The Net Effect of Exchange Rates on Agricultural Inputs and Outputs

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Introduction

For more than thirty years, studies about the effect of the exchange rate on exports have been conducted. However, few have considered the combined effect of the exchange rate on imported inputs into the agricultural system and the exports of final agricultural products those inputs produce. A current concern is for the net effect as the total value and quantity of inputs imported has increased. This research examines the effect of the exchange rate on imported inputs into the corn, wheat, and beef cattle production systems, breaking it down to a producer's budget, examining how the exchange rate affects profitability.

Objectives

1. Determine the net effect the exchange rate has on the corn, wheat, and feeder steers production systems
2. Determine if the impact of the exchange rate has increased over time

Methodology

- A Vector Autoregression (VAR) was estimated to model the relationship between the variables and the exchange rate
- Corn, Wheat, and Feeder Steers system variables included:
  - Exchange Rate
  - Diesel
  - Ethanol
  - Ammonia
  - Urea
  - DAP
- After the initial tests for stationarity, need for seasonal harmonic and dummy variables, and block exogeneity the data was split into two time periods.
- This decision was based upon the idea that a structural change in the commodity markets had occurred. The early period was from 1997-2006 and the late time period was from 2007 until the end of the data in March 2011.
- The Schwarz Bayesian Criterion (SBC) and Likelihood Ratio Test were used to indicate lag length of variables in the equation.

$$SBC: (-2\ln(L))/T + (n\ln(T))/T$$

Where n = number of parameters estimated, T = number of usable observations, L = maximized value of the multivariate log likelihood function.

$$\text{Likelihood Ratio Test: } (T-c)(\ln|\Sigma r| - \ln|\Sigma u|)$$

Where T = number of observations, c = number of parameters estimated in each equation of the unrestricted system, $\ln|\Sigma r|$ = the natural logarithm of the determinant of Σr, the restricted system, $\ln|\Sigma u|$ = the natural logarithm of the determinant of Σu, the unrestricted system.

Methodology (continued)

- The indicated lag length structure between the SBC and the Likelihood Ratio Test were incongruous. Therefore, a Bayesian Averaging of Classical Estimates (BACE) model was estimated.
- A BACE model comes from the approach that there is not a "true" model. It attaches probabilities to different possible models, in this case, different lag lengths.

Posterior Probability for ith model: $p(M_i \mid y) = \dfrac{p(M_i)p(y \mid M_i)}{\sum_{j=1}^{N} p(M_j)p(y \mid M_j)}$

Where $p(M_i)$ is the prior probability on the ith model and $p(y \mid M_j) = \int L(y, \theta_j)p(\theta_j \mid M_j)d\theta_j$ is the integrated likelihood of model j.

- Following the estimation of the posterior probability, the mean of the quantity of interest, which is the price response to an exchange rate shock, was calculated.

Mean of Quantity of Interest: $E[\eta(\hat{\Theta}) \mid y] = \sum_{i=1}^{2^K} p(M_i \mid y)\eta_i(\hat{\Theta}_i \mid y, M_i)$

Where $\eta_i(\hat{\Theta}_i \mid y, M_i)$ is the quantity of interest calculated from the estimated parameter vector $\hat{\Theta}_i$ emanating from model i.

Analysis and Results

Table 1. BACEMean of Quantity of Interest for a 1% shock in Exchange Rate on Various Agricultural Inputs and Outputs, 1997-2008

Early* Corn	-2.2912
Late Corn	-4.5031
Early Wheat	-1.8468
Late Wheat	-4.4829
Early Feeder Steers	0.0518
Late Feeder Steers	-0.5643
Early Diesel	-2.1758
Late Diesel	-8.2424
Early Ammonia	-2.0791
Late Ammonia	-5.2771
Early DAP	-0.5868
Late DAP	-1.8412
Early Urea	-1.1190
Late Urea	-4.8905
Early Ethanol	0.4007
Late Ethanol	-1.7465

* The early period means 1997-2006. The late period is 2007-2011.

- The posterior probabilities heavily favored the models with a lag length structure of one. The probabilities for models of all other lag lengths was very near zero and rapidly declined as additional lags were added.
- Because the posterior probability favored the models with a lag length structure of one the mean of the quantity of interest was equal to the cumulative response to the exchange rate shock of one standard deviation.
- Table 8 contains the responses by each variable to a 1% increase in the value of the exchange rate. The results can be interpreted as, for example, a corn producer in the early time period would observe a 2.29% decline in the price of corn for a 1% increase in the value of the exchange rate.
- An increase in the exchange rate lead to a decrease in the prices of for all variables in both time periods, except for the early period of the feeder steers and ethanol. However, the positive effect observed is very small in feeder steers.
- Between the early and late time periods the effect of the exchange rate increased on all variables. One hypothesized reason could be that expected effects of exchange rates might be more quickly incorporated by commodity market traders.
- Table 9 contains an example of the effect of a one percent increase in the value of the exchange rate on the corn, wheat, and feeder steers production systems. The examples are for one year during the early time period and one year during the late.

- The prices of corn and wheat are the average price received by U.S. producers in December and July, respectively, during those years. Feeder steers price is the average price during March of those years. Texas Agrilife Extension cost of production budgets were used in the estimation of these examples as well.
- The examples are as follows, the prices of the corn, wheat, and feeder steers systems experience the effect of a one percent increase in the exchange rate. An approximate profit per bushel or cwt is calculated and compared to an approximate profit before the increase in the exchange rate to demonstrate the net effect that a one percent increase in the exchange rate has on profit.
- In 1999, a one percent change cause a decrease of $0.04/bu profitability for corn and in 2009 the decrease in profitability was $0.13. For a producer who harvests 10,000 bushels of corn the decrease in profit is $400 and $1,300 in the two time periods.
- In wheat, the one percent change cause a $0.02/bu decrease in profitability for both the early and late time period.
- There was an increase of $0.06/cwt in the feeder steers system in 1999, with a decrease of $0.56/cwt in 2009. A producer selling a 550 pound feeder steer would realize a decrease in profitability of $3.08 per head, which on a truckload of steers would sum to a decrease in profit of $215.60. These examples demonstrate the claim that has been made for many years; a stronger U.S. dollar hurts agricultural producers.

Analysis and Results (continued)

Table 2. The Net Effect of Exchange Rate Shocks on Corn, Wheat, and Feeder Cattle Production Profits

	Before Shock	After Shock
1999 Corn, $/bu		
Corn	$1.82	$1.78
Ammonia	-$0.12	-$0.11
DAP	-$0.07	-$0.07
Urea	-$0.08	-$0.08
Diesel	-$0.02	-$0.02
Net Effect	**$1.52**	**$1.48**
2009 Corn, $/bu		
Corn	$3.60	$3.44
Ammonia	-$0.24	-$0.23
DAP	-$0.42	-$0.41
Urea	-$0.28	-$0.27
Diesel	-$0.02	-$0.02
Net Effect	**$2.63**	**$2.50**
1999 Wheat, $/bu		
Wheat	$2.22	$2.18
Ammonia	-$0.42	-$0.41
Diesel	-$0.18	-$0.18
Net Effect	**$1.81**	**$1.68**
2009 Wheat, $/bu		
Wheat	$5.17	$4.94
Ammonia	-$3.46	-$3.28
Diesel	-$0.38	-$0.35
Net Effect	**$1.33**	**$1.31**
1999 Feeder Steers, $/cwt		
Feeder Steers	$96.16	$96.21
Diesel	-$0.30	-$0.29
Net Effect	**$95.88**	**$95.92**
2009 Feeder Steers, $/cwt		
Feeder Steers	$113.93	$113.29
Diesel	-$0.91	-$0.83
Net Effect	**$113.02**	**$112.46**

- In interpreting the results it important to consider the amount by which the exchange rate varies over time. Over the 14 year period, there was a 37% change in the exchange rate from the minimum to the maximum value.
- The average percentage change in the index value was 0.2%, with only 27 changes with a value greater than one percent out of 3,679 observations.
- Most producers do not buy and sell their final products and inputs everyday. More often, only a few times a year.

Summary and Conclusions

1. The correlation between the exchange rate and all studied variables increased over the time period studied.
2. A positive increase in the value of the exchange rate generally lead to a negative net effect on the profit levels of the corn, wheat, and feeder steers systems.
3. The increasing dependence on imported inputs has not reached a level where the positive effects of exchange rate shocks on output price are overwhelmed by the negative effect on input prices.
4. Agricultural producers should not be overly concerned about a lower valued dollar from the perspective of their agricultural business.