

Center for Agricultural Policy and Trade Studies  
North Dakota State University

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**AGRICULTURAL POLICY BRIEF**

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No. 18

June 2008

**Impacts of Corn-based Ethanol Production on  
Prices of Agricultural Commodities**

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Industrial use of corn has increased dramatically during the past two decades. The most recent increases are due to increasing ethanol production since 2005. In addition, high fructose corn syrup (HFCS) production, used as a substitute for sugar in the soft drink industry, caused a major increase in demand for corn during the 1980s, utilizing 500 million bushels of corn per year. These two non-traditional uses of corn consume almost 40% of the current U.S. corn crop.

Significant growth in ethanol production is likely to continue given recent federal legislation mandating increased ethanol use. The Energy Security Act of 2005 includes a renewable fuel standard that requires annual U.S. ethanol and biodiesel consumption to total 7.5 billion gallons by 2012. Ethanol production has more than doubled since 2004 to meet this goal. Further, the Energy Independence and Security Act (EISA) of 2007 sets a high renewable fuel standard (RFS) which requires fuel producers to use at least 36 billion gallons of bio-fuels by 2022. The Act requires 9 billion gallons of conventional bio-fuels to meet the standard in 2008, 13.2 billion gallons by 2012, and 15 billion gallons by 2015. As a result of this increased demand, a number of plants are being completed. The current ethanol production capacity is 7.9 billion gallons and an additional capacity of 5.5 billion gallons is under construction in the United States. As a result of the increased corn-based ethanol production, the price of corn has increased from \$1.90 in 2005 to \$3.97 in 2007. The futures price of corn for December 2008 delivery is \$5.88. The price increase could have significant effects on prices of other commodities as well as the U.S. economy. This paper, therefore, attempts to examine the impact of the corn-based ethanol production on corn price and prices of other agricultural commodities.

**Impacts of increased corn price on price of wheat and soybeans**

Since corn is competing with soybeans and wheat for crop land, an increase in corn price would increase the prices of soybeans and wheat. The price relationships among the three crops are shown in Figure 1. A fundamental question is what would be the prices of soybeans and wheat when corn price increases to the long-run equilibrium price of corn with corn-based ethanol production. To examine the relationship, econometric models, in which the price of soybeans or wheat is a function of the price of corn, are developed. The data used for this estimation were obtained from the ERS/USDA. The estimated equations for soybeans and wheat prices with annual time series data from 1980 to 2007 are as follows;

$$PS_t = 2.09 + 1.60PC_t + 0.80DY_t \quad (1)$$

(3.18) (7.27) (1.86)

$$R^2 = 0.73$$

$$PW_t = 0.33 + 0.93CP_t + 0.39CP_{t-1} + 0.59e_{t-1} \quad (2)$$

(0.46) (4.35) (2.12) (1.96)

$$R^2 = 0.75$$

where PS is the price of soybeans, PC is the price of corn, DY is a dummy variable for 2005 when China increased soybean imports from the U.S. substantially, PW represents the price of wheat, and  $e_{t-1}$  is a lagged error term to adjust the first order serial correlation. The numbers in parentheses are t-statistics of the corresponding variables.

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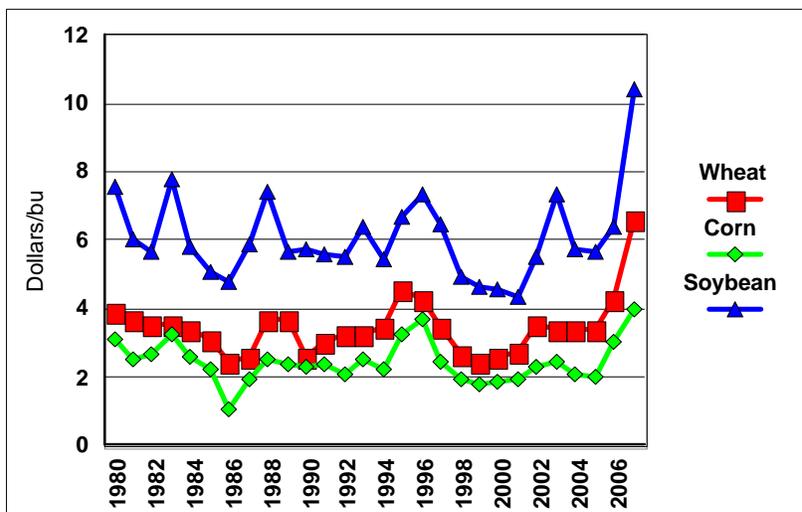


Figure 1. U.S. Wheat, Corn, and Soybean Prices

The t-statistics indicate that the corn price variables for both equations are significantly different from zero at the one percent significant level, implying that the corn price is significantly correlated to the price of wheat or soybeans. The  $R^2$ s are 0.73 for soybean equation and 0.75 for wheat equation, indicating that 73% and 75% of changes in soybean and wheat prices are explained by the price of corn. This implies that the remaining portion can be explained by other factors such as crop rotation, regional weather conditions, and international impacts.

The breakeven price of corn for ethanol production is considered as a long-run price of corn under an assumption that demand for corn for ethanol production is a main force affecting the price of corn in the near future. The breakeven price of corn for profitable ethanol production is \$4.52 per bushel of corn with production subsidy of \$0.51 per gallon of pure ethanol and assumed price of gasoline at \$2.50 per gallon, according to a study completed in Iowa State University. Given the breakeven price of corn, the long run prices of soybeans and wheat can be calculated from the equations 1 and 2. The prices of soybeans and wheat calculated from the equations are \$13.66 per bushel and \$6.29 per bushel, respectively. It should be noted that these prices are obtained from the price of corn under normal marketing and weather conditions.

The increased prices of corn, wheat and soybeans are generally favorable for producers in the agricultural sector in the short run. However, a surge in farm income has contributed to increases in land value and cash rent, and prices of chemicals and fertilizers, and prices of farm equipment, eventually resulting in the increase in production costs of the crops in the long run. In North Dakota, land price has increased about 53% from \$425 per acre to \$650 per acre since 2003 (NASS). The price of chemicals, fertilizer, and farm equipment also have increased in a similar proportion. This clearly indicates that even though there is a substantial increase in the price of agricultural commodities, the net farm income in the future would be much smaller than the net farm income realized in 2007.

On the downside, the increased price of the agricultural goods has increased production costs of livestock in the U.S. and this trend will continue in the near future. This will make the U.S. livestock sector less competitive in the U.S. and foreign markets. The U.S. may import more beef and reduce its exports to major importing countries, mainly because of higher production cost due to increased prices of agricultural commodities.

In addition, increased price of agricultural commodities could attribute to an increase in the retail price of food. The food price index has increased more than the inflation rate for the last three years. Inflation in the U.S. food sector may affect the U.S. economy negatively.

### Impacts on the U.S. sugar industry

The price of corn is also highly correlated with the price of HFCS. Figure 2 shows the two prices for the last three decades. In 2008, however, the trend has reversed; the price of HFCS is higher than the whole sale price of sugar in the U.S. Since the price of HFCS has been lower than the price of sugar until 2007, there has been a major increase in demand for HFCS. The U.S. soft drink industry switched from sugar to HFCS for beverage production in 1980s. In addition, it has been general knowledge that Mexico will import HFCS from the U.S. under the full implementation of NAFTA and use it to produce beverage and export its surplus sugar to the U.S.

A question of what is the price of HFCS when the price of corn is equal to the breakeven price of corn for ethanol production (\$4.52/bushel). An econometric model was developed to examine the relationship between the prices of

corn and HFCS. In the model, the price of HFCS is specified as a function of the price of corn. The model was estimated using an econometric technique with the monthly time series data from 1990 to 2007. The estimated model is presented as

$$PH_t = 10.32 + 3.95PC_t \quad (3)$$

(12.64) (12.16)

$$R^2 = 0.612$$

where PH represents the price of HFCS and PC represents the price of corn. The number in the parentheses represents the t-value of the corresponding variable.

The t-value indicates that the estimated coefficient of PC is different from zero at one percent significant level, indicating that the prices of HFCS and corn are highly correlated. The  $R^2$  is 0.612, indicating that 61% of the fluctuations of the price of HFCS can be explained by changes in the price of corn.

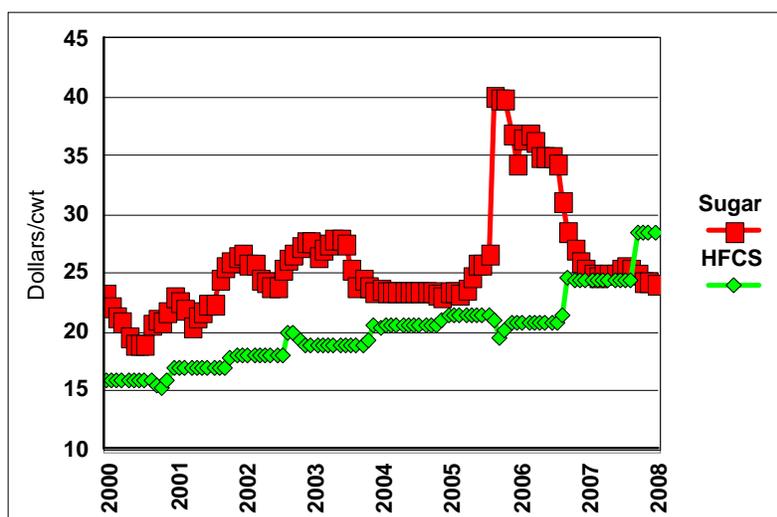


Figure 2. U.S. Wholesale Sugar and HFCS Price

The price of HFCS would be 28.22 cents per pound, assuming that the price of corn remains at \$4.52 in the long run. This price is higher than the wholesale price of sugar in the U.S. If this price difference is sustained in the near future, demand for HFCS may decrease, while consumption of sugar increases. In addition, Mexico may not import HFCS from the U.S. to use for beverage production. In fact, some beverage producers in the U.S. may start to use sugar for beverage production. The increased consumption of sugar could be met by increases in domestic production of sugar and /or imports from major sugar producing countries.

## Conclusion

Increased corn-based ethanol production in the United States has attributed to major increases in corn price as well as the prices of other agricultural commodities, such as soybeans and wheat. The price of HFCS also has increased substantially as a result of increased corn price.

Increased commodity prices has contributed to increases in land values and cash rents, prices of chemicals and fertilizer, and prices of farm equipment, eventually resulting in increases in production costs of the crops in the long run. In addition, increased prices of corn also have increased production costs of livestock in the United States. As a result, the food price index has increased more than the general inflation rate for the last three years.

Increased price of HFCS may affect the U.S. sugar industry positively. In the long run demand for industrial use of sugar may increase if the price of corn remains at the break-even price.