Hedging Crude Oil and Corn Futures: An Application in International Trade

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INTRODUCTION

Purpose

- Corn and crude oil futures contracts are analyzed for their effectiveness in reducing uncertainty for international corn traders after China's accession to the World Trade Organization.
- Use crude oil prices (used as proxy for bunker fuel costs) for transportation costs under a cross-market price dynamics framework.

Previous Findings

- time-varying covariability between different yet related markets (corn and crude oil) in a multiple risk environment.
- The cross-hedge quality of index futures and forward freight agreements are extremely limited, which resulted in historically low levels of trading and consequently, makes a simple hedging of futures contracts impossible.
- Thus, one must employ an alternate approach (e.g., using crude oil futures)

HEDGING MODEL

- The hedged outcome at time t for the trader is determined as:

$$W_t = -C_t e_t - O_t e_t + b_1(c_t e_t - c_{t-1} e_t) + b_2(o_t e_t - o_{t-1} e_t)$$

- The minimum variance hedge ratios collapse to the traditional OLS hedge ratios:

$$\frac{b_{t-1}}{q_{t-1}} = \frac{h_t^{21}}{h_t^{22}}$$

ECONOMETRIC ESTIMATION

- VECM

$$\Delta p_t = c + \Pi p_{t-1} + \Gamma \Delta p_{t-1} + u_t$$
$$= c + \alpha\beta^{\intercal} p_{t-1} + \Gamma \Delta p_{t-1} + u_t$$

- DCC MGARCH Model

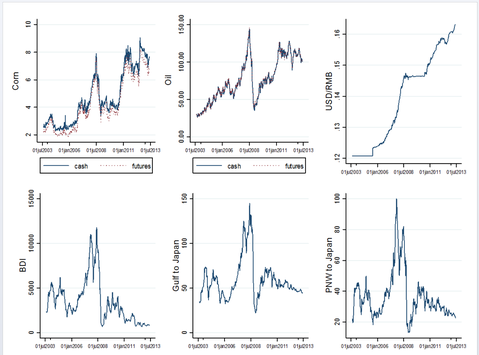
$$p_t = \mu_t + u_t$$
$$u_t = H_t^{\frac{1}{2}} z_t$$
$$H_t = D_t R_t D_t$$

MOTIVATION

Correlations of Variables

Full Sample Period	(C)	(c)	(O)	(o)	(e)	(G)	(P)	(B)
corn cash (C)	1							
corn futures (c)	0.997	1						
oil cash (O)	0.818	0.803	1					
oil futures (o)	0.814	0.798	0.999	1				
USD/RMB (e)	0.910	0.898	0.811	0.812	1			
Gulf to Japan (G)	0.297	0.312	0.348	0.342	0.200	1		
PNW to Japan(P)	0.163	0.167	0.240	0.233	0.057	0.910	1	
BDI (B)	-0.098	-0.087	0.005	0.117	-0.218	0.870	0.931	1
Recession Period (Dec. 2007- Jun. 2009)								
corn cash (C)	1							
corn futures (c)	0.995	1						
oil cash (O)	0.911	0.921	1					
oil futures (o)	0.917	0.927	0.998	1				
USD/RMB (e)	-0.026	-0.050	-0.260	-0.237	1			
Gulf to Japan (G)	0.800	0.817	0.937	**0.932**	-0.474	1		
PNW to Japan(P)	0.768	0.785	0.915	**0.909**	-0.557	0.974	1	
BDI (B)	0.718	0.747	0.884	**0.878**	-0.580	0.975	0.977	1

The Spot and Futures Market Prices



- During financial crisis period, market estimates of implied volatility of prices ***increased*** dramatically

RESULTS

Monthly Average Hedge Performance (Full Sample)

	Utility	Variance	Effectiveness (%)
Unhedged	-529	37047.28004	-
Portfolio 1: using only corn futures contracts			
Naïve	-531.1756	36555.7574	1.3267
OLS	-531.1709	36555.2985	1.3279
VECM-DCC-MGARCH	-531.1802	36547.9953	1.3476
Portfolio 2: using both futures contracts: corn and oil			
Naïve	-527.96	36974.9826	0.1951
OLS	-527.9698	36967.0607	0.2165
VECM-DCC-MGARCH	-527.5866	37025.9951	0.0574

Monthly Average Hedge Performance (Financial Crisis of 2007-2008)

	Utility	Variance	Effectiveness (%)
Unhedged	-692.7047	15915.13449	-
Portfolio 1: using only corn futures contracts			
Naïve	-701.3631	15154.7671	4.7776
OLS	-701.3242	15145.8803	4.8334
VECM-DCC-MGARCH	-701.422	15169.1492	4.6872
Portfolio 2: using both futures contracts: corn and oil			
Naïve	-672.838	10844.2856	31.8618
OLS	-672.9272	10849.3889	31.8297
VECM-DCC-MGARCH	-672.1316	10880.7847	31.6324

- The cross hedging effectiveness have ***increased*** considerably compared to traditional hedging in corn futures markets alone.
- In general, hedging effectiveness is ***increasing*** in hedging horizon.

Daily Average Hedge Performance (Full Sample)

	Utility	Variance	Effectiveness (%)
Unhedged	-520.1704	38267.4583	-
Portfolio 1: using only corn futures contracts			
Naïve	-520.2842	38242.1491	0.0661
OLS	-520.284	38242.1882	0.0660
VECM-DCC-MGARCH	-520.4068	38215.6754	0.1353
Portfolio 2: using both futures contracts: corn and oil			
Naïve	-520.119	38335.7995	-0.1785
OLS	-520.1195	38334.9772	-0.1764
VECM-DCC-MGARCH	-520.2798	38276.7313	-0.0242

Daily Average Hedge Performance (Financial Crisis of 2007-2008)

	Utility	Variance	Effectiveness (%)
Unhedged	-727.0452	14067.0037	-
Portfolio 1: using only corn futures contracts			
Naïve	-727.5433	14027.1098	0.2836
OLS	-727.541	14026.8492	0.2854
VECM-DCC-MGARCH	-727.5525	14028.2942	0.2751
Portfolio 2: using both futures contracts: corn and oil			
Naïve	-725.8237	13952.2635	0.8156
OLS	-725.8294	13951.5784	0.8205
VECM-DCC-MGARCH	-726.1999	13939.5331	0.9061

CONCLUSIONS

- The ***naïve*** hedge strategy is compared to the ***OLS*** hedge ratio estimation and the ***VECM-DCC-multivariate-GARCH*** method.
- Explicit modeling of the time-varying in hedge ratios using all derivatives, and taking into account dependencies between different, yet related markets, results in reduction in risk especially during ***financial crisis period***.
- This process can be replicated on the U.S. export traders, which remain without suitable commodity-specific export indices to provide the foundation for new contracting methodologies and hedging instruments.

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