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Sino-U.S. Price Transmission in Agricultural Commodities: How Important are Exchange Rate Movements?

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ABSTRACT

Commodity price transmissions between China and the U.S. are examined. The results indicate that variations in Chinese cotton and soybean prices are transmitted to U.S. cotton and soybean prices while variations in Chinese wheat and rice prices do not get transmitted to U.S. wheat and rice prices. The effects of volatilities in oil prices and in the exchange rate on the price transmission are also assessed.

Key words: rice, soybean, cotton, wheat, China, U.S., price transmission, exchange rate

JEL code: Q11; Q17

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Introduction

Global market prices for grains, oilseeds and cotton have risen sharply to historic highs in the last couple of years. Both demand (e.g. population growth and shifts in consumer preferences) and supply-side (e.g. biofuels production, adverse weather conditions and production cost increases) factors account for these price spikes (Trostle 2008; Headey and Fan 2008).[1] The emerging roles of China and India in world trade and as economies with rising incomes seem conspicuous to almost all who participate in the rising commodity price debate. With increased trade volumes arising from globalization, the debate on the link between globalization and prices has been resurrected (Kamin et al 2004; Chen et al 2004; Pain et al 2006; Ball 2006; Ihrig et al 2007; Sibert 2007). If markets are efficient and policies do not obscure world trading, changes in the world price of any given commodity should be similarly reflected in changes in domestic prices – known as "price transmission". In reality, however, local prices may not change as expected in response to movements in the world market, owing to border measures, domestic price policies, fluctuating exchange rates, transport costs, and market imperfections (Mundlak and Larson 1992; Keats et al 2010). With impediments to the price transmission mechanism, recent episodes of rising world prices in grains, oilseeds and cotton were mirrored in clear, significant albeit subdued increases in corresponding domestic prices in both developing and developed countries (Dawe 2008; Delille 2008; Minot 2010; Cudjoe et al 2009; Keats et al 2010). The magnitudes of transmission, generally indicative of incomplete price transmission, vary across crops and countries.

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[1] In the long-run, however, inflation is determined by monetary policy.

And with prices closely linked with increasing trade, the relative importance of the exchange rate in the price transmission mechanism has also been amplified (Mihaljek and Klau 2001; Vigfusson et al 2007; Bussiere and Peltonen 2008; Charlebois and Hamman 2010; Auer 2011). Exchange rate movements affect the relative prices of tradable goods between countries. Imports are denominated in foreign currency and they need to be converted to local currency. In the conversion, differing bilateral exchange rates affect the relative prices of tradable goods across different sources. An importing country with a stronger currency can now import more foreign currency-denominated commodities for the same amount of local currency as before. These cheaper imports compete with similar goods produced domestically (importables). Eventually, competition will drive down prices and lead to lower inflation in the importing country (Rogoff 2006; Kohn 2006).

The literature on exchange rates and U.S. agricultural prices is rife. While most studies attest to a significant effect of exchange rates on prices of commodities (Johnson et al 1977; Collins et al 1980; Chambers and Just 1981; Chambers 1984; Longmire and Morey 1983; Orden and Fackler 1989; Bradshaw and Orden 1990; Denbaly and Torgerson 1992; Dorfman and Lastrapes 1996; Miljkovic et al 2003; MacDonald and Seeley 2007; Charlebois and Hamman 2010), others have argued for a weaker or insignificant effect (Vellianitis-Fidas 1976; Bessler and Babula 1987; Babula et al 1995; Baek and Koo 2010). The results vary with the modeling techniques used, crops examined and the time frame of the studies.

At the heart of the globalization-price debate in the U.S. is China's enlarging involvement in world agricultural trade particularly in the grains and cotton sectors. Among the trading partners of the U.S., China remains the most contentious for two reasons. First, while the U.S. runs large overall trade deficits with China, the U.S. is a net exporter of agricultural products to China. Between 2005 and 2010 China's agricultural imports expanded by a yearly average of 24% valued at $66.4 billion in 2010 (from $25 billion in 2005). 27% of these imports over 2005-10 were sourced from the U.S. China's main agricultural imports are limited to a few agricultural products: soybeans, cotton, hides and skins, dairy, and wool (among others). In 2010, soybeans and cotton accounted for nearly half of China's agricultural imports with corresponding shares of 38% and 9%; remaining items each had less than 10% share. China's imports from the U.S. are even narrower: soybeans (63%), cotton (11%), hides and skins (5%) and processed animal feed (5%) make up 84% of the China's total import bill from the U.S. in 2010; imports of grains particularly rice, wheat, barley and corn make up less than 2%. In 2010, about 15% of U.S. agricultural exports went to China. In the same year, over half (58%) of U.S. exports of soybeans and more than a third (38%) of U.S. cotton exports made their way to Chinese markets in the same year. From 2005-10, China's agricultural exports rose by 13% from $19.6 billion in 2005 to $35.7 billion in 2010. While only 9% of China's agricultural exports are destined for the U.S., the U.S. is the fourth largest export market for China's agricultural exports trailing Japan, EU-27, and Hong Kong (USITC 2011).

Second, China's exchange rate policy is a managed float that mutes the adjustment of exchange rates to world prices. China maintained a fixed exchange rate of roughly 8.3 renminbi (RMB) per U.S. dollar from 1996 to 2005. In July 2005, the exchange rate was allowed a minor initial revaluation of 2.1% and subsequently under a managed float that allowed a movement of up to +/-0.3 in bilateral exchange rates within any given day (Frankel and Wei 2007). Notwithstanding a series of revaluations, the renminbi is still extensively viewed as undervalued (U.S. Department of the Treasury 2010; IMF 2010; Subramanian 2010; U.S. Department of the Treasury 2011). As such, Chinese exports remain relatively inexpensive and U.S. exports to

China continue to be relatively expensive. Further revaluations (depreciation of the U.S. dollar against the RMB) are expected to enhance the price-competitiveness of U.S. agricultural commodities in China (Gale and Tuan 2007).

This article examines two major questions. First, to what extent do variations in Chinese soybean, corn, wheat, and cotton prices get transmitted to corresponding U.S. prices? Second, does the RMB to dollar exchange rate play a significant role in altering U.S. prices for the same set of commodities? In the next sections, the data, methodology, results and conclusions are discussed, in turn.

Data

The data used in the study were collected from different sources. U.S. cotton, soybean, corn, and wheat prices were collected from Index Mundi. The U.S. refiner acquisition cost of crude oil was from the U.S. Energy Information Administration. Chinese cotton prices were provided by the China Cotton Association. Chinese soybean, corn and wheat prices were sourced from the China National Grain and Oils Information Center. The data ranges from January 2002 to December 2010 following China's accession to the WTO in December 2001 - a total of 108 observations. All regressions and tests were performed using STATA.

Table 1 presents descriptive statistics on the price variables including the mean, variance, skewness, and kurtosis. Under assumption of normality, skewness and kurtosis have asymptotic distributions of N (0,6/T) and N (3,24/T) where T is the number of observations (Xu 1999, 143). The skewness/kurtosis tests suggest that empirical distributions of the four prices in China and in the U.S. deviate from a normal distribution. The positive skewness indicates that none of the distributions are symmetric and the positive kurtosis indicates that all the distributions are leptokurtic compared to a normal distribution. Judging from the test statistics including the chi-squared statistic from the test of normality, the distribution of cotton prices tends to be less normal than the distributions for soybeans, wheat and corn.

Methodology

In this section, we present the empirical framework to measure price and exchange rate linkages between China and the U.S. We analyze how much of the fluctuations in China's domestic commodity prices, and exchange rate are transmitted to U.S. commodity prices. To specify the price transmission model, the vector error correction model (VECM) developed by Engle and Granger (1987) is used in order to establish any long-run equilibrium relationship between the U.S. and Chinese price variables and to identify the short-run dynamics between these prices. We examine the time series properties of each of the price variables and use the Augmented Dickey-Fuller (ADF) test (Fuller, 1976) to characterize any mean-reversion in the series. Subsequently, the order of integration of each of the commodity prices is determined. Guided by these orders of integration, VECMs or vector autoregressions (VARs) are specified and estimated. Although there are several criteria available in the literature (Ivanov and Kilian 2005), the VECM and VAR models were run based on lag lengths based on the Akaike Information Criterion (AIC).

In order to analyze the degree of intertemporal interactions of price and exchange rate time series, we examine their volatilities and carry out ARCH-LM tests; the vector exponential generalized autoregressive conditional heteroscedastic (VEGRACH) specification is used to accommodate time-varying conditional variances. Engle (1982) introduced the ARCH (autoregressive conditional heteroskedastic) model where the variance forecast of UK inflation was updated with the most recent squared residuals in the market. Bollerslev's (1986) extension of this model allowed for the forecast of market volatility to depend on updates of both the squared residuals as well as of previous forecasts - the GARCH (generalized ARCH) model. While the GARCH specification has gained widespread acceptance in the econometric literature, it does not explain the asymmetric impact of good and bad news on the behavior of volatility. In fact, in ARCH and GARCH models, it is assumed that only the magnitude and not the sign of the unexpected shock may determine the future volatility pattern. Such specification is not in line with empirical findings. To model the asymmetric effects of price shocks on the conditional variance between U.S. and Chinese commodity prices, the exponential GARCH (EGARCH) model is specified (Nelson 1991):

(1) $$\Phi(L)(x_t - u_0) = \Theta(L)\varepsilon_t$$

where x_t is the column vector of Chinese domestic commodity prices, the U.S. domestic commodity prices, and the RMB to the dollar exchange rate. ε_t is the column vector of innovations, which, under the assumption of a Gaussian distribution, has a mean zero and a standard deviation of $h_t^{1/2}$ conditional on information set up to time *t-1*. Let z_t be of standard Normal distribution; each variance is assumed to follow an EGARCH process of Nelson (1991):

(2) $$\ln h_t = \varpi_0 + \alpha(L) g(z_t) + \beta(L) \ln h_t$$

(3) $$g(z_t) = \theta_1 z_t + \theta_2 [z_t - EZ_t]$$

In equation (3), h_t will be covariance stationary if θ_1, θ_2 do not both equal zero, and positive definite for all t ; β reflects positive/negative influences of volatilities on U.S. domestic commodity prices.

Results

Price Transmission Between China and the U.S.

Table 2 presents the ADF results for both levels and first differences of the variables. The hypothesis tests are based upon the comparison of calculated statistics with the critical McKinnon (1991) statistics. Based on the critical values calculated from McKinnon (1991), unit roots cannot be rejected for all the price series in levels at the 5 percent significance level, but the unit root hypothesis was rejected for all the price series in first differences at the same significance level. The presence of unit roots in the price series indicates that there may exist a long-run relationship among such price series. We confirm this by performing a test of cointegration on the price series. If cointegration is found, this implies that a stable long-run relationship holds among the price series and that short-run dynamics among the prices are represented within an error correction model. If, on the other hand, there is no evidence of cointegration, then the first difference VAR estimation is appropriate. Cointegration is tested using Johansen's maximum likelihood procedure (Johansen, 1988). The rank of $\theta(r)$ equals the number of cointegrating vectors which is tested by the maximum eigenvalue and trace test statistics. The critical values for these statistics are obtained from Johansen (1988) and Johansen and Juselius (1990). The null hypothesis is that there are r or fewer cointegration vectors. The alternative hypotheses are $r+1$ and at least $r+1$ cointegration vectors for the maximum eigenvalue and trace statistics, respectively. As shown in Table 3, the trace test rejects the null hypothesis of zero cointegrating vectors ($H_0=0$) at the 5 percent significance level but fails to reject the null hypotheses $r=1$ for soybean and wheat prices. However, the null hypothesis of zero cointegrating vectors cannot be rejected at the 5 percent significance level for corn and cotton prices.

After having confirmed that the price series are indeed first-difference stationary and cointegrated for soybeans and wheat prices, we estimate the error correction models. All inference in this analysis is based on robust or quasi-maximum likelihood estimates of standard errors. Such estimations are robust to symmetric non-Normality in the residuals. STATA uses the full Huber-White sandwich estimator. As opposed to the Bollerslev and Wooldridge (1992) methodology used by Glosten et al. (1993), STATA also calculates the second derivative of the log likelihood function (StataCorp LP 2009). The results are presented in Table 4. The lags used in each equation were pretested by minimum AIC. A significant and negative error correction term in the Chinese cotton, soybeans and corn price equations, and in the U.S. soybeans and wheat equations validate the existence of an equilibrium relationship between U.S. and Chinese soybean prices; this suggests that ignoring the nonstationarity and cointegration of the variables would introduce misspecification in the underlying dynamic structure (Arize 1995). Following the results, a 6% of adjustment towards the long-run equilibrium in the Chinese and U.S. soybean market and 16% of the adjustment towards the long-run equilibrium in the U.S. wheat market occur within the first month.

For both soybean and wheat price equations, parameter estimates are presented along with the standard errors (in parentheses). In the U.S. price equations, only in the soybean equation did the Chinese market price have statistically significant coefficients up to 2 lags (of the difference). This implies that the U.S. soybean price is affected by changes in Chinese domestic prices, but movements in the Chinese domestic prices do not seem to have any significant effect on U.S. wheat prices. On the other hand, Chinese wheat domestic prices are affected by changes in U.S. wheat market prices.

For both cotton and corn price equations, parameter estimates based on first differenced VAR specifications are presented in Table 5. The Chinese market price is statistically significant in the U.S. cotton price equation at 11 lags while the U.S. price is statistically significant in the Chinese cotton price at one lag, two lags, and 4 lags. For the corn price equations, the U.S. market price is statistically significant at 2 lags and 3 lags in the Chinese corn equation while none of Chinese corn price is significant in the U.S. corn price equation.

Contribution of the Exchange Rate on Price Transmission

To further check whether there is nonlinearity in the variance, an ARCH LM test is performed. The results indicate that there exist ARCH errors in all equations (with corresponding test statistics of 20.68, 46.13, 12.47, and 11.10 for the corn, cotton, soybean, and wheat price equations for the U.S.). Table 6 presents EGARCH results for the four crops based on first differences in both independent variables and dependent variables. The positive and significant coefficients for $L_{1.EARCH\_a}$, $L_{2.EARCH\_a}$, and $L_{3.EARCH\_a}$ imply that the symmetric effects are substantially larger than asymmetric price effects. Time periods with relatively large variances are associated with relatively larger prices. In fact, the relative scales of the two coefficients imply that the symmetric effect completely dominates positive leverage (asymmetric response to market news or information) effects. The symmetric effects of Chinese domestic price shocks on U.S. commodity prices indicate that Chinese price shocks are an indication of imminent international price movements.

Further, the results in Table 6 suggest that changes in oil prices and in the exchange rate bear significant effects on U.S. commodity prices.[2] It appears from the above bivariate

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[2] The correlation between exchange rate and oil prices is 0.2 for the data used in the study.

EGARCH model that the impacts of a higher exchange rate on U.S. commodity prices are positive. A positive response suggests that a Chinese currency appreciation is likely to increase U.S. commodity prices. The results also further confirm that variations in Chinese cotton and soybean prices have significant effects on U.S. cotton and soybean prices while changes in Chinese corn and wheat prices have no corresponding (statistically) significant effects on U.S. prices.

To further check the effects of an exchange rate shock on U.S. commodity prices, we examined the feedback linkages between U.S. commodity prices and Chinese commodity prices given a shock to the exchange rate that can be captured within a VAR or VECM framework. From the Johansen trace tests, only U.S. wheat prices are first-difference stationary and cointegrated with the exchange rate; the other three U.S. commodity prices (soybeans, corn, cotton), while also first-difference stationary are not cointegrated with the exchange rate. As such, we present impulse response functions with respect to an exchange rate shock within the VECM model for wheat (long-run responses of wheat prices to an exchange rate shock) and within the VAR models for soybeans, corn and cotton (short-run responses of prices to an exchange rate shock). The impulse response functions are presented in Figure 1. The results indicate that the effect of a shock to the exchange rate (U.S. $ depreciation relative to the RMB) on U.S. commodity prices are as follows: (a) positive and significant for the first 9 months for U.S. soybean prices and dies out on the 10th month; (b) positive and significant until a year and 4 months later for U.S. cotton; (c) positive, significant and tend to linger longer for U.S. wheat and corn prices. Wheat prices, tend to be affected more permanently than corn prices, although the contemporaneous effect of an exchange rate shock on both corn and wheat are weaker than cotton and soybeans. The results suggest that an exchange rate shock is immediately transmitted to price changes in commodities heavily traded between the U.S. and China, soybeans and cotton. The effects on wheat and corn prices in the U.S. of an exchange rate shock while also immediate, are weaker and tend to linger mainly due to China's less important position in the U.S. and international trade market.

Conclusions and Policy Implications

The transmission of price and exchange rate movements from China to the U.S. appear to be significant, especially for cotton and soybeans. Since China became a WTO member in 2001, China has become one of the major importers of soybeans and cotton in the world. In 2001, China's estimated self-sufficiency rates for cotton, soybeans, corn, and wheat were 96%, 54%, 93%, and 86%, respectively. In 2009, the rates corresponded to 21%, 23% for cotton and soybeans, and 99% for both corn and wheat (PSD 2010). In 2010, over half of U.S. exports of soybeans and more than a third of cotton made their way to Chinese markets. With China almost self-sufficient in corn and wheat, China's weaker presence in the world market for both commodities implies muted responses of U.S. prices on Chinese prices. Under the current trading pattern in agricultural commodities, corn and wheat price increases within China whether induced by cost increases due to factors unique to the local corn and wheat industries or induced by greater demand due to a change in consumer preferences are less likely to affect corn and wheat prices in the U.S. This, however, is not the case for cotton and soybeans.

This paper reinforces the importance of fluctuations in oil prices and in the exchange rate on U.S. commodity prices. The recent quantitative easing (increase in monetary circulation) and the imminent depreciation of the U.S. dollar with respect to the RMB will allow for increased agricultural exports of the U.S. to China. From the impulse response functions, a shock to the exchange rate leaves a positive shorter-run impact on corn, soybeans, and cotton prices. On the other hand, it is interesting to note that a positive shock to the exchange rate leaves a permanent increase in U.S. wheat prices (the effect of the exchange rate shock does not dissipate over time). These results put a cautionary note that exchange rate policies have differential effects across commodities. Finally, the volatility observed in recent months in U.S. commodity prices may have, to an extent, been caused by the volatility in oil prices.

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Table 1. Summary of Basic Statistics

	Unit	Mean	Standard Deviation	Skewness	Kurtosis	Adj. χ^2 test of Normality
Chinese cotton price $P_{ct,cn}$	RMB/lb	77.93	25.39	2.22	10.88	50.94
Chinese soybean price $P_{sb,cn}$	RMB/lb	47.43	14.99	1.08	4.27	17.41
Chinese corn price $P_{cn,cn}$	RMB/lb	19.02	5.38	0.29	1.61	
Chinese wheat price $P_{wt,cn}$	RMB/lb	20.59	5.36	0.19	1.90	19.37
U.S. cotton price $P_{ct,us}$	Cents/lb	65.39	19.11	2.79	14.08	63.3
U.S. soybean price $P_{sb,us}$	Cents/lb	29.70	9.75	0.69	2.55	13.2
U.S. corn price $P_{cn,us}$	Cents/lb	14.16	4.68	0.99	3.34	8.18
U.S. wheat price $P_{wt,us}$	Cents/lb	20.27	6.85	1.40	4.54	23.65
Exchange Rate P_{exh}	\$/RMB	0.13	0.01	0.52	1.51	
U.S. Refiner Acquisition Cost of Crude Oil Price P_{oil}	\$/Barrel	55.34	24.56	0.70	3.26	8.06

Table 2. ADF Unit Root Test (H_0: *unit root*)

		U.S.				**China**			
		Cotton	Soybean	Corn	Wheat	Cotton	Soybean	Corn	Wheat
Level	trend & intercept	-0.48	-2.7	-2.29	-2.32	0.43	-2.27	-2.6	-1.72
	no trend	1.41	-1.62	-0.99	-1.69	1.63	-1.86	-0.04	0.54
	no trend & no intercept	1.67	0.38	0.67	-2.32	2.17	0.21	2.44	3.16
First -difference	trend & intercept	-5.583	-7.178	-8.03	-5.583	-10.68	-8.28	-9.635	-8.586
	no trend	-5.291	-7.206	-8.024	-5.291	-10.467	-8.301	-9.651	-8.516
	no trend & no intercept	-5.088	-7.153	-7.952	-5.088	-10.206	-8.277	-9.069	-7.613
Critical value		*1%*	*5%*	*10%*					
	trend & intercept	-4.04	-3.45	-3.15					
	no trend	-3.51	-2.89	-2.58					
	no trend &no intercept	-2.6	-1.95	-1.61					

Table 3. Johansen Tests for Cointegration: *r(1)*

	Chinese Cotton		Chinese Soybean		Chinese Corn		Chinese Wheat	
	Eigenvalue	Trace Statistic	Eigenvalue	Trace Statistic	Eigenvalue	Trace Statistic	Eigenvalue	Trace Statistic
U.S. Cotton (H_0: $r=0$)	0.001	13.45 (18.17)						
U.S. Soybean (H_0: $r=1$)			0.12	0.34 (3.76)				
U.S. Corn (H_0: $r=0$)					0.11	12.17 (15.41)		
U.S. Wheat (H_0: $r=1$)							0.03	3.29 (3.76)

Note: Table indicates that soybean and wheat are cointegrated: *r(1)*, cotton and corn: *r(0)*, critical values in the parentheses .

Table 4. Vector Error-Correction Model for Soybean and Wheat Prices

	Soybeans		Wheat	
	$\Delta P_{sb.cn}$	$\Delta P_{sb.us}$	$\Delta P_{wt.cn}$	$\Delta P_{wt.us}$
ΔP_{cn} (-1)	0.02 (0.10)	-0.05 (0.07)	0.11 (0.11)	0.72 (0.41)
ΔP_{cn} (-2)	0.14 (0.09)	0.20* (0.07)	0.05 (0.11)	-0.16 (0.42)
ΔP_{cn} (-3)			0.09 (0.11)	-0.17 (0.42)
ΔP_{cn} (-4)			0.14 (0.11)	-0.23 (0.42)
ΔP_{cn} (-5)			0.02 (0.11)	0.23 (0.42)
ΔP_{us} (-1)	0.23 (0.14)	0.32* (0.10)	0.04 (0.03)	0.35* (0.10)
ΔP_{us} (-2)	0.64* (0.15)	0.05 (0.10)	0.004 (0.03)	-0.15 (0.10)
ΔP_{us} (-3)			0.008 (0.03)	0.25* (0.10)
ΔP_{us} (-4)			0.02 (0.03)	-0.12 (0.10)
ΔP_{us} (-5)			-0.003 (0.03)	0.38* (0.10)
Z_{cn} (-1)	-0.06* (0.03)		-0.001 (0.01)	
Z_{us} (-1)		-0.06* (0.02)		-0.16* (0.05)
Adj. R^2	0.34	0.27	0.25	0.31

*Significant at 10% level of significance. Standard error in parentheses.

Table 5. VAR model for Cotton and Corn Prices

	Cotton		Corn	
	$\Delta P_{ct.cn}$	$\Delta P_{ct.us}$	$\Delta P_{corn.cn}$	$\Delta P_{corn.us}$
ΔP_{cn} (-1)	-0.67*	0.08	-0.03	0.10
	(0.15)	(0.09)	(0.09)	(0.19)
ΔP_{cn} (-2)	0.37	0.06*	-0.04	-0.01
	(0.21)	(0.13)	(0.09)	(0.19)
ΔP_{cn} (-3)	-0.39	0.03	0.01	-0.15
	(0.21)	(0.13)	(0.09)	(0.19)
ΔP_{cn} (-4)	0.25	0.10		
	(0.19)	(0.12)		
ΔP_{cn} (-9)	-0.20	-0.16		
	(0.19)	(0.13)		
ΔP_{cn} (-11)	0.02	0.26*		
	(0.20)	(0.12)		
ΔP_{us} (-1)	0.86*	0.42*	0.04	0.20*
	(0.20)	(0.12)	(0.05)	(0.10)
ΔP_{us} (-2)	0.46*	0.04	0.09*	0.08
	(0.24)	(0.12)	(0.05)	(0.10)
ΔP_{us} (-3)	-0.33	0.001	0.22*	0.15
	(0.23)	(0.15)	(0.05)	(0.10)
ΔP_{us} (-4)	0.48*	0.07		
	(0.23)	(0.15)		
ΔP_{us} (-9)	0.06	-0.04		
	(0.22)	(0.13)		
ΔP_{us} (-11)	0.33	0.12		
	(0.22)	(01.4)		
Adj R^2	0.37	0.37	0.25	0.31

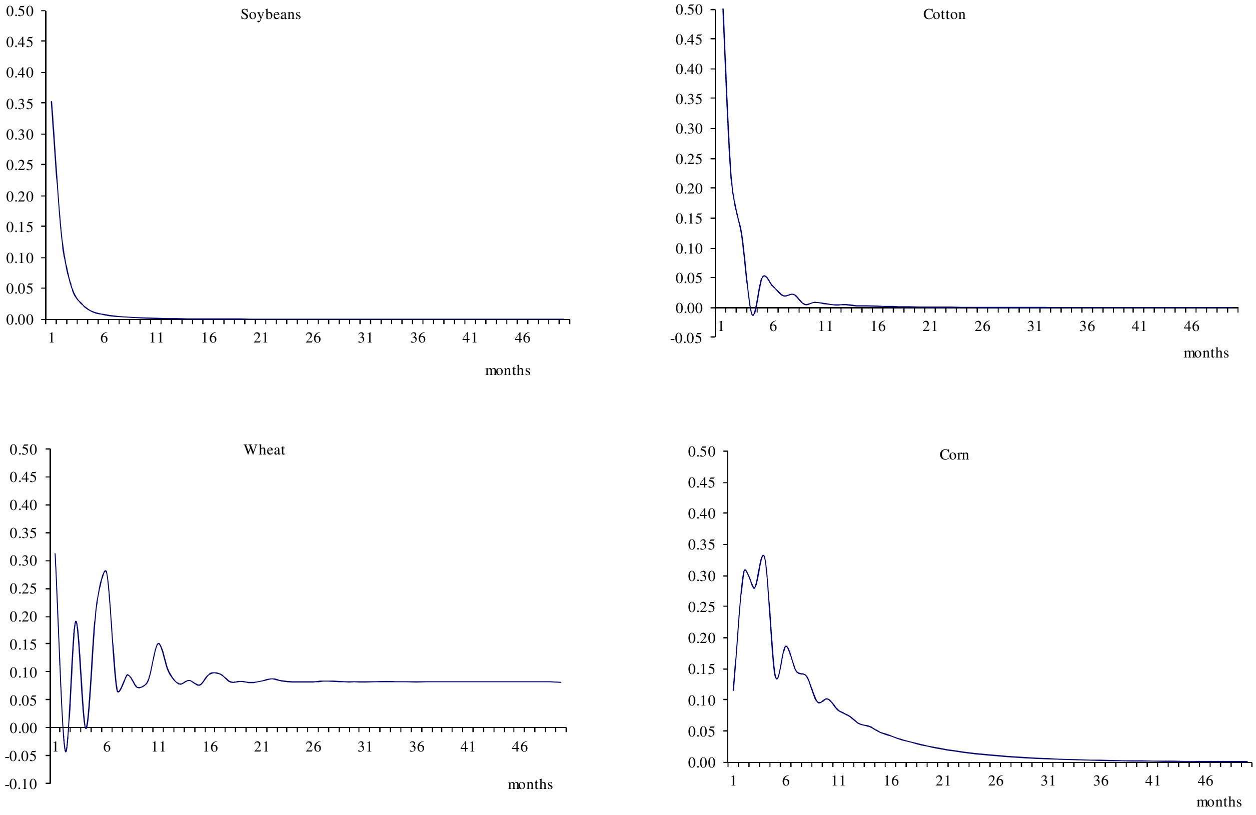
*Significant at 10% level of significance. Standard errors in parentheses.

Table 6. Parameter estimates of the EGARCH specification

	$\Delta P_{ct.us}$	$\Delta P_{sb,.us}$	$\Delta P_{cn.us}$	$\Delta P_{wt.us}$
constant	-0.09	0.20	-0.03	0.01
	(0.24)	(0.19)	(0.10)	(0.10)
ΔP_{cn}	0.47*	0.08*	-0.12	0.17
	(0.06)	(0.04)	(0.15)	(0.19)
ΔP_{oil}	0.11*	0.08*	0.09*	0.04*
	(0.04)	(0.04)	(0.01)	(0.02)
ΔP_{exh}	841.41*	874.10*	256.80*	507.08*
	(520.68)	(281.37)	(131.47)	(234.40)
$L_{1.EARCH}$	-0.11	0.09	0.11	-0.19
	(0.13)	(0.15)	(0.18)	(0.16)
$L_{2.EARCH}$	0.34	-0.16		-0.10
	(0.18)	(0.16)		(0.16)
$L_{3.EARCH}$	-0.24			0.25
	(0.23)			(0.23)
$L_{1.EARCH\_a}$	0.66*	0.55*	1.04*	0.55*
	(0.14)	(0.20)	(0.29)	(0.23)
$L_{2.EARCH\_a}$	1.06*	0.93*		1.24*
	(0.22)	(0.24)		(0.20)
$L_{3.EARCH\_a}$	-0.14			0.89*
	(0.28)			(0.21)
Likelihood	-278.49	-219.24	-143.00	-188.70

*Significant at the 10% level of significance. Standard errors in parentheses.

Figure 1. Impulse response functions (IRF) of U.S. commodities to an exchange rate (US$/RMB) shock



Soybeans

Cotton

Wheat

Corn