

Article Title: Examining the impact of macroeconomic announcements on gold futures in a VAR-GARCH framework

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Abstract: This note considers the impact of major scheduled U.S. macroeconomic announcements on the COMEX gold futures market in a high-frequency setting. A VAR-GARCH framework identifies the significant relationship between the release of macroeconomic news and measures of market activity. There is a well-defined link between (higher) volatility, (higher) trading costs, and (lower) transaction volume.

## 1. Introduction

Owing to its importance in price formation, the incorporation of economic news into asset prices has been the subject of extensive research for more than three decades; the role of scheduled macroeconomic announcements has been frequently examined since the news events are readily identifiable and have implications for market efficiency. Importantly, market efficiency dictates that the expected portion of an announcement should have no effect on asset prices, instead it is the surprise (news) component that the market responds to (Andersen et al., 2003; Kim et al., 2004; Smales, 2013). Further, Fleming and Remolona (1997) suggest that daily data are not sufficient to cleanly capture the market reaction.

Much of the extant literature has focused on the stock, bond, and foreign exchange markets. Flannery and Protopapadakis (2002) and Nikkinen et al. (2006) employ GARCH models for U.S. equity returns, while Chen et al. (2013) consider U.S. stock futures, to investigate the importance of macroeconomic news and report that key announcement surprises significantly affect both the level and volatility of returns. Becker et al. (1996) and Balduzzi et al. (2001) show that a number of economic announcements affect U.S. Treasury bond prices, with inflation and employment data having the largest impact. Andersen et al. (2003) examine the relationship between macroeconomic news and the U.S. dollar exchange rate against six major currencies, while Galati and Ho (2003) and Ehrman and Fratzscher (2005) consider the euro-dollar exchange rate response, reporting that U.S. macroeconomic news tends to have a greater impact on returns and volatility than news from other countries.

Only limited attempts have been made at investigating the impact of macroeconomic news on commodity prices. Christie-David et al. (2000) report gold prices respond to the news component of the consumer price index, gross domestic product, the producer price index, and the unemployment report. Cai et al. (2001) report similar results for intraday volatility with personal income as an additional significant announcement. Most recently, Elder et al. (2012) consider the period 2002-2008 and report that the response to economic news is both swift and significant, and that announcements reflecting an unexpected improvement in the economy tend to have a negative impact on gold and silver prices. Roache and Rossi (2010) suggest that the results for gold relate to its status as a “safe-haven”.

Using transaction level data, aggregated into 30-second intervals, we investigate the response in COMEX gold futures market activity for the 1-hour period<sup>1</sup> around U.S. macroeconomic announcements. Graphical analysis identifies a significant impact on market activity induced by macroeconomic news. A more formal analysis is conducted in a VAR-GARCH framework; confirming the significant effect of macroeconomic news on trading costs, returns, volatility of those returns, and trading volume. Notably, we find that increased volatility induces wider spreads that results in lower transaction volume.

## 2. Data

Transaction level data for COMEX gold futures<sup>2</sup> are obtained from Thomson Reuters Tick History (TRTH) provided by SIRCA<sup>3</sup> for the period 24<sup>th</sup> November 2006<sup>4</sup> – 31<sup>st</sup> December 2012, a total of 1,532 trading days; the nearest-to-maturity contract is used and switched to the second-nearest contract when open interest becomes greater. The transaction level data is aggregated into 30-second intervals for the 1-hour period surrounding macroeconomics announcements. We use bid-ask midpoints to compute returns, volatility, bid-ask spreads, and trading volume for each 30-sec interval

Data for major macroeconomic announcements is collected from Bloomberg with our sample restricted to those announcements identified as important in the extant literature<sup>5</sup>. All announcements occur at 08:30AM (EST), just 10-minutes after the official market open. Following Balduzzi et al. (2001), each component of the releases (expected and news components) is standardized using their respective standard deviations, to enable comparison of coefficients on announcements with different magnitudes. In particular, for announcement type  $k$  on day  $t$ , the news surprise is defined as:

$$N_{kt} = \frac{A_{kt} - E_{kt}}{\sigma_k} \quad (1)$$

Where  $A_{kt}$  is the actual value of the data release,  $E_{kt}$  is the (Bloomberg) market survey expectation, and  $\sigma_k$  is the standard deviation of the news component ( $A_{kt} - E_{kt}$ ). The news

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<sup>1</sup> From 15 minutes prior to the scheduled announcement to 45 minutes after the announcement.

<sup>2</sup> Contract size is 100 troy ounces and minimum price fluctuation is \$0.10 per troy ounce.

<sup>3</sup> Securities Industry Research Centre of Asia-Pacific

<sup>4</sup> TRTH transaction data for gold futures is incomplete prior to this date.

<sup>5</sup> Cai et al. (2001) identify Consumer Price Index (CPI), Gross Domestic Product (GDP), and the Unemployment Rate (UNEMP) as important. Christie-David et al. (2000) add Personal Income (PINC) to the list, and others highlight the Producer Price Index (PPI).

components are calibrated so that a positive value represents data that is stronger than expected with regards economic growth, and a negative value represents weaker than expected economic growth.

Summary statistics for the gold futures market are provided in Panel A of Table 1. The mean value for all variables is greater in the 30-second interval following announcements. The average absolute return is close to zero, there is evidence of a high degree of kurtosis (fat-tails) typical of asset price returns, and no significant evidence of return autocorrelation. High degrees of kurtosis, skewness, and positive autocorrelation are apparent for volatility, BAS and volume measures; typical of the volatility clustering identified in time-series by Engle (1982) and Bollerslev (1986). For all variables the unit root is rejected at a high level of significance. Panel B shows that macroeconomic news tends to be positive on average, i.e. analysts underestimate the strength of economic data releases.

<Insert Table 1>

### 3. Empirical Evidence

#### *Impact of macroeconomic announcements*

We first gain an insight into the impact of macroeconomic news on market activity by considering the unconditional response to data releases. We analyse 30-second intervals around the scheduled data release, capturing 30 intervals (15-min) prior to the announcement and 90 intervals (45-min) afterwards. Figure 1 shows the average reaction for each of the market activity variables around announcements, and contrasts with activity at the same time on days without major announcements. There is a clear jump in all measures of market activity as the announcement is released, this subsides to a level statistically indistinguishable from non-announcement days within 3-minutes (6 intervals). A spike in market activity of a lower magnitude is also registered as the trading pit opens in Chicago (10-minutes prior to the release).

<Insert Figure 1>

#### *VAR-GARCH Model*

The vector autoregressive (VAR) process for the endogenous variables (traded volume, period return, realized variance, and bid-ask spread) around exogenous scheduled macroeconomic releases is specified:

$$y_t = c + \sum_{i=1}^p (\Gamma_i y_{t-i}) + \Xi \cdot N_t + \varepsilon_t, \varepsilon_t \sim N(0, \Omega) \quad (2)$$

Where  $\Gamma_i$  and  $\Xi$  denote coefficient matrices<sup>6</sup>. To capture the impact of the macroeconomic surprise effect, a news variables  $N_t$  is defined; this is equal to the summation of the values for macroeconomic news occurring during interval  $t$  calculated using Eq. (1). In order to account for GARCH effects in the error term of the VAR model, a diagonal VECH specification<sup>7</sup> is utilized:

$$VECH(H_t) = C + AVECH(\varepsilon_{t-1}\varepsilon'_{t-1}) + BCVECH(H_{t-1}) \quad (3)$$

Where  $C$  is a vector of constants, while  $A$  and  $B$  are the parameter matrices for ARCH and GARCH terms respectively. The model is applied to all appropriate trading intervals (8:15am – 9.15am) for the 1,532 trading days in the sample. Results are reported in Table 2<sup>8</sup>.

<Insert Table 2>

Considering the mean equation first (Panel A), the constant is positive and well-defined for all variables. Second, there is significant positive own dynamics for all variables consistent with autocorrelations identified earlier. Third, higher bid ask spreads in prior periods, which indicate higher trading costs, tend to increase returns but decrease the volume of futures traded. Lagged volatility has a similar impact with the additional effect of wider bid-ask spreads consistent with market participants increasing their spreads in the presence of higher volatility. Importantly, the impact of macroeconomic news is significant for each of the market activity variables; that is, consistent with Figure 1, market activity and spreads increase in the presence of macroeconomic news. The response of returns is consistent with Elder et al. (2012) such that good economic news results in negative returns in the gold market.

The estimates for the VECH(1,1) specification are reported in Panel B; own-volatility shocks are significant for all variables, indicating the presence of ARCH effects. The magnitude of lagged shocks is highest for bid-ask spreads ( $a_{i3}$  and  $a_{33}$ ) indicating the importance of trading costs in explaining the volatility of other variables. The  $b_{ij}$  coefficients show the GARCH effects; the own-volatility effects are highly significant and positive, with the volume variable having the largest magnitude of impact on conditional variance. The sum of the lagged ARCH and GARCH coefficients indicates volatility persistence in the data, particularly for volatility and log(volume).

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<sup>6</sup> Akaike Information Criteria (AIC) are utilized to obtain optimal lag length, with the first two lags reported here.

<sup>7</sup> A VECH(1,1) specification is adopted on the basis of AIC and in consideration of computational issues.

<sup>8</sup> The reported results are robust to the ordering of variables.

<Insert Figure 2>

The impulse response of market activity to macroeconomic news is depicted in Figure 2. Returns, volatility, bid-ask spreads, and volume increase immediately following the release of macroeconomic news. The shape of the response indicates the time taken for news to disseminate through the market; the impact is short-lived with volatility and returns returning to normal within approximately 2½-min (5 x 30-sec intervals).

#### **4. Conclusion**

An increasing number of investors are utilizing investments linked to the price of gold, in order for rational portfolio choices to be made it is necessary to have an understanding as to how important news events impact market activity. This article finds evidence to suggest that major scheduled macroeconomic announcements have a significant influence on market activity as measured by returns, volatility, spreads, and trading volume. Having identified an impact via graphical analysis a more formal analysis is conducted in a VAR-GARCH framework. Empirical evidence confirms the significant effect of macroeconomic news, and the relatively quick speed with which news is disseminated throughout the market and activity returns to normal. There is a well-defined relationship between trading costs (measured by bid-ask spreads), volatility and trading volume, such that increased volatility induces wider spreads that results in lower transaction volume; such results are consistent with the extant literature.

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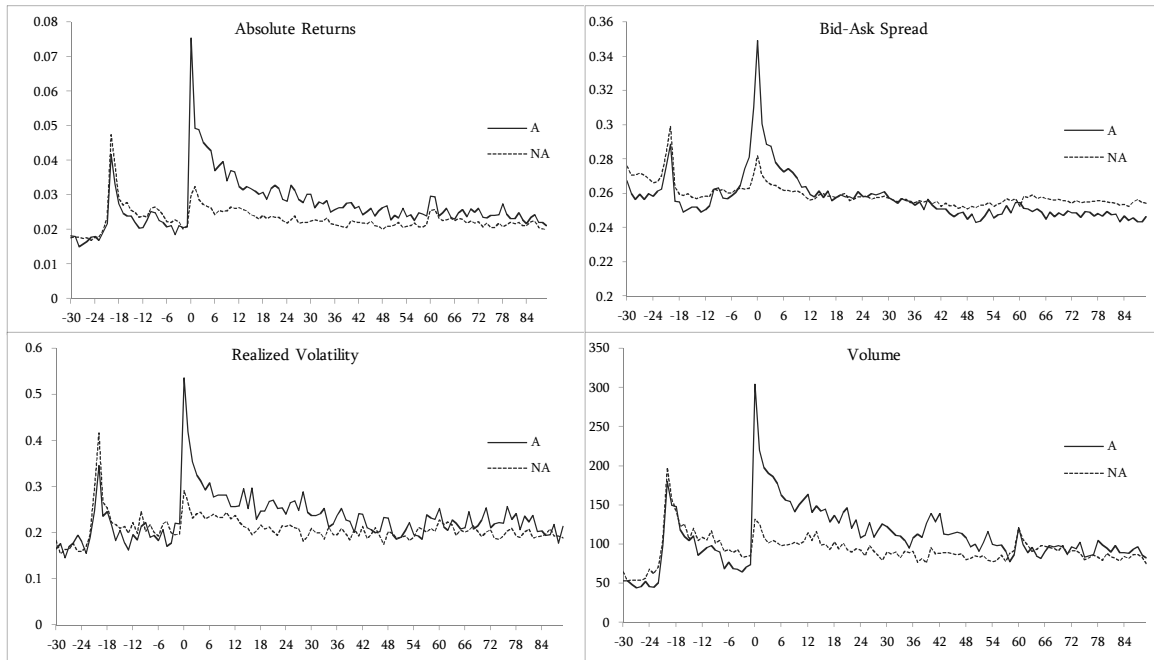
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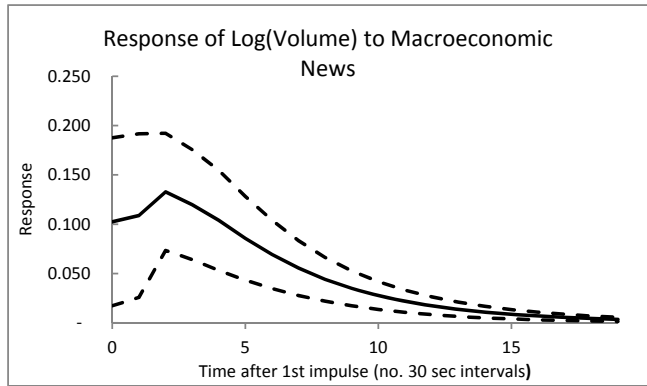
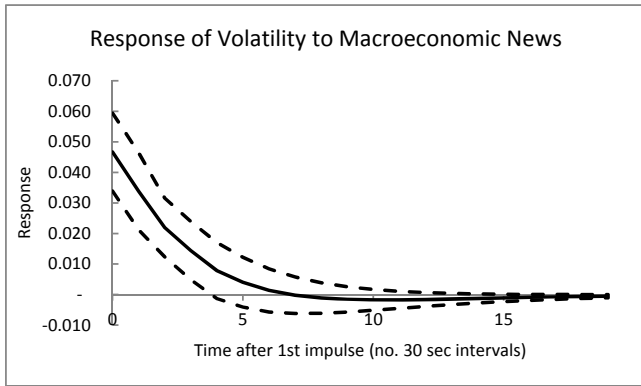
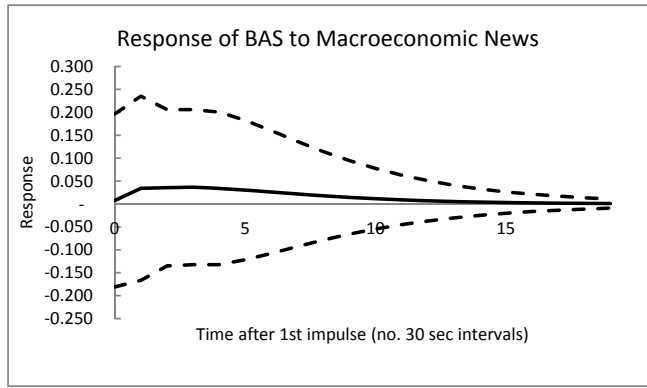
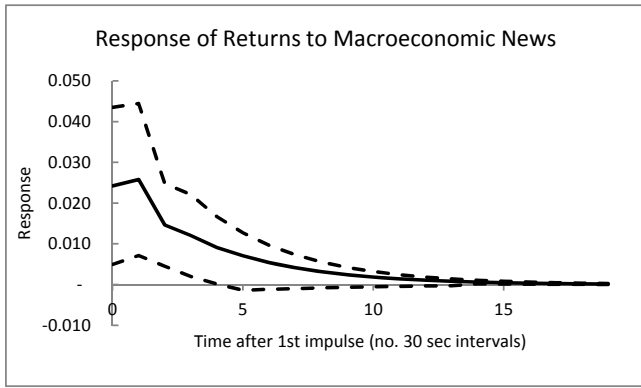
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**Figure 1. Response of market activity to major macroeconomic announcements**

This figure displays the absolute return, realized volatility, bid-ask spread and volume traded in the gold futures market for the 30-second intervals surrounding major macroeconomic announcements; the 1-hour period runs from 15-mins prior to the announcement to 45-mins after (8:15am-9:15am). A denotes major announcement day; NA denotes non-major announcement day.





**Fig 2.** Response analysis of the arrival of macroeconomic news on market activity

**Table 1**  
Summary Statistics

Panel A: Gold Futures	Summary Statistics						Partial Autocorrelation at Lag:			Unit Root
	Mean - Ann	Mean - All	SD	Skewness	Kurtosis	Jarque-Bera	1	2	3	
Return	0.075	0.00004	0.034	-0.710	226.85	230	0.080	-0.014	-0.004	-97.53*
Volatility	0.536	0.145	0.466	15.685	333.22	502	0.337	0.335	0.150	-14.51*
BAS	0.349	0.262	0.136	2.802	27.79	493	0.945	0.328	0.178	-21.09*
Volume	304.37	20.92	58.243	12.192	347.79	546	0.571	0.257	0.182	-27.83*

Panel B: Macroeconomic News

	N	Std. Dev. Of				Time of announcement	Frequency of release
		Mean News	News	Min. News	Max. News		
Consumer Price Index	73	0.000	0.992	-2.866	2.866	8:30 AM	Monthly
Gross Domestic Product	24	0.051	0.914	-2.124	2.580	8:30 AM	Quarterly
Personal Income	74	0.174	1.083	-1.736	5.209	8:30 AM	Monthly
Producer Price Index	73	0.164	0.999	-2.320	3.286	8:30 AM	Monthly
Unemployment Rate	73	0.143	1.154	-3.267	2.613	8:30 AM	Monthly

This table presents summary data for the variables utilised in this study, using intraday observations around macroeconomic announcements for the period 24 November 2006 - 31 December 2012. The specific period for 30-second intervals runs from 15-minutes prior to each announcement to 45-minutes post-announcement (8:15am - 9:15am). Panel A contains statistics relevant to the absolute *return*, *volatility*, *bid-ask spread* and *volume* of gold futures. Unit root tests are conducted using Augmented Dickey Fuller with trend and intercept; \* indicates rejection of the null of a unit root. Mean - Ann refers to the mean value of the variable in the 30-seconds immediately following the data release, while Mean - All refers to the overall sample mean. Panel B provides information on the macroeconomic announcements considered in the study, with *news* indicating the standardised surprise component of the given data release.

**Table 2**

Response to Macroeconomic News: VAR-GARCH Model Estimates

Panel A - VAR Estimates		Panel B - VEC(1,1) Estimates																
		Returns	Volatility	Bid-Ask Spread	Log(Volume)	Returns	Volatility	Bid-Ask Spread	Log(Volume)									
<i>Dynamics</i>																		
	c	0.010 (0.001)	***	0.064 (0.003)	***	0.021 (0.001)	***	0.312 (0.006)	***	c <sub>11</sub>	0.062 (0.0002)	***						
Returns	Ret <sub>t-1</sub>	0.010 (0.002)	***	-0.036 (0.007)	***	0.004 (0.001)	***	-0.115 (0.015)	***	c <sub>12</sub>	0.008 (0.0003)	***	0.001 (0.0001)	***				
	Ret <sub>t-2</sub>	0.004 (0.002)		-0.026 (0.007)	***	0.002 (0.001)	**	-0.109 (0.015)	***	c <sub>13</sub>	0.053 (0.0002)	***	0.008 (0.0003)	***	0.050 (0.0002)	***		
Volatility	Volatility <sub>t-1</sub>	0.008 (0.001)	***	0.413 (0.002)	***	0.002 (0.000)	***	-0.046 (0.004)	***	c <sub>14</sub>	-0.042 (0.001)	***	-0.004 (0.0003)	***	-0.040 (0.001)	***	0.031 (0.001)	***
	Volatility <sub>t-2</sub>	-0.001 (0.001)		0.310 (0.002)	***	0.001 (0.001)		-0.003 (0.004)		a <sub>11</sub>	0.769 (0.002)	***						
Bid-Ask Spread	BAS <sub>t-1</sub>	0.028 (0.006)	***	0.027 (0.019)		0.622 (0.002)	***	-0.727 (0.038)	***	a <sub>12</sub>	0.306 (0.001)	***	0.121 (0.001)	***				
	BAS <sub>t-2</sub>	0.022 (0.006)	***	0.007 (0.019)		0.318 (0.002)	***	-0.098 (0.038)	**	a <sub>13</sub>	0.812 (0.002)	***	0.323 (0.001)	***	0.857 (0.002)	***		
Log(Volume)	Volume <sub>t-1</sub>	0.003 (0.000)	***	-0.002 (0.001)		-0.004 (0.001)	***	0.549 (0.002)	***	a <sub>14</sub>	0.253 (0.001)	***	0.099 (0.001)	***	0.268 (0.001)	***	0.083 (0.001)	***
	Volume <sub>t-2</sub>	-0.002 (0.003)		-0.002 (0.001)		-0.002 (0.000)	***	0.385 (0.002)	***	b <sub>i1</sub>	0.011 (0.003)	***						
<i>Macroeconomic News</i>																		
News	News <sub>t</sub>	-0.024 (0.006)	***	0.046 (0.019)	**	0.008 (0.002)	***	0.101 (0.038)	**	b <sub>i2</sub>	0.107 (0.002)	***	0.875 (0.003)	***				
	News <sub>t-1</sub>	-0.003 (0.006)		0.022 (0.019)		0.016 (0.014)		0.010 (0.033)		b <sub>i3</sub>	0.013 (0.002)	***	0.111 (0.002)	***	0.014 (0.002)	***		
										b <sub>i4</sub>	0.116 (0.003)	***	0.889 (0.004)	***	0.117 (0.003)	***	0.903 (0.001)	***
										a <sub>ii</sub> + b <sub>ii</sub>	0.597		0.806		0.628		0.986	

The table provides estimation results for the VAR-GARCH model outlined in equation 2 & 3. Optimal lag length is chosen using AIC with 2 lags reported. \*\*\* denotes significance of the coefficient estimates at the 1% level, \*\* at the 5% level, and \* at the 10% level.