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Commodity Price Volatility and U.S. Monetary Policy: The Overshooting Hypothesis of Agricultural Commodity Prices

Sima Siami-Namini[1], Darren Hudson[2], A. Alexandre Trindade[3]

[1.] Graduate Research Assistant and Ph.D. Student, Dept. of Agricultural & Applied Economics [2.] Professor and Larry Combest Endowed Chair, Dept. of Agricultural & Applied Economics [3.] Professor, Dept. of Mathematics & Statistics, Texas Tech University

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ABSTRACT

- Commodity price volatility has raised concerns for the central bank policy-makers in the recent decade.
- They are often seen as being connected in a cause and effect relationship with inflation, then the driving forces behind them are crucial for the conduct of monetary policy (Svensson, 2005).
- The aim is to analyze how far an expansionary monetary policy shock can drive up commodity prices index and vice versa.
- Using an ARMA-EGARCH model, we extract GARCH variance series to identify the volatility spillovers between monetary policies and commodities price index.
- Because of long-term relationship between GARCH variance series of variables, we used vector error correction model (VECM) Granger causality approach to identify the short- and long-term cause and effect interrelationships between variables.
- The results of impulse response functions (IRFs) show that the agricultural commodity price index and other commodity sub-indices overshoot their long-run equilibrium in response to an impulse in the monetary policy instruments.

METHODS

- Using EGARCH model proposed by Nelson (1991), we extract the conditional variance series of all variables.
- We model the ***conditional mean*** equation using an ARMA process as below:

$$(1) \qquad R_{j,t} = \mu + \sum_{i=1}^{p} \varphi_i R_{j,t-i} + \sum_{i=1}^{q} \theta_i \varepsilon_{j,t-i} + \varepsilon_{j,t}$$

$$(2) \qquad \varepsilon_{j,t} = \sigma_{j,t} \nu_{j,t}$$

Where $R_{j,t}$ denotes the log return of price index, φ_i are parameters of the autoregressive term, θ_i are parameters of the moving average part, $\{\varepsilon_{j,t}\}$ is independent and identically distributed mean zero and conditional variance of $\sigma_{j,t}^2$.

- The ***conditional variance***, $\sigma_{j,t}^2$ depicted as EGARCH process which is an ***asymmetric function*** of lagged distributions $\varepsilon_{j,t-1}$:

$$(3) \qquad ln\sigma_{j,t}^2 = \omega_j + \sum_{i=1}^{p} (\alpha_i \left| z_{j,t-i} \right| + \gamma_i z_{j,t-i}) + \sum_{i=1}^{q} \beta_i \, ln\sigma_{j,t-i}^2$$

$$(4) \qquad z_{j,t-i} = \frac{\varepsilon_{j,t-i}}{\sqrt{\sigma_{j,t-i}^2}}$$

Where ω_j is constant, $z_{j,t}$ is the ***standardized residual*** from the ***conditional mean*** equation. The parameter γ_i, allows for ARCH effect to be asymmetric.

- To identify and evaluate the impact of the U.S. monetary policy on commodities price volatility, we consider VECM approach as below

$$(5) \qquad \Delta y_t = \alpha + \pi y_{t-1} + \sum_{i=1}^{p-1} \phi_i \, \Delta y_{t-i} + \epsilon_t$$

Where y_t is a $n \times 1$ vector holding the ***series of conditional variances*** to be studies, and Δ is the first difference operator, π and ϕ_i are matrices of parameters to be estimated and ϵ_t is assumed to be independent and identically distributed with mean zero.

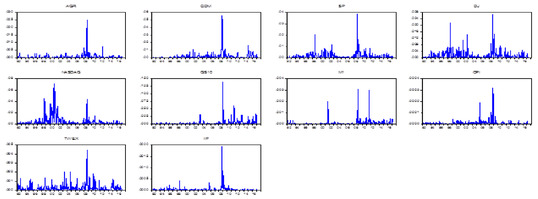
INTRODUCTION

- The issues of commodity price volatility and the driving forces behind them are crucial for the conduct of monetary policy in the economies who have taken inflation targeting in a tight monetary policy (Svensson, 2005).
- As a response to the severe recession of 2007-2009, with short-term interest rates at nearly zero, the Fed made a series of large-scale asset purchases (LSAPs) between late 2008 and Oct 2014 to promote a stronger economic recovery which in turn has quadrupled its balance sheet to $4.5 trillion, driving down the value of the dollar, increasing the overall supply of money, speculation and boosting asset prices, including commodities.
- The claim is that low real interest rates lead to high real commodity prices which confirms *overshooting hypothesis* of Dornbusch (1976), specially in agricultural commodity markets [Overshooting have significant effects on short-term farm income and the financial viability of farms (Bakucs, 2005)].
- The aim is to analyze how far an expansionary monetary policy shock can drive up the commodity price index including agricultural commodity price index, find the short- and long-term relationship between variables, and examine the short-term *overshooting hypothesis* of agricultural commodity prices in the U.S. economy.

RESULTS

- Evidence of volatility clustering, implying that low/high values of volatility are tended to be followed by low/high values.

Figure 1. Squared Log Returns of Time Series over Study Period



- The volatility processes of the commodities return is dominated by the ARCH and GARCH effect.
- No asymmetric effect in COM, AGR, NASDAQ, and TWEX.

Table 1. Parameter Estimates of the ARMA-EGARCH (1, 1) Model

Panel A: Conditional Mean Equation	IP ARMA (5,5)	CPI ARMA (3,3)	COM ARMA (5,4)	AGR ARMA (2,3)	SP ARMA (4,5)	DJ ARMA (3,3)	NASDAQ ARMA (4,4)	TWEX ARMA (5,3)	M1 ARMA (5,4)	GS10 ARMA (4,4)
Intercept	0.00167	0.00174	-0.00017	0.00111	0.00414	0.00576	0.01119	0.00040	0.00233	-0.00723
	(0.0052)	(0.0000)	(0.9438)	(0.5927)	(0.0000)	(0.0105)	(0.0000)	(0.7272)	(0.1199)	(0.0155)
AR (1)	-0.55383	0.73281	0.68182	-1.41528	-0.78281	-0.82058	-0.20484	0.86267	-	-
	(0.0003)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		
AR (2)	0.26301	-	-0.10206	-0.45026	0.50968	-0.79378	1.13221	-	-0.22633	0.31062
	(0.0001)		(0.0085)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		(0.0055)	(0.0000)
AR (3)	0.85272	0.25543	0.40059	-	0.33130	-0.89034	-0.37056	-0.90590	0.21958	-0.32236
	(0.0000)	(0.0000)	(0.0000)		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)
AR (4)	0.14753	-	-1.00511	-	0.03783	-	-0.85950	0.42379	0.61387	-0.65936
	(0.0809)		(0.0000)		(0.0000)		(0.0000)	(0.0000)	(0.0000)	(0.0000)
AR (5)	-0.38474	-	0.19931	-	-	-	-	-0.18978	0.21078	-
	(0.0000)		(0.0018)					(0.0003)	(0.0001)	
MA (1)	0.62840	-0.39744	-0.44123	1.81881	0.76743	0.81860	0.25721	-0.49604	-	0.25726
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		(0.0000)
MA (2)	-	-0.29755	0.04000	1.07627	-0.52989	0.75905	-1.15645	-0.27090	0.33438	-0.40730
		(0.0000)	(0.0359)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0003)	(0.0000)
MA (3)	-0.59613	-0.37377	-0.47883	0.25081	-0.23839	0.90072	0.32452	0.85316	-	0.30017
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		(0.0000)
MA (4)	-	-	0.95380	-	-	-	0.91829	-	-0.62911	0.86366
			(0.0000)				(0.0000)		(0.0000)	(0.0000)
MA (5)	0.35874	-	-	-	-0.02776	-	-	-	-	-
	(0.0070)				(0.0419)					
Panel B: Conditional Variance Equation	IP	CPI	COM	AGR	SP	DJ	NASDAQ	TWEX	M1	GS10
ω	-2.38704	-1.69141	-0.66490	-0.30558	-0.94500	-1.03398	-0.72669	-12.3848	-2.84494	-0.29186
	(0.0029)	(0.0000)	(0.0293)	(0.1461)	(0.0020)	(0.0394)	(0.0025)	(0.0000)	(0.0023)	(0.0017)
α	**0.18145**	**0.43678**	**0.39505**	**0.09753**	**0.25416**	**0.18418**	**0.41174**	**-0.24072**	**0.60238**	**0.11581**
	(0.0674)	(0.0000)	(0.0012)	(0.0165)	(0.0118)	(0.0339)	(0.0005)	(0.0424)	(0.0000)	(0.0471)
γ	**-0.35166**	**0.08048**	**-0.03983**	**0.03605**	**-0.18618**	**-0.15159**	**-0.07100**	**-0.04730**	**0.15855**	**-0.16289**
	(0.0000)	(0.0389)	(0.4741)	(0.1663)	(0.0008)	(0.0152)	(0.1709)	(0.5257)	(0.0214)	(0.0000)
β	**0.78990**	**0.88982**	**0.94733**	**0.96895**	**0.88661**	**0.86433**	**0.93185**	**-0.48263**	**0.75978**	**0.96320**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0321)	(0.0000)	(0.0000)
Panel C:	IP	CPI	COM	AGR	SP	DJ	NASDAQ	TWEX	M1	GS10
AIC	-7.7697	-9.5678	-3.7278	-4.5984	-3.7294	-3.7032	-2.9885	-5.5594	-7.0268	-3.0698
LL	1166.81	1440.39	567.59	699.77	568.67	594.63	458.29	837.57	1054.49	469.40

Figure 2. Graphical Residual Diagnostics from Fitted EGARCH(1,1)

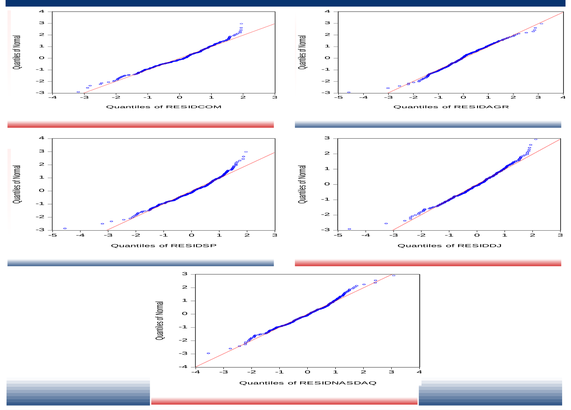
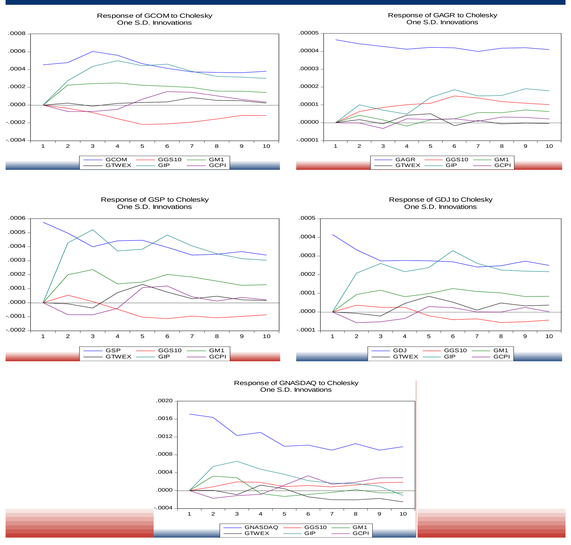


Figure 3. Results of Impulse Response Function (IRFs)



DATA

- Monthly observations from Feb 1992 to Mar 2017 including:
  - 10-year treasury constant maturity rate (GS10);
  - M1 money stock (M1);
  - The trade weighted U.S. dollar index in terms of major currencies (TWEX);
  - Consumer price index (CPI);
  - Industrial production index (IP);
  - Aggregate commodity price index (COM);
  - Agricultural commodity index (AGR);
  - Dow Jones industrial average index (DJ);
  - Nasdaq composite index (NASDAQ), and S&P 500 commodity index (SP);

CONCLUSIONS

- **Short-term Granger causality:** There is no short-term Granger causality running from the conditional variance series of interest rate (GGS10) to the conditional variance series of individual commodity price index except for the conditional variance series of agricultural commodity price index (GAGR).
- **Long-term Granger causality:** An unidirectional long-term causality from the factors influencing the conditional variance series of exchange rate and inflation to those factors influencing the conditional variance series of agricultural commodity price index, respectively.
- **The joint test (short- and long term)**: (i) A bilateral strong causality between the conditional variance series of agricultural commodity price index and the conditional variance series of exchange rate, industrial production, and inflation, respectively (ii) and the unidirectional strong causality from the conditional variance series of interest rate to the conditional variance series of agricultural commodity price index.
- The findings show that the commodity prices and specially agricultural commodity price index overshoot their long-run equilibrium in response to an impulse in the monetary policy and support our previous empirical results (Siami-Namini & Hudson, 2016).
- Agricultural commodity price index takes longer time to adjust to the equilibrium.

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