Implications for Soybean & Livestock Producers from Relationships in the Soybean, Soybean Oil and Soybean Meal Markets

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Introduction

Soybeans are the second largest row crop in the U.S. with 82.65 million acres planted in 2015 (USDA-NASS, 2016). In the U.S., soybeans are processed into two primary products: soybean oil and soybean meal. In general, soybean oil is used for human consumption (cooking oil, salad dressings, etc.) and soybean meal as a protein source in animal feeds (poultry, swine and cattle). Soybeans are typically processed into meal and oil through mechanical or solvent extraction. Mechanical extraction involves crushing soybeans to remove oil and denature (heat) the meal to enhance the digestibility for livestock (Ishler, 2016). Solvent extraction uses chemicals, such as hexane, to separate the oil and meal (Ishler, 2016). Most commercial soybean processing plants use solvent extraction to process soybeans and create oil and meal due to greater oil extraction rates, compared to mechanical extraction. The markets for soybeans, soybean oil and soybean meal are interconnected, resulting in strong linkages and price relationships for all three products.

This study examines the monthly average futures price relationships between soybeans, soybean oil and soybean meal and provides estimated crush margins for soybean processors from 2006-2016. Futures price data for soybeans, soybean meal and soybean oil were collected from the Chicago Mercantile Exchange (CME) for 10 years, 2006-2016 (Barchart, 2016).

Global Participants

Roughly half (45.7 percent in the 2015/2016 marketing year) of the soybeans produced in the U.S. are exported; the other half are crushed domestically (USAD-OCE, 2016). Crushing is a common term for the extraction of oil from the raw soybean, producing oil and meal. The global soybean industry is made up of a complex network of buyers and sellers that directly dictate prices that U.S. and global soybean producers receive. Global production and trade of soybeans and soybean products has risen dramatically over the past 10 years (USDA-OCE, 2016). In 2015, global soybean production exceeded 11 billion bushels (Table 1). Global production is dominated by three countries: U.S., Brazil and Argentina, which, combined, produce 83 percent of the world’s soybeans. The U.S. has historically been the largest producer and exporter of soybeans; however, Brazil and Argentina have dramatically increased market shares the past 25 years. For the 2015/16 marketing year, Brazil was estimated to be the leading exporter at 43 percent of global soybean exports, followed by the U.S. at 37 percent and Argentina at 9 percent. Global soybean imports are dominated by China at 64 percent and the E.U. at 10 percent.

Soybean meal and oil are also important import/export products. Major exporters of soybean meal (percent of global market share) are Argentina (48 percent), Brazil (23 percent) and the U.S. (16 percent). The same three countries are also the major exporters of soybean oil: Argentina (50 percent), Brazil (12 percent) and the U.S. (8 percent). Soybean meal imports are dominated by the E.U. at 32 percent and Southeast Asia1 at 25 percent. Soybean oil imports are led by India (34 percent), North Africa2 (16 percent) and China (7 percent).

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1 Indonesia, Malaysia, Philippines, Vietnam, and Thailand.
2 Algeria, Egypt, Morocco, and Tunisia.
The above illustrates that the export supply of soybean and soybean products are controlled by three countries: U.S., Brazil and Argentina. However, import demand is dependent on the commodity or soybean product: soybeans-China, soybean oil-India, and soybean meal-E.U. Supply and demand for all three products are important in determining prices at the CME and the price received by U.S. soybean producers.

**Soybeans**

Nearby soybean futures prices over the past 10 years ranged from a low of $5.37/bu in 2006 to a high of $17.70 in 2012 (Figure 1). Over the 10-year interval evaluated, June and July offered the highest monthly average nearby futures price in four out of the 10 years. June and July never had the lowest monthly average nearby futures price in any of the 10 years analyzed. December nearby futures prices had the highest monthly average nearby futures price two out of 10 years (2007 & 2010) and the lowest monthly average nearby futures price two out of 10 years (2008 & 2011). This was expected as soybeans are not being harvested during these three months and as a result supplies are typically at their tightest. The U.S. typically harvests soybeans from late August through November, and South America (Argentina and Brazil) harvests from February through May (Figure 2). The prices offered during harvest are typically lower than other times of the year due to the large supplies that enter the market. Figure 3 shows the 10-year average monthly price for nearby soybean futures. A strong average monthly price pattern is depicted with prices bottoming out during peak U.S. harvest (October-November) and topping out in June-July.

**Soybean Meal**

Processing soybeans typically results in 18 percent oil and 80 percent meal (exact proportions will depend on soybean characteristics and processing technology utilized [Wisconsin Soybean Association, 2012]). Soybean meal is predominantly used in livestock feed rations as a protein source (about 98 percent of soybean meal produced in the U.S. is utilized in animal feed [Wisconsin Soybean Association, 2012]). Growing global demand for meat (fish, poultry, swine and cattle) has increased demand for soybean meal (Steinfeld, 2006; USDA-OCE, 2016). Generally, the price of soybean meal is correlated to the price of soybeans. Over the 10 years analyzed, the nearby futures price of soybean meal ($/ton) divided by the price of soybeans (cents/bu) was 0.3 with a range of 0.24 to 0.40. Soybean meal futures have varied dramatically the past 10 years from a low of $156.7/ton in 2006 to a high of $548.1/ton in 2012 (Figure 1). Similar to soybean futures, the highest monthly average nearby futures price in six out of 10 years occurred in June, July and December. June and July never had the lowest average nearby futures price, while December had the lowest average nearby future price three out of the 10 years (2008, 2011 and 2015). The average monthly price pattern for soybean meal is similar to soybeans with a peak in June-July and a low during harvest (Figure 3). However, early in the calendar year, soybean meal prices remained lower for a longer period and ascended more rapidly to the price peak than soybeans (i.e., soybean meal prices January through April had a less steep slope than soybean prices). Demand for soybean meal for livestock is reasonably consistent throughout the year (minor variations in demand will occur due to seasonal changes in hog and cattle production), so it is likely that supply is the driver in the rapid seasonal increase in soybean meal prices. Additionally, many domestic soybean processing plants will have downtime during the summer to conduct annual maintenance
and upgrades which could also limit soybean meal supplies. It is also important to note that soybean meal can be substituted with other protein sources if prices are higher than substitute feedstocks (corn silage, cottonseed hulls, cottonseed meal, corn gluten meal and citrus pulp).

**Soybean Oil**

Of the products produced from crushing soybeans, soybean oil brings the highest value (in terms of price per pound). Over half of the edible vegetable oil in the United States contains soybean oil (USB, 2014). An increasing interest in soy biodiesel production has the potential to provide additional future demand for soybean oil, but with energy prices currently depressed, demand for this use is currently limited. Additionally, soybean oil prices are dependent on the price of substitutes such as canola or palm oil. Soybean oil futures the past 10 years have ranged from a low of 20.84 cents/lb in 2005 to 70.82 cents/lb in 2008 (Figure 1). For soybean oil, the highest monthly average nearby futures prices typically occurred from April through July and the monthly average low in October (Figure 3). April, June and December accounted for the highest average monthly price nine out of the 10 years. However, December also had the lowest average monthly nearby futures price four out of the 10 years. Soybean oil prices have the same seasonal low as soybeans and soybean meal; however, the prices offered in the first six months were higher relative to the season average than the other two commodities.

**Estimated Crush Margin**

Crush margin can be used to describe many different relationships, depending on context. For this study, crush margin is broadly defined as the futures price of the outputs (soybean meal and oil) less the futures price of the primary input (soybeans). Thus, crush margin can be interpreted as the amount of revenue per bushel that processors generate to cover fixed and variable costs (excluding the cost of soybeans). The estimated crush margin was calculated using an assumption that oil was 18.3 percent and meal 80 percent of unprocessed soybean weight. The estimated crush margin ($/bu) was calculated as: (soybean meal price x 80% + soybean oil price x 18.3%) - soybean price. All futures prices were converted to $/bushel using a standard weight of 60 lbs/bu. The average estimated crush margin was $1.33/bu with a low of $0.78/bu in 2013 and a high of $3.24/bu in 2014 (Figure 1). The 10-year average monthly price pattern did not follow soybeans, soybean meal or soybean oil (Figure 3). The estimated crush margin average monthly low occurred in March-April and the high in August. In seven of the 10 years, the average monthly estimated crush margin high occurred in June, July or August. In six of the 10 years, the average monthly estimated crush margin low occurred in January, March or June (two times in each month). The strongest correlation between estimated crush margin and nearby futures price was soybean meal at 0.5, followed by soybeans at 0.28 and, lastly, soybean oil at 0.04 (Table 2).

**Conclusion**

U.S. soybean producers and soybean processing facilities share a common goal: maximize profits. Nearby futures prices for all three commodities are highly correlated with soybeans and soybean meal showing the greatest price correlation at 0.93 (Table 2). Over the 10-year period analyzed, nearby soybean futures were highest in June-July and lowest in October-November. If soybean producers have access to storage or are comfortable with futures and options strategies, producers could potentially utilize monthly average price patterns
in their marketing plan. Similarly, purchasers of soybean meal and soybean oil can use the monthly average price patterns in futures markets to make their purchases at lower average price points. Processing costs and profit margins for soybean processing facilities will vary dramatically from location to location. However, our analysis has shown that nearby futures prices for soybean meal are more highly correlated with estimated crush margin than either soybeans or soybean oil. This implies that over this 10-year period, soybean meal was the most important factor for processing profitability. Additionally, the analysis showed estimated crush margins do not follow the same monthly average price pattern as soybean, soybean meal or soybean oil futures.

3 It is important for producers and users of commodities to understand the impact of local basis on the price paid/received and the marketing strategies that are best suited for their operations. Basis was not considered in this analysis.

References


### Table 1. Global production, exports, imports, and ending stocks of soybeans, soybean meal and soybean oil, 2015/16 marketing year

<table>
<thead>
<tr>
<th></th>
<th>Soybeans (billion bu)</th>
<th>Soybean Meal (million tons)</th>
<th>Soybean Oil (million tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>11.48</td>
<td>241.52</td>
<td>57.53</td>
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<tr>
<td>Exports</td>
<td>4.84</td>
<td>75.05</td>
<td>13.75</td>
</tr>
<tr>
<td>Imports</td>
<td>4.79</td>
<td>71.45</td>
<td>12.92</td>
</tr>
<tr>
<td>Ending Stocks</td>
<td>2.65</td>
<td>13.38</td>
<td>4.27</td>
</tr>
</tbody>
</table>

Source: USDA-WASDE, 2015/16 marketing year
Table 2. Correlation between daily nearby soybean, soybean meal and soybean oil futures prices and estimated crush margin, 2006-2016

<table>
<thead>
<tr>
<th></th>
<th>Soybeans</th>
<th>Soybean Oil</th>
<th>Soybean Meal</th>
<th>Est. Crush Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybeans</td>
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<td></td>
<td></td>
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<tr>
<td>Soybean Oil</td>
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<tr>
<td>Soybean Meal</td>
<td>0.93</td>
<td>0.62</td>
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<td></td>
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<tr>
<td>Est. Crush Margin</td>
<td>0.28</td>
<td>0.04</td>
<td>0.50</td>
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</tbody>
</table>
Figure 1. Nearby Futures Prices for Soybeans, Soybean Oil, and Soybean Meal, and Estimated Crush Margin, 2006-2016

- Soybean Oil Nearby Futures Closing Price, 2006-2016
- Soybean Meal Nearby Futures Closing Price, 2006-2016
- Estimated Crush Margin, 2006-2016
Figure 2. Soybean Production Regions and Crop Calendar for Brazil, Argentina, and the U.S.
Figure 2. Seasonality of Nearby Soybean, Soybean Oil, and Soybean Meal Futures and Estimated Crush Margin, 2006-2015

Average Monthly Nearby Soybean Futures Price, 2006-2015

Average Monthly Nearby Soybean Oil Futures Price, 2006-2015

Average Monthly Nearby Soybean Meal Futures Price, 2006-2015

Average Monthly Estimated Crush Margin, 2006-2015

Figure 3. Monthly Average Nearby Soybean, Soybean Oil, and Soybean Meal Futures and Estimated Crush Margin, 2006-2015
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