detect the causality of information flow between price change and trading volume. We find that lagged causality in mean running from the price change to trading volume but not for opposite direction under the original AR-GARCH model. The causality in variance is not found in our results. After that, we find evidences of mild lagged causality in variance running from the percentage price change to the trading volume under the augmented AR-GARCH model, which supports the sequential information flow hypothesis and consistent with the previous study by Bhar and Hamori (2004) in gold futures contracts. However, the contemporaneous causality has been found in the gold futures contract is not consistent with our findings.

Keywords: *Information flow, causality, price, volume, futures*

1. INTRODUCTION

There is a saying on the Wall Street that “it takes volume to move stock prices”. The volume data is important in financial market because of some reasons. First, the trading volume is deemed to reflect information about the overall activity in a market or expectation changes of investors. Second, according to Gallant, Rossi and Tauchen (1992), we can learn more about the market through studying the joint dynamics of price and volume than by focusing on the univariate dynamics of price.

The advocates of the presence of price-volume linkage express support on technical analysis. From the perspective of technical analysis, the price of financial products moves in trend since new information that change the relation between supply and demand does not come to the market at one single time point, and investors in the market are impossible to react to the new information at the same time point as well. In other words, the arrival of fresh information can be seen as a significant key to affect the trading activities in financial market. Clark (1973) states that both volume and price are induced by the same underlying information flow. Moreover, Copeland (1976) states that lagged linkage between price and volume exist since the information flow arrives to the market at different time. Therefore, it is reasonable to imply that the knowledge of price-volume dynamics will help investors understanding of the market performance better and thus achieving financial success.

There are numerous literatures have provided empirical evidences regarding the price-volume dynamics. Researchers have pay attention to price-volume dynamics of speculative market, because the knowledge of price-volume relationship in speculative market is significant and help improving the hedging skills of speculators and other investors. As for the futures market, available

published literatures that examine the futures contracts and its volume-price dynamics includes currency futures market by McCarthy and Najandi (1993), agricultural futures market by Malliaris and Urrutia (1998), and crude oil futures market by Moosa and Silvapulle (2000). The lately available literature relating to the metal futures is the study on gold futures contract by Bhar and Hamori (2004). It is stated that gold futures volume-price dynamics support both the mixture of distribution hypothesis and sequential arrival of information hypothesis, and they imply that the unique result is probably due to the special intrinsic natures of gold. It is worth to keep in mind that the metal futures are quite different in many aspects from other commodity futures due to its intrinsic characteristics. Most metals can be stored indefinitely and not subject to seasonal production and they are excellent commodities to hedge against risks of inflation and store of value. Moreover, differences between physical asset market and the futures market lead to a more complex joint interaction between trading volume and prices. With the background, it is necessary to examine other metal futures contracts’ price-volume linkage and eventually provide comparisons with existing evidences for market participants.

The study will examine the volume-price dynamics of silver futures and platinum futures contracts traded on Commodity Exchange, Inc. (COMEX) for a period of time of past ten-years. The rest of the paper is organized as follow: Section two provides a brief literature review about theory of information flow, methodology of testing the price-volume relationship in response of information flow, and available empirical futures market evidences in price-volume relation. Section three and four introduces the time series data used in analysis and the robust two-step procedure proposed by Cheung and Ng (1996) adopted in the study. We then examine the data sets and followed by presenting the empirical results in section five based on AR-GARCH model and augmented AR-GARCH model. Finally, section six gives the overall conclusion on our empirical research.

2. LITERATURE REVIEW

The published literatures address two famous hypotheses to explain the information flow arrival to the market. One is Mixture of Distribution Hypothesis proposed by Clark (1973) suggests that the dissemination of information is contemporaneous and further implies a positive contemporaneous causality from volume to price volatility in response to new information flow. This theory has been further tested by Anderson (1996), who develops a modified mixture of distribution hypothesis and concludes that the information disseminated asymmetric across market participants. Epps and Epps (1976) find the price variance of a transaction is conditional on the volume of the transaction.

The other is Sequential Arrival of Information Hypothesis proposed by Copeland (1976) and Jennings (1981), who indicate that information flow comes to the market at different point of time so that a lagged relationship must exist. It states lagged volume implies price volatility or in opposite direction. On the other side, two relative new hypotheses as to information flow between price and volume have been developed recently; there are the Dispersion of Belief Hypothesis proposed by Shalen (1993) and the Noise Trader Hypothesis proposed by Delong, Shleifer, Summers and Waldmann (1990a).

Dispersion of beliefs states the different types of trader response to same information in different ways, and uninformed trader tend to overreact to the price change and likely to cause greater price volatility. Daigler and Wiley (1999) have provided evidences that the differences in trades' beliefs do affect the contemporaneous volume and price volatility relationship. The Noise Trader Hypothesis is based on the assumption that noise trader occupying a greater portion of the market and have enough ability to destabilize pricing.

Besides the theory, the methods adopted by various researchers are traditionally based on Vector auto regression (VAR) model to capture the interdependencies between absolute price changes and trading volume. Then the Granger causality test detects the possible direction of the relationship. VAR model is usually used to prove the Sequential Arrival of Information Hypothesis. According to Ciner (2002), VAR model accounts for linear inter temporal dynamics between two time series variable. The Granger causality test, developed by Engle and Granger (1987), is a method for detecting whether one time series is useful in forecasting another, or the direction of the casual relationship.

For instances, Chen, Firth and Rui (2001), and Kamath and Wang (2006) adopt the Granger causality test investigating the price-volume dynamics and the return-volume dynamics in equity markets. Moreover, there is a growing concern regarding the test of conditional variance in recent time. The reasons are provided by Cheung and Ng (1996). First, changes in variance reflect new information dissemination and the extent to which the market assimilates the information. Second, causal pattern in variance offers a concerning about the natures and dynamics of financial prices. Moreover, Ross (1989) states that the variance of price changes is related directly to the information transmission. Engle, Ito and Lin (1990) indicate the information flow lead to the time to variance change. Consequently, studying on the interaction between conditional variance will shed light on relationship between price-volume dynamics in response to new information.

The empirical study about the price and volume relationship as to futures market is at a big mix. Some of the evidences support the mixture of distribution hypothesis and the others support the bi-directional sequential arrival of information hypothesis. McCarthy and Najand (1993) find a significant relationship between lagged absolute return and volume in the currency futures market which is consistent with the sequential hypothesis. Malliaris and Urrutia (1998) finds price and volume are co integrated and reports bidirectional causality between them in the agricultural futures market. Chen, Firth and Xin (2004) reports that new information is absorbed sequentially in copper, soybean and wheat futures, and the dissemination of information is contemporaneous in aluminum futures in China. Moosa and Silvapulle (2000) find bidirectional causality between them in crude oil futures contract as well. Bhar and Hamori (2004) provides evidences that strong contemporaneous causality in variance and mild causality in variance transfer from price change to volume with a lag of ten days.

3. DATA AND METHODOLOGY

The data sample used in the research are retrieved from DataStream, which are daily settlement price and trading volume of silver futures and platinum futures contracts traded on COMEX covering the period between 1st February 2000 and 31th August 2010. The data interval is 5 days per week. Some data are missing due to emergency or holiday issues. To recover the missing data, we calculate the average of corresponding weekly data before and after 5 weeks of time 0. For example, the missing data in this Monday is computed by averaging 10 Monday data for 5 weeks before and after of this Monday.

For the purpose of this study, we have considered the rate of return $y_t = [(P_t – P_{t-1}) / P_{t-1}] \times 100$, where P_t is the future price of silver or platinum futures contract at time t. and the trading volume in day t is expressed as V_t =

log (*Volume*), where volume is just the daily trading volume of silver or platinum futures contract.

Following the previous work of Cheung and Ng (1996), a two-step procedure based on the residual cross-correlation function (CCF) could be used to determine mean and variance causal relationship. Because this CCF based method is independent of simultaneous modeling of both intra- and inter-variables dynamics, the implement of this method in practice becomes fairly straightforward. The first stage is to estimate the appropriate univariate time-series models which allow for time variation in both conditional means and conditional variances. In this stage, In this stage, the AR-GARCH process could be used to model the dynamics of the percentage price change and the trading volume for both silver and platinum data, because the use of the AR structure is simple to use in the mean equation for the single time series, and the GARCH effect is a well-known effect in the variance process for most futures contracts, particularly within the daily frequency. The mean equations are as follows:

$$y_t = a_0 + \sum_{i=1}^{\rho 1} a_i y_{i-1} + \varepsilon_t, \varepsilon_{t|t-1} \sim N(0, \sigma_t^2), \tag{1}$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{\rho 2} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{\rho 3} \beta_i \sigma_{t-i}^2 \tag{2}$$

Where equation (1) shows the conditional mean dynamics for percentage price change or trading volume, and is specified as an AR (ρ1) model. Here, ε_t is the heteroskedastic error term with its conditional variance σ_t^2. Equation (2) shows the conditional variance dynamics and is specified as a GARCH (ρ2, ρ3) model. And, ρ2 is the number of ARCH terms and ρ3 is the number of GARCH terms.

The second stage is to test the causal relationships in mean and in variance for both silver and platinum futures contracts. In this stage, the standardized residuals and the squared standardized residuals estimated from AR-GARCH models will be analyzed by using cross-correlation functions (CCF), according to Cheung and Ng (1996) procedure. Using the notation in equation (1) and (2), the standardized residual is defined by $\varepsilon_t/\sqrt{h_t}$. Causality in mean is tested using cross correlation coefficients between standardized residuals, whereas the squares of standardized residuals could be used to investigate the causality in variance. The causality pattern is indicated by significance of the cross correlation. If there is no causality either in mean, or in variance, the cross correlations at different lags will be independently and normally distributed in large samples.

After we revealed the causality pattern of information flow between percentage price change and trading volume for both silver and platinum futures contracts, the new time series models – augmented AR-GARCH model can be reconstructed by using such relationship. According to Cheung and Ng (1996), by using the same procedure above, these augmented models can be estimated and analyzed further just by adding the relevant and significant exogenous variables from the previous results of cross correlation test (i.e., the volume variable for the price change equation and the price change variable for the volume equation), in order to detect the pattern of information flow.

4. EMPIRICAL RESULTS AND FINDINGS

We begin the empirical analysis by first investigating the summary statistics of the percentage price change and the log of the trading volume for both silver and platinum futures contracts. It is observed that the sample mean of returns is very small and the corresponding variance of returns is much higher for both contracts. The skewness are negative for all variables except the R_t of platinum (0.670), which indicates a longer left tail in the asymmetry of the probability distribution, whereas the negative skewness indicates a longer right tail. Both the percentage price change and the trading volume for silver and platinum data have positive kurtosis and high value of J-B statistic test.

Table 1: Summary Statistics

	Silver		Platinum	
	R_t(%)	V_t	R_t(%)	V_t
Mean	0.066	4.253	0.057	3.098
Median	0.092	4.267	0.000	3.087
Maximum	13.155	5.250	20.536	4.235
Minimum	-13.752	0.903	-13.426	1.079
Std. Dev.	1.926	0.313	1.634	0.383
Skewness	-0.563	-1.032	0.670	-0.194
Kurtosis	10.070	9.515	21.797	0.923
Jarque-Bera	5894.871	5372.483	40838.410	37244.630

Probability	0.000	0.000	0.000	0.000
Notes: $R_t = [(P_t - P_{t-1}) / P_{t-1}] \times 100$ and $V_t = \log(\textit{Volume})$.				

This means that the probability distribution function is leptokurtic. Also, the J-B statistic test suggests that the null hypothesis of normality is rejected at the 1% significance level for both variables.

In this part, the Table 2 shows the results of fitting AR-GARCH model to percentage price change and trading volume for both silver and platinum futures contracts. The lag orders of the AR part of mean equation (1) is set to be 5 for price return and 10 for the trading volume for both types of contracts. In respect of GARCH model, the GARCH (2, 1) model is chosen for the price data and the GARCH (1, 1) model is chosen for the trading volume data. The maximum likelihood estimates confirm that the percentage price change and the trading volume exhibit significant conditional heteroskedasticity.

Table 2: AR-GARCH Model for Percentage Price Change and Trading Volume

$$y_t = a_0 + \sum_{i=1}^{\rho 1} a_i y_{i-1} + \varepsilon_t, \varepsilon_{t|t-1} \sim N(0, \sigma_t^2), \quad (1)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{\rho 2} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{\rho 3} \beta_i \sigma_{t-i}^2 \quad (2)$$

	Silver				Platinum			
	Price Change %		Trading Volume		Price Change %		Trading Volume	
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
a_0	0.065	0.037	4.257**	0.034	0.057	0.030	3.101**	0.042
a_1	-0.006	0.019	0.430**	0.019	0.009	0.019	0.409**	0.019
a_2	0.005	0.019	0.123**	0.021	-0.012	0.019	0.173**	0.021
a_3	0.010	0.019	0.079**	0.021	-0.034	0.019	0.086**	0.021
a_4	-0.014	0.019	0.034	0.021	-0.022	0.019	0.040	0.021
a_5	0.005	0.019	0.085**	0.021	0.017	0.019	0.095**	0.021
a_6			0.038	0.021			0.001	0.021
a_7			-0.034	0.021			-0.016	0.021
a_8			0.040	0.021			0.022	0.021
a_9			0.025	0.021			0.016	0.021
a_{10}			0.058**	0.019			0.060**	0.019
ω	0.007**	0.002	0.011**	0.001	0.013**	0.002	0.016**	0.002
α_1	0.110**	0.015	0.326**	0.038	0.140**	0.016	0.283**	0.037
α_2	-0.076**	0.016			-0.111**	0.015		
β_1	0.965**	0.003	0.510**	0.035	0.964**	0.001	0.614**	0.038
Log-Likelihood	-5244.132		494.291		-4901.191		-122.299	

Notes: * indicates significance at the 5% level and ** indicates significance at the 1% level.

As the persistence in volatility is measured by parameters α and β, the parameter estimates of the AR-GARCH model in Table 2 are found to be statistically significant for both types of futures contracts just as the log likelihood estimates confirmed. For the ARCH parameters "α", we find the price change are significant at 0.076 for silver data and -0.111 for platinum data, and the trading volume are significant at 0.326 for silver data and 0.283 for platinum data. For the parameter measures the GARCH affect specifically, β, the coefficients for the percentage price return of silver and platinum data are 0.965 and 0.964, and their corresponding standard errors

Table 3: Cross-Correlation Analysis for the Levels and Squares of the Standardized Residuals

	Silver				**Platinum**			
	Levels		**Squares**		**Levels**		**Squares**	
	Lag	**Lead**	**Lag**	**Lead**	**Lag**	**Lead**	**Lag**	**Lead**
k	R&V(-k)	R&V(+k)	R&V(-k)	R&V(+k)	R&V(-k)	R&V(+k)	R&V(-k)	R&V(+k)
0	0.003	0.003	-0.019	-0.019	-0.019	-0.019	-0.009	-0.009
1	0.034	**-0.070***	-0.021	-0.002	-0.006	-0.041	0.005	0.018
2	-0.015	0.026	-0.012	-0.027	-0.006	0.019	-0.011	-0.010
3	0.007	0.044	-0.012	-0.022	-0.022	0.006	-0.014	-0.013
4	-0.001	0.018	-0.018	-0.022	-0.025	0.029	-0.030	-0.008
5	0.018	0.008	-0.009	-0.019	0.008	**0.053***	-0.027	0.001
6	0.000	0.007	-0.022	-0.019	0.001	0.011	-0.016	-0.011
7	0.004	0.002	-0.024	-0.021	-0.011	0.004	-0.002	0.002
8	-0.008	0.018	-0.022	-0.008	-0.032	0.000	0.027	-0.023
9	-0.021	0.030	-0.018	-0.017	0.010	0.026	0.009	0.012
10	-0.005	0.010	-0.006	-0.019	-0.007	0.019	-0.012	-0.009

Notes: * indicates significance at the 5% level and ** indicates significance at the 1% level

are 0.003 and 0.001 respectively, which indicating substantial persistence.

For trading volume data, the GARCH term coefficients are relatively small, 0.510 for silver futures contract, whereas 0.614 for platinum futures contract, with the corresponding standard errors of 0.035 and 0.038, which indicate less persistence compared to the percentage price change. All those coefficients for GARCH effect are significant at 1% confidence level. Thus the results show that it is a successful GARCH model and the daily price return and the trading volume series can be characterized by this AR-GARCH model. In addition to the coefficients for lags, all coefficients for 5 lags of price return are not significant for both silver and platinum data, which indicate there is no relationship between the current percentage price changes with the data of previous period.

However, the coefficients for the first 4 lags, the fifth and the last lags of trading volume are significant at 1% confidence level, indicating strong evidence that the persistence of past trading volume in explaining the current trading volume.

Next, the cross correlation results are provided in Table 3, which are computed from the standard residuals and square of standard residuals of AR-GARCH models in Table 2. The "Level" refers to the results computed based on standardized residuals and are used to test the causality in mean, whereas the "Squares" refers to the results computed based on the squares of standardized residuals which can be used to test for causality in variance. The statistics listed under "Lag" column shows the number of days that the trading volume data lags behind the percentage price change, and implies that the significance of trading volume causes the percentage price change. Similarly, the statistic results under the "Lead" column are explained by the number of days that the percentage price change lags behind the trading volume data, and interpret the correlation that the percentage price change causes the trading volume.

As the empirical results in Table 3 reveals the causal pattern of information flow between the percentage price change and the trading volume, we find the percentage price change causes the mean of trading volume at lag 1 at the 5% confidence level for silver futures contract, at lag 5 also at 5% significance level for platinum futures contract. This indicates mild evidence of lagged causality in mean going from the percentage price change to the trading volume only. However, there is no evidence of causality in variance in either direction; this is inconsistent with empirical result of gold futures contracts concluded by Bhar and Hamori (2004). Furthermore, there is no evidence of contemporaneous causality for percentage price change or trading volume to support the mixture distribution hypothesis. Thus, we can only conclude that the information flow between the price change and trading volume only affects their mean movements but not the volatility movements for both types of contracts until this stage.

Based on the empirical results shown in Table 3, the causal pattern in the mean and the variances is revealed. According to Cheung and Ng (1996), such causal relationships can offer some useful information on the interaction between time series, and could be utilized to refine the time-series models to better describe the time-series dynamics of the data. Thus, the augmented AR-GARCH model could be re-estimated for each variable just by adding the relevant and significant lagged (and squared) data of the other series to its benchmark AR-GARCH model mentioned in section 3. As no evidence of causality in mean runs from trading volume to percentage price change is found, we don't need to change the equations for the percentage price change data. The evidence discovered before implies the percentage price change causes the mean of trading volume only, thus, we propose the following augmented AR-GARCH model for the trading volume data:

For silver data:

$$V_t = a_0 + \sum_{i=1}^{10} a_i V_{t-i} + b_1 R_{t-1} + \varepsilon_{Vt}, \varepsilon_{Vt|t-1} \sim N(0, \sigma_{Vt}^2), \quad (3)$$

$$\sigma_{Vt}^2 = \omega + \sum_{i=1}^{2} \alpha_i \varepsilon_{Vt-1}^2 + \beta_1 \sigma_{Vt-i}^2 \quad (4)$$

For platinum data:

$$V_t = a_0 + \sum_{i=1}^{10} a_i V_{t-i} + b_5 R_{t-5} + \varepsilon_{Vt}, \varepsilon_{Vt|t-1} \sim N(0, \sigma_{Vt}^2), \quad (5)$$

$$\sigma_{Vt}^2 = \omega + \sum_{i=1}^{2} \alpha_i \varepsilon_{Vt-1}^2 + \beta_1 \sigma_{Vt-i}^2 \quad (6)$$

Equation (3) and (5) show the mean dynamic for the trading volume V_t for silver and platinum futures contracts respectively. Those equations include both the past value of the trading volume and the past value of the percentage price change. The past value of the percentage price change is involved because the empirical result of causality in mean runs from price change to trading volume at lag 1 for the silver data, and at lag 5 for the platinum data as shown in Table 3. Equations (4) and (6) show the conditional variance dynamic for the trading volume and are specified as GARCH (1, 1) models without any augmentation term, because there is no causality in variance exists for either direction as the empirical results in Table 3 indicated.

The results of fitting augmented AR-GARCH model to the percentage price change and the trading volume are reported in Table 4. All the estimates for the price change data are remain the same, because the equations for percentage price change data didn't change. However, we can see that the likelihood estimates increases from 494.291 in Table 2 to 508.018 in Table 4 for the silver's trading volume data, and rises from -122.299 in Table 2 to -107.046 in Table 4 for the volume data of platinum futures contract.

Those changes reflect the incremental explanatory power of the model for selected type of data. The GARCH term coefficients for trading volume data of silver and platinum futures contracts are 0.495 and 0.686 respectively, and the corresponding standard errors are 0.036 and 0.028, which indicate less persistence than the empirical results under the original AR-GARCH model. However, it is still very significant and at 1% confidence level. Thus, we can conclude that there are significant feedback effects in mean only for both the percentage price change and the trading volume.

Then in Table 5, the cross-correlation statistics are computed from the standardized residuals of the augmented models. By comparing the results in Table 3 and Table 5, we find the interaction between the percentage price change and the trading volume under the augmented AR-GARCH models is much weaker than that under the original AR-GARCH models for both markets. The empirical results in Table 5 show that, the information flow between the price change and the trading volume only affects their volatility movements for both silver and platinum futures markets, as there is no more residual causality in mean for either lag or lead for both markets.

Table 4: Augmented AR-GARCH Model for Percentage Price Change and Trading Volume

For silver data:

$$V_t = a_0 + \sum_{i=1}^{10} a_i V_{t-i} + b_1 R_{t-1} + \varepsilon_{Vt}, \varepsilon_{Vt|t-1} \sim N(0, \sigma^2_{Vt}), \quad (3)$$

$$\sigma^2_{Vt} = \omega + \sum_{i=1}^{2} \alpha_i \varepsilon^2_{Vt-1} + \beta_1 \sigma^2_{Vt-i} \quad (4)$$

For platinum data:

$$V_t = a_0 + \sum_{i=1}^{10} a_i V_{t-i} + b_5 R_{t-5} + \varepsilon_{Vt}, \varepsilon_{Vt|t-1} \sim N(0, \sigma^2_{Vt}), \quad (5)$$

$$\sigma^2_{Vt} = \omega + \sum_{i=1}^{2} \alpha_i \varepsilon^2_{Vt-1} + \beta_1 \sigma^2_{Vt-i} \quad (6)$$

	Silver				Platinum			
	Price Change%		Trading Volume		Price Change %		Trading Volume	
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
a_0	0.065*	0.037	4.257***	0.034	0.057*	0.03	3.100***	0.042
a_1	-0.006	0.019	0.428***	0.019	0.009	0.019	0.409***	0.019
a_2	0.005	0.019	0.129***	0.021	-0.012	0.019	0.173***	0.021
a_3	0.010	0.019	0.076***	0.021	-0.034*	0.019	0.086***	0.021
a_4	-0.014	0.019	0.035*	0.021	-0.022	0.019	0.0409*	0.021
a_5	0.005	0.019	0.085***	0.021	0.017	0.019	0.093***	0.021
a_6			0.038*	0.021			0.002	0.021
a_7			-0.035*	0.021			-0.017	0.021
a_8			0.042**	0.021			0.024	0.021
a_9			0.025	0.021			0.014	0.021
a_{10}			0.056***	0.019			0.059***	0.019
b1			-0.008***	0.002				
b5							0.006**	0.003
ω	0.007***	0.002	0.011***	0.001	0.013***	0.002	0.011***	0.002
α_1	0.110***	0.015	0.412***	0.049	0.140***	0.016	0.211***	0.024
α_2	-0.076***	0.016			-0.111***	0.015		
β_1	0.965***	0.003	0.495***	0.036	0.964***	0.001	0.686***	0.028
Log-Likelihood	-5244.132		508.018		-4901.191		-107.046	

Notes: * indicates significance at the 10% level, ** indicates significance at the 5% level, and *** indicates significance at the 1% level

The evidence of mild lagged causality in variance going from the percentage price change to the trading volume has been found, but not in the opposite direction. The percentage price change causes the variance of trading volume at lag 8 only for the silver futures market at 10% significant level, and at lag 9 only for the platinum futures market at 5% confidence level, which is the indication of the sequential information linkage because the interaction between the conditional variances indicates the information arrival in the market. In addition, there is no evidence suggests contemporaneous causality in variance rejecting the mixture of distribution hypothesis.

International Journal of Economics, Finance and Management

http://www.ejournalofbusiness.org

Table 5: Cross Correlation Analysis under Augmented AR-GARCH Model for the Levels and Squares of Standardized Residuals

	Silver				**Platinum**			
	Levels		**Squares**		**Levels**		**Squares**	
	Lag	**Lead**	**Lag**	**Lead**	**Lag**	**Lead**	**Lag**	**Lead**
k	R&V(-k)	R&V(+k)	R&V(-k)	R&V(+k)	R&V(-k)	R&V(+k)	R&V(-k)	R&V(+k)
0	-0.017	-0.017	-0.010	-0.010	0.003	0.003	-0.017	-0.017
1	0.034	-0.002	-0.021	-0.006	-0.002	-0.039	0.008	0.016
2	-0.015	-0.011	-0.012	-0.027	-0.002	0.022	-0.011	-0.010
3	0.008	0.040	-0.013	-0.021	-0.017	0.007	-0.013	-0.010
4	0.002	0.013	-0.019	-0.022	-0.024	0.027	-0.031	-0.008
5	0.017	0.004	-0.011	-0.018	0.009	0.019	-0.029	-0.009
6	-0.002	0.002	-0.023	-0.019	0.002	0.020	-0.018	-0.012
7	0.003	-0.001	-0.024	-0.022	-0.009	0.005	0.002	0.004
8	-0.006	0.017	-0.022	**-0.007***	-0.033	0.000	0.022	-0.022
9	-0.019	0.028	-0.018	-0.017	0.011	0.022	0.010	**0.013****
10	-0.010	0.011	-0.005	-0.019	-0.012	0.018	-0.011	-0.008

Notes: * indicates significance at the 10% level, ** indicates significance at the 5% level, and *** indicates significance at the 1% level.

5. CONCLUSIONS

This paper tests the joint dynamics of the percentage price change and trading volume in silver and platinum futures contracts using daily data over about ten-year period. The two-stage procedure developed by Cheung and Ng (1996) has been applied to test the causality of information flow between the percentage price change and trading volume in silver and platinum futures contracts, and give us a more robust result. In the first stage, we employ the appropriate AR-GARCH models for both price change and trading volume variables to test the potential persistence of the volatility, and then we implement the cross correlation test from the standardized residuals and their squares.

The results show the percentage price change causes the mean of trading volume at lag 1 at the 5% confidence level for silver futures contract, at lag 5 also at 5% significance level for platinum futures contract. This indicates mild evidence of lagged causality in mean going from the percentage price change to the trading volume only. However, the causality in variance is not found in our results. Based upon these results we refine the models with relevant lagged variables in the mean equations to get the augmented AR-GARCH models to test the cross correlation again.

We find evidence of mild causality in variance running from the percentage price change to the trading volume with a lag of 8 days for silver data, and a lag of 9 days for platinum data, which indicate mild support for the sequential information flow hypothesis; this is consistent with the previous gold futures study by Bhar and Hamori (2004). However, the contemporaneous causality has been found in the gold futures contract which is inconsistent with our findings. We believe this is probably due to the special investment characteristic of gold that silver and platinum may not have.

REFERENCES

[1] Andersen, T. G. (1996). Return volatility and trading volume: an information flow interpretation of stochastic volatility. Journal of Finance, 51, 169-204.

[2] Bhar, R., & Hamori, S. (2004). Information flow between price change and trading volume in gold futures contracts. International Journal of Business and Economics, 3, 45-56.

[3] Clark, P. K. (1973). A subordinated stochastic process model with finite variance for speculative process. Econometrica, 41, 135-155.

[4] Chen, G., Firth, M., & Xin, Y. (2004). The price-volume relationship in China's commodity futures markets. The Chinese Economy, 3, 87-122.

[5] Chen, G., Firth, M., & Rui, O. M. (2001). The dynamic relationship between stock returns, trading volume, and volatility. The Financial Review, 38, 153-174.

[6] Cheng, J. C., Taylor, L. W., Weng, W. (2010). The links between international parity conditions and Granger causality: a study of exchange rates and prices. Applied Economics, 42, 3491-3501.

[7] Cheung, Y. W., & Ng, L. K. (1996). A causality-in-variance test and its application to financial market prices. Journal of Econometrics, 72(1), 33-48.

[8] Ciner, C. (2002). The stock price-volume linkage on the Toronto Stock Exchange: before and after automation. Review of Quantitative Finance and Accounting, 19, 335-349.

[9] Copeland, T. E. (1976). A model of asset trading under the assumption of sequential information arrival. Journal of Finance, 31, 1149-1168.

[10] Daigler, R. T., & Wiley, M. K. (1999). The impact of trader type on the futures volatiliy-volume relation. Journal of Finance, 54, 2297-2316.

[11] Delong, J. B., Shleifer, A., Summers, L. H., & Waldmann, R. J. (1990). Noise trader risk in financial markets. Journal of Political Economy, 98, 703-738.

[12] Delong, J. B., Shleifer, A., Summers, L. H., & Waldmann, R. J. (1990). Positive feedback investment strategies and destabilized rational speculation. The Journal of Finance, 45, 379-395.

[13] Engle, R. F., Ito, T., & Lin, W. L. (1990). Meteor showers or heat waves? Heteroskedastic intra-daily volatility in the foreign exchange market. Econometrica, 28, 525-542.

[14] Engle, R. F., & Granger, C. W. J. (1987). Co integration and error correction: representation, estimation, and testing. Econometrica, 55, 251-276.

[15] Epps, T. W., & Epps, M. L. (1976). The stochastic dependence of security price changes and transaction volumes: implication for the mixture-of-distributions hypothesis. Econometrica, 44, 305-322.

[16] Gallant, R., Rossi, P., & Tauchen, G. (1992). Stock price and volume. Review of Financial Studies, 5, 199-242.

[17] Jennings, R. H., Starks, L. T., & Fellingham, J. C. (1981). An equilibrium model of asset trading with sequential information arrival. The Journal of Finance, 1, 143-161.

[18] Kamath, R., & Wang, Y. (2006). The causality between stock index returns and volumes in the Asian equity market. Journal of International Business Research, 5, 63-74.

[19] McCarthy, J., & Najand, M. (1993). State space modeling of price and volume dependence: evidence from currency futures. Journal of Futures Markets, 13, 335-344.

[20] Malliaris, A. G., & Urrutia, J. L. (1998). Volume and price relationship: hypothesis testing for agricultural futures. Journal of Futures Market, 18, 53-72.

[21] Moosa, I. A., & Silvapulle, P. (2000). The price-volume relationship in the curde oil futures market: some results based on linear and nonlinear causality testing. International Review of Economics and Finance, 9, 11-30.

[22] Ross, S. A. (1989). Information and volatility: the no-arbitrage martingale approach to timing and resolution irrelevancy. Journal of Finance, 44, 1-17.

[23] Shalen, G. T. (1993). Volume, volatility, and the dispersion of beliefs. Review of Financial Studies, 6, 405-434.