

# Stocks and the Stocks-to-Use Ratio: Are They Meaningful for Price Determination?

## Executive Summary

The relationship between stocks and the stocks-to-use ratio and prices was studied from a number of different perspectives (summarized below). The data from these various studies establish that stocks and the stocks-to-use ratio are often meaningful for price determination primarily in that stocks and prices move inversely to each other. However, this correlation occurs within a limited price range, meaning that stocks do not dictate the *extent* of the price moves—stocks do not influence overall price *levels*. The correlation is also often a reversed one: changes in prices cause changes in stocks as well.

Mathematically, stocks can affect prices only in inverse proportion to the reduction in product actually traded on the market, and no more. Since production shortages responsible for low stocks are not sustained for more than a year or two, it is impossible for low stocks to be responsible for an ongoing rise in prices. Since production levels actually *rise* over time, most price level changes—particularly increases—over longer periods are due solely to changes in the quantity of money spent for a commodity.

### The Analyses:

- 1) An analysis of long-term correlations revealed weak but certain correlations between the stocks-to-use ratio and prices for the crops in the study. However, the paper demonstrates how that outcome is a result of mere price inflation through time.
- 2) An analysis testing the degree to which annual stocks-to-use changes result in comparable magnitudes of resulting price changes show that there is no consistency at all between the two variables: changes in the stocks-to-use ratios result in price changes of unpredictable amounts—and even direction—year-by-year.

- 3) An analysis of the tendency for increased imports or decreased exports to compensate during years of low stocks reveals that, for the most part, there is no such compensation. Barley is the exception. This points to the likelihood that low stocks are not as much of an actual threat as commonly imagined.
- 4) An analysis comparing production and supply changes (i.e., the driver of low stocks) to price changes reveals a general tendency for larger price changes to occur when larger *production* changes occur, but also shows that the results are sporadic year by year. No relationship was found between *supply* changes and price changes.
- 5) Discussions with industry experts on the extent of concern in the industry regarding access to needed corn during times of low supply indicate a general feeling of anxiety during low production years, yet the discussions also revealed that corn processors, feed processors, and livestock farmers all have various forms of “shock absorbers” (substitutes, ability to shut down plants, etc.), costly as they might be, that allow them to get by without an overly strong need for additional corn.
- 6) A last analysis displays that the four crops in the study—corn, wheat, oats and barley—all have wildly different patterns of production and stock levels through time, but have an almost identical price pattern over time, as do most commodities. This shows that other forces besides stocks, production or any other fundamentals of the individual crops appear to be the primary driver of larger price movements.

The other force is shown to be changes in the quantity of money and volume of spending, which is mostly unrelated to agricultural factors, and which is channeled mostly through a single source and hits all commodities rather evenly, and at the same time. This spending, not stocks or production levels, is the dominant factor setting the price level of agricultural commodities. Influences like stocks and production do affect prices, to a degree, *within the larger price levels* that are dictated by monetary factors.

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## Introduction

The level of stocks and the stocks-to-use ratio of crops are held to be key indicators of likely price direction for agricultural commodities. The assumption is that low stocks and/or a low stocks-to-use ratio (SUR) leads to a higher market price, because low stocks reflect a scarcity. If stocks are low, users of a crop might run out of it during the year before the new crop arrives. The threat of not having enough stocks leads to higher prices, as the market rations the limited supply.

Years that see low stocks or a low SUR are usually thought to be associated with years of low production and supply. When production is reduced, there is not enough supply to provided to all the different uses of agricultural products, and the shortfall is attempted to be made up for by drawing down on available stocks.

This report will employ varous techniques to test how much of an influence stocks and the SUR have on prices. In particular, we assess the data associated with corn, wheat, barley and oats, with a focus on corn, since that is such a dominant crop. The results of the tests show that levels of stocks and the SUR usually have an inverse relationship with prices, but do not *determine* the general height of prices.

## 1. Background and Fundamentals

Before beginning the actual discussion there are some fundamental concepts to consider. These are important because once these details about basic economics and the market are fully understood, it can be seen how occurences in the marketplace that are commonly attributed to changes in the SUR are often a result of completely different factors.

### Low Stocks or SUR Could Never be a Driver of Ever-Higher prices

The first concept is that of the cause of rising prices in general. If the supply of a commodity is static or increasing, the only way for its price to rise is with new and additional money flowing into that market. A price is necessarily an amount of money spent: if the price of something is \$100, then \$100 actual dollars must be spent to purchase the product. For the price to become \$200, twice as much money must be handed over.

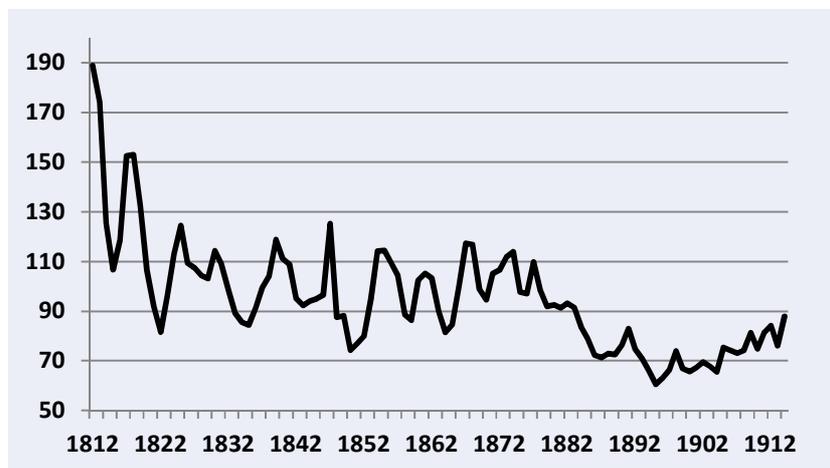
Consider the following. In 2008, \$49.1 billion was spent to purchase 12.1 billion bushels of corn in the U.S., resulting in an average 2008 corn price of \$4.06 ( $\$49.1 \text{ billion} / 12.1 \text{ billion} = \$4.06$ ). But in 2011, \$76.9 billion was spent to purchase 12.4 bushels, resulting in an average 2011 price of \$6.22. Since the supply between the two years remained about the same, the only factor driving prices higher was the 57% increase in spending for the same amount of supply. Put another way, the only possible way corn prices could have gone higher than \$4.06 was for more money to have been spent in the corn market.

One might ask “so what?,” because they would argue that people simply spent more money based on the fundamentals. Well, to be able to hand over more money buyers must actually have more money to spend. Where do they get the additional money, since in general people spend at the margin? They can spend more in one

market by spending less in another market, or they can spend more by earning more money. But since growing economies produce more goods and services and not money, the only way all people together have more money to spend is by way of the central bank creating more money. As will be shown below, people do not and cannot spend more when no more money is being created. Thus, rising prices are not a fundamental economic phenomenon related to market conditions of production and supply. Rather, they are a phenomenon of central bank money-printing which increases the amount of money being spent.

Since long-term rising prices are a monetary phenomenon and unrelated to the fundamentals, it cannot be the fundamentals pushing prices to new highs. No matter the weather, the level of stocks, or the rate of usage, the price cannot and will not go higher if there is no more money to be spent in that market. For more perspective, consider the evolution of arable land ag prices between the 100-year period of 1812-1912 in **Figure 1**.

**Figure 1:** One hundred years of falling agriculture prices in the form of an arable land crop index.



Source: Gregory Clark, University of California, Davis

During this time the United States dollar was on a (quasi) gold standard or linked to gold or silver in some fashion, which prevented new paper money from being created any faster than gold (or silver) could be dug out of the ground. This resulted in a rate of production of goods and services—including agricultural products—that was equal to and greater than (depending on the time period) the rate of production of paper money, which caused prices to remain the same or fall. Without new and additional money pouring into the agriculture markets, ag prices did not rise to new heights. Indeed, prices fluctuated greatly, but for 100 years failed to make rise overall. Stocks, stocks-to-use ratios and other fundamental factors changed during this period (as did the money supply) and contributed to *volatile* prices<sup>1</sup>. But it was impossible for those things to create continually *higher* prices.

<sup>1</sup> Changes in the quantity of money still probably had the largest affect on price movements, as individual banks could still expand the money supply to a certain multiple of the gold available, but reaching that limit necessarily set forces into play that caused the

Commentators often state that higher prices are “needed” to ration low supplies. But how is supply rationed when there is no additional money to spend? Prices are only “set” in the market by way of market participants actually buying and selling. In reality, prices ration low supplies, i.e., move higher, by way of changes on the supply side, not the spending side. For example, using the price formula above, suppose there are \$100 dollars spent for 100 bushels of corn. If the expected 100 bushels of corn suddenly fell to a supply of only 50 bushels, the same \$100 in spending would then have to buy half as much of a supply as before, resulting in a price of \$2 per bushel ( $\$100/50$  bushels).

It is extremely important to understand that if the money spent remains at \$100, then \$2 is as high as prices could go as a response to the supply change alone. It is also important to realize that once the supply returns to its prior levels, *prices would return to their prior levels*. This is why changes in stocks or supply cannot be responsible for on-going changes in prices (as long as supply is steady or rising through time).

The doubled price of \$2 makes sure that the small supply does not get taken too easily. But such price rationing did not occur from market participants bidding up the price by spending more money; it occurred by spending the same amount of money. They just got less for their money. This is how price rationing took place during the 100 year period where prices did not rise. So to say that the all-time high corn prices of 2006, 2010, or 2011 were achieved as a means of price rationing related to reduced production or stock levels of those years is to confuse price rationing with new and additional money flowing into the corn market. This is because the amount that prices rose was far in excess of that caused by production decreases. Prices could rise that high only with new money flowing into the corn market *on top of* prices rising due to reduced supplies.

People are not able to actually spend a greater quantity of money just because stocks are low. Indeed, low production and supply could result in a higher price—without people spending more money—but lower stocks alone could not. For prices to rise while stocks are low, production and supply must necessarily be low as well.

This last insight makes low production and supply doubly important in the analysis of the relationship between the stocks and the SUR to price because: 1) low stocks and a low SUR are usually seen as reflecting low supplies; and 2) low supplies must *actually be present* for low stocks or SUR to be a true source of higher prices.

### **Stocks Have No *Direct* Affect on Market Prices**

While it is commonly thought that reduced stocks mean prices should be higher, low stocks cannot directly play into price determination. Prices are determined by supplies that trade *on* the market, not *off* of it. (Unsold) stocks are not part of the market; they are outside of the market.

A market consists of exchanging money for goods. Prices are determined by the interaction of the amount of money offered in a market for commodities and the amount of commodities offered for money. Unsold commodities that are put in storage are not actively offered for sale in the market. Thus, they do not become part of the market. Since they are not part of the money spent in the market, nor part of the supply offered for sale in

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money supply to contract, leading to falling prices. This boom-bust sequence causing price volatility occurred many times during the 1800s.

the market, they do not in any way *directly* contribute to determination of prices (recall that a price is the mathematical product of the amount of money spent in the market divided by the number of units sold).

Stocks can affect prices only indirectly. They can influence the amount of money market participants decide to spend in the market or the amount of commodities they decide to offer for sale in the market. If the observation of low stocks make market participants think there might be a shortage of commodities in the near future, they might *spend* more or spend sooner in order to acquire the supply they need. They might also wait to spend or spend less because they think that concern about low stocks has already caused others to bid prices higher. Similarly, the awareness of low stocks might make suppliers of commodities *supply* more because they perceive buyers are willing to pay more in light of the low stocks, or, they might supply less due to the perceived need to hold stocks for safety.

Notice that these actions affect prices only through the amount of money spent or the amount of supplies brought to market. If market participants do not alter their spending or supplying patterns based on low stocks, the low stocks have no affect on prices.

### **The Potential for Running out of Stocks**

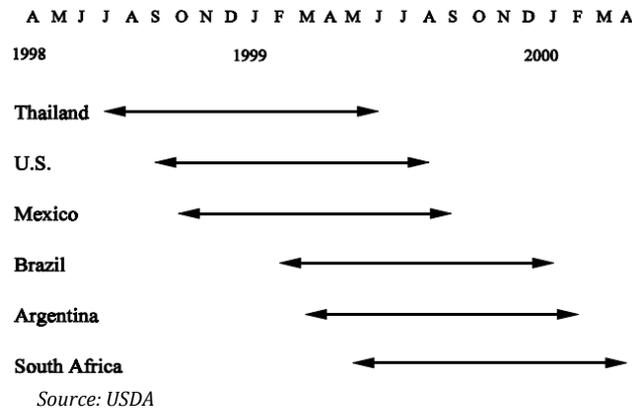
As part of determining whether stocks or the SUR (indirectly) affects prices, we want to clearly understand the actual level of threat that the marketplace might run out of commodities—so as to confirm the theory. On the surface, the threat seems logical: when commodities like agricultural commodities such as corn, soybeans and wheat are produced only once a year, there is not a continuing supply of those commodities during the year. If we run out of them, there are no more until next year.

But the theory might contain a few false assumptions. It must first be considered that users of agricultural products in the U.S. do not have access to new crops of the commodities in question only once a year. They have access all year long, because needed crops can always be imported from other countries who are producing at different times than the U.S. is (**Figure 2**). The U.S. market has actually been utilizing oats imports more each year as domestic production has decreased.

It should also be considered that another source of domestic commodities are those that are exported to other countries because there is not enough relative use for them domestically (relative to how much domestic market participants are willing to pay compared to foreign buyers). When supplies are short, there is access to a greater supply by way of outbidding foreign buyers and preventing the commodities from leaving the country (as is done for the rest of the annual supply of crops that is not exported).

Based on these ideas, a key factor that will be studied in the analyses below is whether imports and exports tend to adjust in years with low stocks, SURs and production so as to compensate for those low supplies. This will help shed light on how desperate people are to get hold of additional supplies during periods of scarcity.

**Figure 2:** The timeline of corn production in various countries, showing that new corn is coming to the global market throughout the year.



Lastly, an argument might be able to be made that the U.S. does not come *really* close to running out of commodities during the year since SURs, even in the crops with typically low stock levels, are never “running on empty” at the time the new crop is harvested. In other words, even though the SUR falls to 10%, 8%, and even 5%, we do not observe them running down to 2%, 1% or 0% on the eve of the arrival of the new crop. However, there are other factors to consider, such that there might be regional shortages due to prohibitive transportation costs preventing regions with excess stocks shipping to regions of near zero stocks. Additionally, much of those stocks could be related to government programs and loans, and are unable to be freed up.

Similarly, most of the crops in the study consistently experience SURs that usually bottom out in the 20%-30% range. The 20-year average stock-to-use ratios for wheat, barley and oats, respectively, are 35%, 37% and 30% (wheat used to have SURs of over 100%!). It does not seem reasonable to consider that stocks for these crops are ever seen as on the verge of running out, when there is almost never less than a quarter or so of annual usage on hand. That level of stocks should easily fix the hole in a 20% drop in production and supply.

Additionally, many years of low production and stocks are years coming off of an all-time high in production, where the production level in the low year falls back to where it was, say, two years prior. It therefore seems unrealistic to consider production levels of two years prior as “low,” since users could not yet have become dependent on the new, higher volumes. Users could seemingly get along quite well with the level of consumption of just two years prior.

### Prices Drive Stocks As Well

While it is commonly assumed that prices are affected by stock levels, it is less often perceived that stock levels are affected by prices. Producers are always looking for the highest market price for their goods. When prices are high, they tend to sell more; when prices are low, they tend to sell less. In recent years as prices have made record highs, producers have kept less in stocks because they wanted to sell more at the higher prices. Conversely, when

prices fell, they waited for higher prices to return before they let go of their stocks. In the fall of 2013, farmers were keeping extraordinarily high supplies of their corn production as they chose not to sell as corn prices slid lower and lower.

As can be seen in Figure 7 below, stocks tend to fluctuate around the same level, while prices move higher through time, albeit in a volatile fashion. It could therefore be argued that changes in prices drive changes in stocks more than the reverse—especially since prices, due to changes in money flow, have a life of their own while stocks do not. Stocks are a residual. In reality, both dynamics likely take place at different points in time. When price moves are the dominant news, stocks adjust in accordance, but when stock levels change while prices are trading water, prices then respond to the news of stock changes.

## 2. Data Analyses

This section displays the results of multiple analyses undertaken to assess the effect of stocks on prices. As part of this, relationships between production, supply, imports, exports, stocks, and the stock-to-use ratio are all explored in depth. The time frame assessed was 1960-2012 in most cases, but sometimes corn analyses utilize data going back to 1926. All data is from the USDA, unless otherwise noted.

### Stocks-to-Use Correlation Analysis

While it might not be the best way to understand cause and effect, a statistical correlation can be a good way to generally summarize the extent of co-movement between two variables. Correlations were run on the relationship between the stocks-to-use ratio and commodity prices for the four crops—both for their nominal values and for their values' year-over-year percentage changes. The relationships ranged from weak to moderately strong (**Figure 3**).

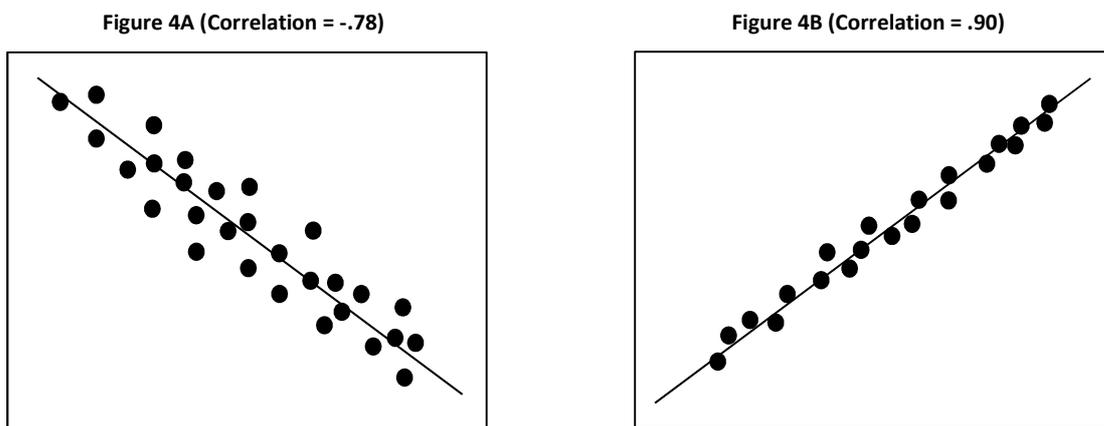
Generally speaking, correlation results consist of values running from -1 to positive 1, with -1 being perfectly negatively correlated and 1 being perfectly positively correlated. Ranges of -.20 to .20 would be uncorrelated; ranges of negative or positive .20 to .40 would be weakly correlated, .40 to .60 moderately correlated, .60 to .80 strongly correlated, and .80 to 1.0 very strongly correlated (some argue that significant correlations are only those that exceed +/- .40). The results show that the strongest correlation was found in the percentage change values for corn, at -.63, meaning that when the corn SUR rate of change is lower, the rate of change of prices *tend* to be higher, but not always, and not to the same extent each time. It signifies that there is a moderate correlation. The lowest correlations were seen for oats and barely, with low numbers that run the gamut between no correlation, very weak correlations, and moderately correlated.

**Figure 3:** Correlations between price and the stocks-to-use ratio for the four crops, in both nominal values and their annual percentage change values.

	Nominal	% Change
<b>Corn</b>	<b>-0.44</b>	<b>-0.63</b>
<b>Wheat</b>	<b>-0.51</b>	<b>-0.55</b>
<b>Oats</b>	<b>-0.45</b>	<b>-0.34</b>
<b>Barley</b>	<b>-0.18</b>	<b>-0.40</b>

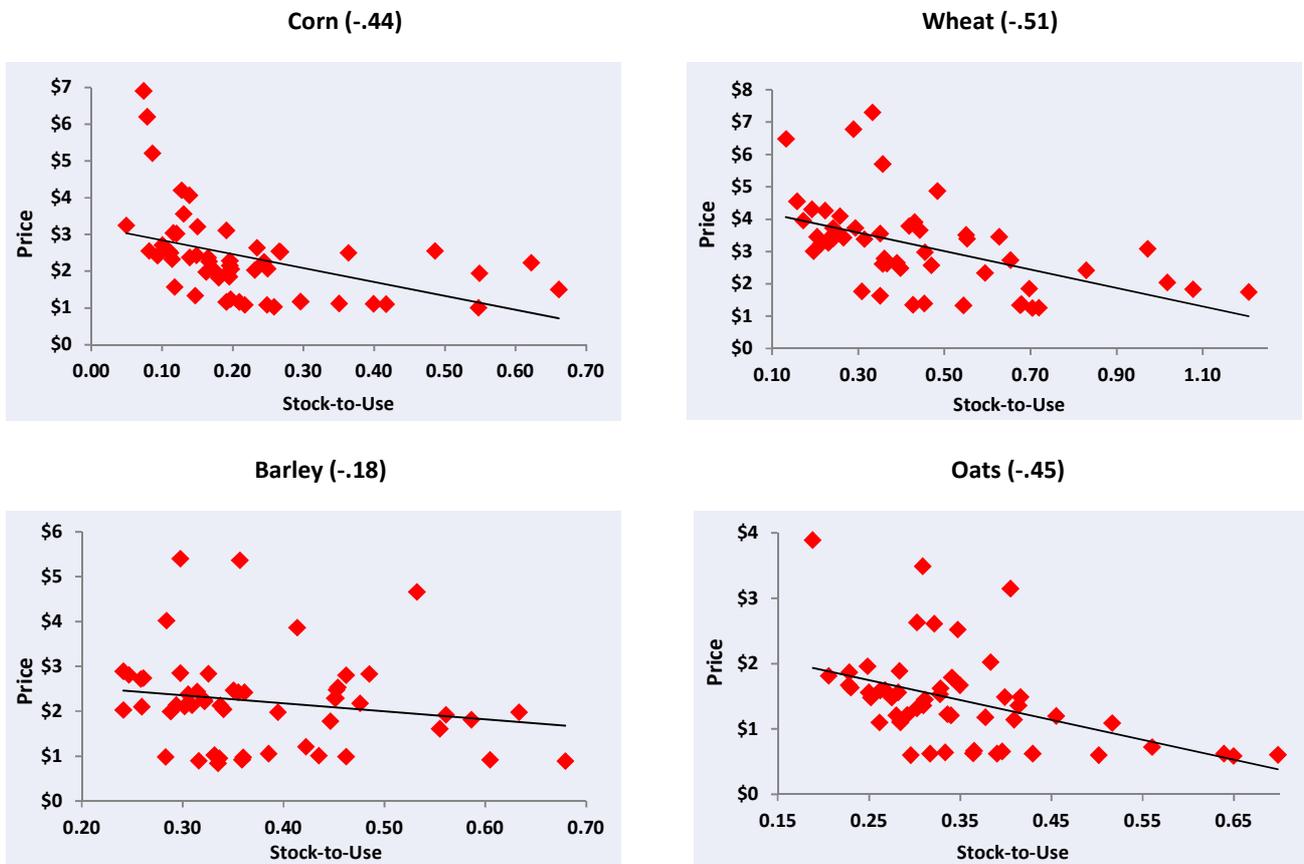
In addition, the actual scatter plots for the nominal correlations are presented. For perspective, consider that very strong negative correlations would look similar to **Figure 4A** below, and strong positive correlations would look similar to **Figure 4B**.

**Figure 4:** Example scatter plot results showing the extent of correlation.



**Figure 5** reveals the actual scatter plots for corn, wheat, barley and oats, with the calculated correlation noted next to the crop name. The straight line is one that minimizes the sum of the distances between each point and the line itself. The resulting angle of the line reveals the correlation. All of the lines in the scatter plots are downward sloping, which implies a negative correlation between the SUR and prices—lower stocks are associated with higher prices (or, higher prices are associated with lower stocks, since correlations do not give information about causality, but instead merely comment on how two variables move with respect to each other).

**Figure 5:** Correlations between the nominal price and the stocks-to-use ratio for the four crops.



Source for all charts: USDA, Quandl.com

There is, however, a flaw in these correlations based on the underlying causality. As we now know, rising prices are a monetary phenomenon—they rise through time due to increased volumes of money being injected into the economy and markets. This tends to vertically raise the level of the dots on the X axis (left axis). Also, SURs have fallen through time, for whatever fundamental reasons or government policies that caused people to hold fewer stocks (with the exception of the early 1980s).<sup>2</sup> This tends to move the dots to the left through time on the Y axis (bottom axis). The result of these two effects is that the dots tend to spread out to the top and to the left on the chart, which causes the fitted line to slope downwards (i.e., to give a negative correlation).

Think about the agriculture prices in the 1800s shown in Figure 1 that fell over time. Had agriculture prices similarly fallen in the most recent century as it did in the prior one (i.e., had there been as little money creation), *lower*, not *higher*, prices would have been associated with lower SURs through time. In this case, the correlation would have been positive instead of negative.

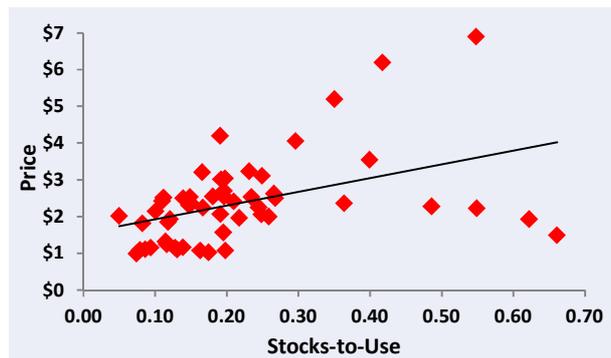
This scenario is shown in **Figure 6**, which has corn prices falling in reverse proportion to how they rose, while keeping the SUR the same. The result is a *positive* correlation through time. This shows that the difference

<sup>2</sup> The decline in stock levels is true only for the 1960-current period in the chart; the data from the 1926-current period shows that stocks were lower prior to mid century.

between this chart and the corn chart above with the negative correlation is of a purely monetary nature—not one based on agricultural fundamentals. Such occurrences are why statisticians remind us that correlations do not prove causality.

The conclusion here is that it is monetary inflation (along with lower stock levels), not a strict price/SUR relationship that produces a correlations between prices and SURs.

**Figure 6:** Demonstration of how the corn scatter plot from Figure 5 would appear if prices had fallen through time instead of risen.



Source: USDA, Quandl.com

### Stocks and Stocks-to-Use Graphical Analysis

There also appears to be a very strong—and legitimate—*intra-year* (monthly) inverse relationship between stocks and prices for corn (the other crops were not tested for intra-year relationships). The relationship can be so strong during some periods that it results in inverse correlations as high as  $-0.89$ . The relationship between corn stocks and corn prices is shown in **Figure 7A**.

In order to better view the relationship, the price has been inverted in **Figure 7B**. This enables the negative relationship to become a positive one, such that corn prices can be fitted on top of corn stocks, revealing how well the two move together. **Figure 7C** “zooms in” on the data to provide a closer look. However, such a close view chops off some of the data.

While the inverse relationship between price and stocks is indisputable, it is apparent from the charts that the *extent* of price movements is not in proportion with the *extent* of stocks movements. In other words, a particular stocks level is not associated with a particular price level.

While Figures 7B and 7C are set up such that stocks and price are at the same level at the 1998-1992 time period, the level between the two variables differs to some degree to the left and right of that time period, and differs by a very large degree towards each end of these charts. The left side of the charts sees stocks rising much higher than price, while the right side sees price dropping so far below stocks that it falls out of view.

**Figure 7:** The evolution of corn stocks and corn prices (and inverted corn prices) on a monthly basis, demonstrating the level of inverse correlation between the two.

Figure 7A

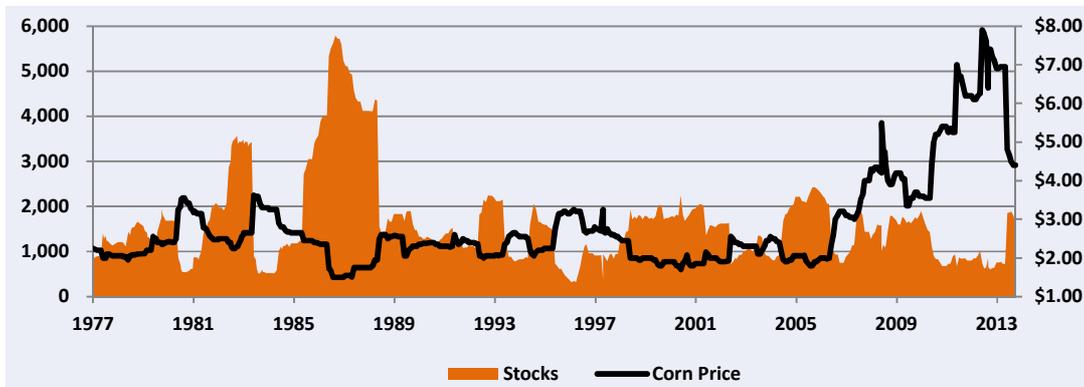


Figure 7B

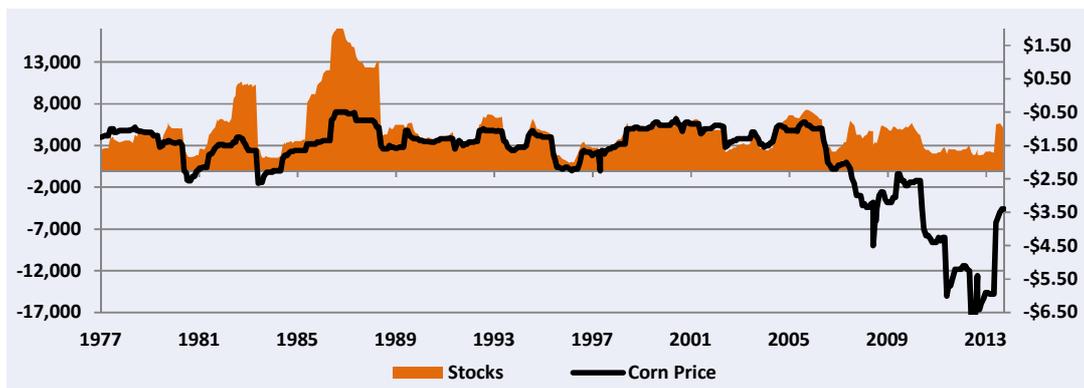
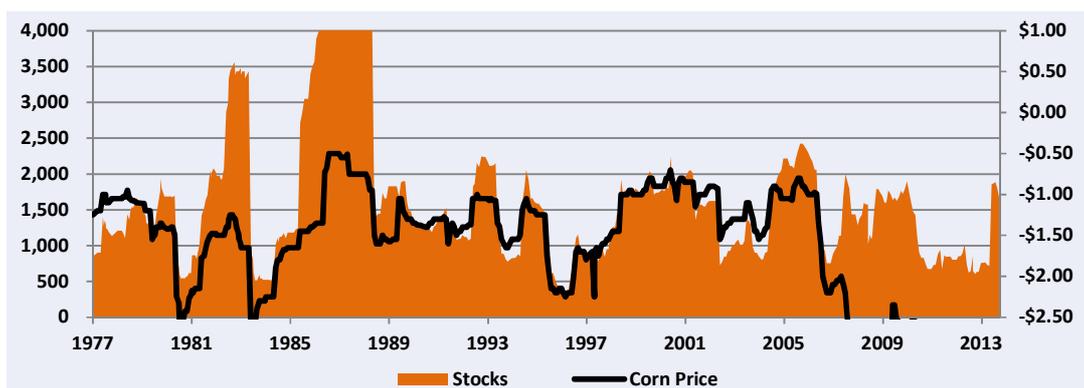


Figure 7C



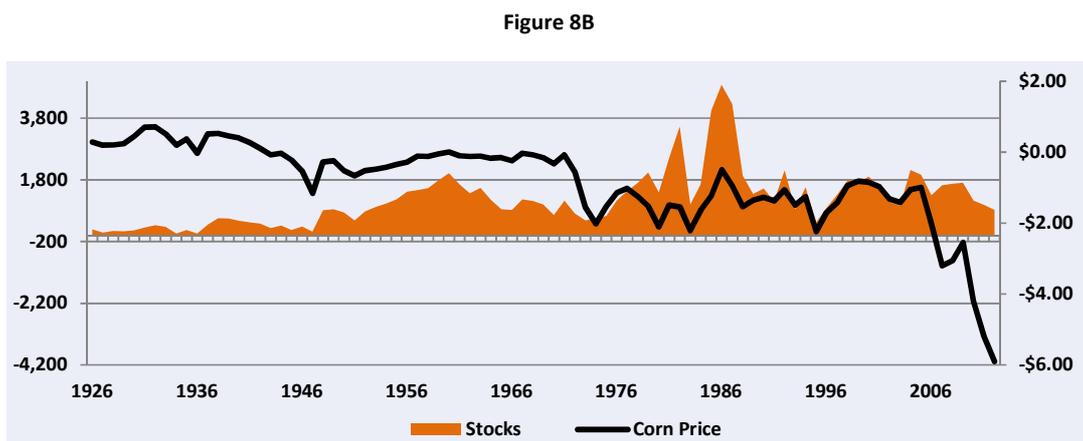
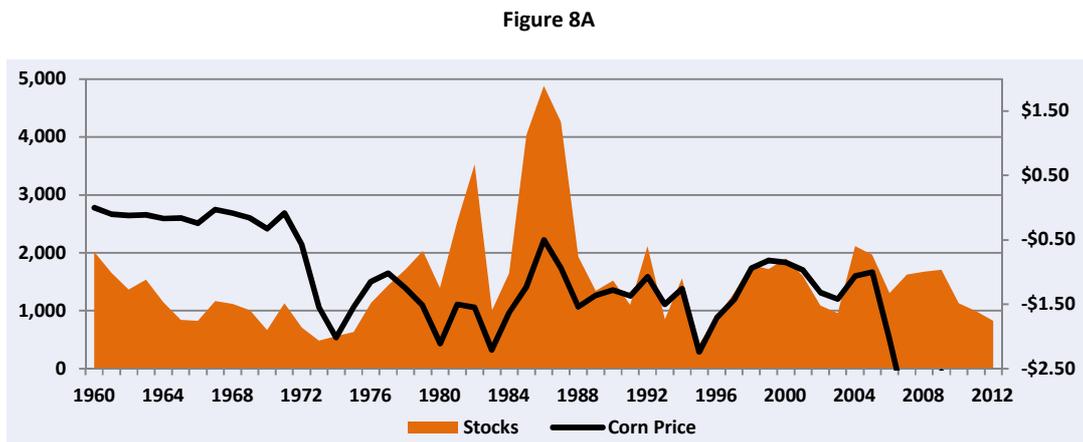
Source for all charts: USDA, Quandl.com

Such unequal levels between the stocks and price can be explained with logic. While stocks rose to new heights in the 1980s, prices could not fall far enough to offset in the same proportion, simply because the quantity of money

and levels of spending in the corn market did not fall far enough to lower prices more. Indeed, prices did fall 50% between 1983 and 1986, but that was not enough to offset stocks rising by a factor of 5 times. Conversely, in the late 2000s corn prices rose tremendously as large volumes of money flowed into commodity markets, while stocks could not fall as much in the opposite direction, since they cannot go to or past zero. Again, the relationship of an inverse correlation is clear, but the magnitude of the movements of each variable is not in the same proportion—the movement of stocks (price) does not dictate the *level* of price (stocks).

With **Figure 8A**, the view switches to annual data. Here, with a longer time-frame it becomes even more apparent that the inverse co-movement between the two variables does not take place to the same magnitude through time (the data are matched in the annual data at the 1989-2002 time frame). Specifically, at the left end of the chart the price level is significantly above the stocks level. As the picture zooms out more in **Figure 8B**, the disproportionate magnitudes become even more extreme.

**Figure 8:** The co-movement between (inverted) prices and corn stocks on an annual basis for various periods of time.

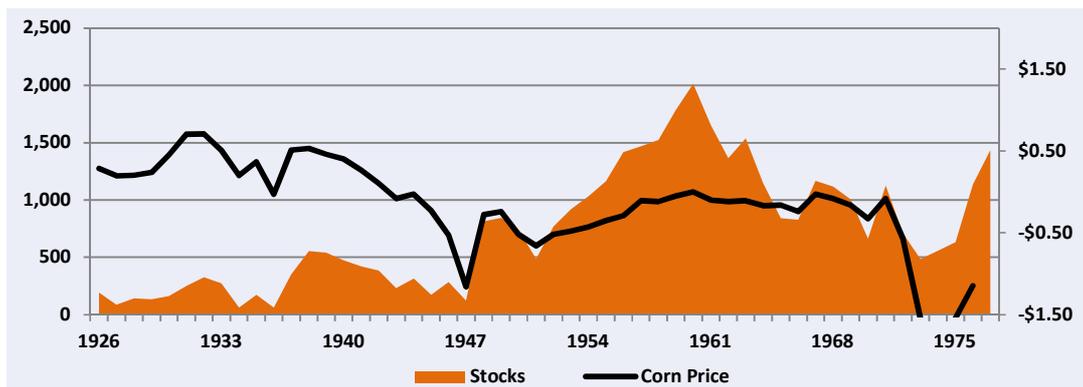


Source for both charts: USDA, Quandl.com

It is important to zoom back in and notice the quality of the relationship between stocks and price in the 1950s and 1960s (**Figure 8C**). After WWII the world went on another quasi-gold standard, the Bretton Woods gold standard, wherein the quantity of money was not allowed to grow at a very fast pace.<sup>3</sup> During this period all commodity prices were very subdued—even oil prices. During this monetary regime corn prices did not move inversely to stocks to a great degree. They moved very little compared to the periods where the money supply was not restrained. Once the gold standard collapsed in 1971, prices immediately exploded (collapsed).

This is a great insight into the effect that the money supply and resulting money flows have on commodity prices. Most of the volatility of commodity prices are due to the volatility of the volume of money created by banks and injected by borrowers into the commodity markets. When there is little new money being created, little new money flows into commodity markets, thereby keeping commodity prices both calmer and unable to rise. This knowledge, and the results observed over the 1950s and 1960s, shows that when the money is not flowing, prices do not move very much with respect to stocks. Since prices do not move much over this period even though stocks do, it is an indication that stocks do not *cause* prices to react. Indeed, market participants will adjust prices based on anticipated stocks changes. But with little access to additional funds, their speculation and corresponding price adjustments are very subdued. When they do have access to funds, price movements are multiplied from what they would otherwise be based on the actual fundamental news.

Figure 8C



Source: USDA, Quandl.com

For a numerical exposition of the differing levels of stocks and prices, consider the table in **Figure 9**. It shows four separate years when the level of stocks was around 1,710-1,790 bushels—about the same number. Yet the corresponding price for these different years was at significantly different levels in different years. The price in 2009 for 1,708 million bushels was 2.5 times higher than it was for the 1959 stocks of the same amount. The right side of the table shows numbers of approximately the same price level as the ones on the left side, as well as their corresponding stocks that are in no way similar to those for the same price levels on the left side. Clearly, the *level* of stocks has no relationship to the *level* of prices. The relationship is random.

<sup>3</sup> This gold standard was a different type than the one in the 18<sup>th</sup> century. In the latter, large amounts of money could be created, but only to a certain point (where the money supply usually contracted). In the 1950s and 1960s, the money supply could be indefinitely expanded, but only at a very slow pace.

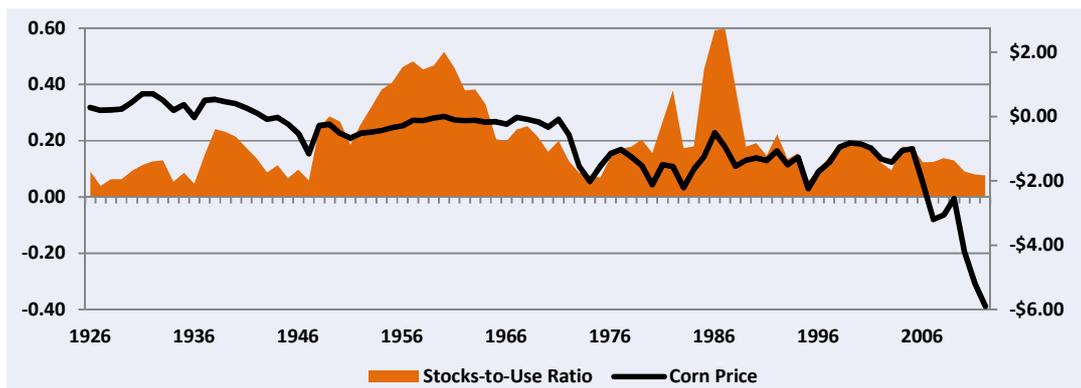
**Figure 9:** A demonstration of the lack of relationship between stocks and prices through time.

Year	Stocks	Price	Price	Stocks	Year
1959	1,787	1.05	1.03	315	1944
1978	1,709	2.25	2.23	4,040	1985
1998	1,787	1.94	1.94	4,259	1987
2009	1,708	3.55	3.24	426	1995

Source: USDA

**Figure 10** brings the corn SU ratio for the comparison. The second half of the chart (1970-2012) has a similar pattern, but the first half is significantly different, mostly in that the level of the SU ratio is much higher, both relative to the stocks level, and the SUR in later years.<sup>4</sup>

**Figure 10:** The co-movement between (inverted) prices and the corn stocks-to-use ratio on an annual basis for various periods of time.

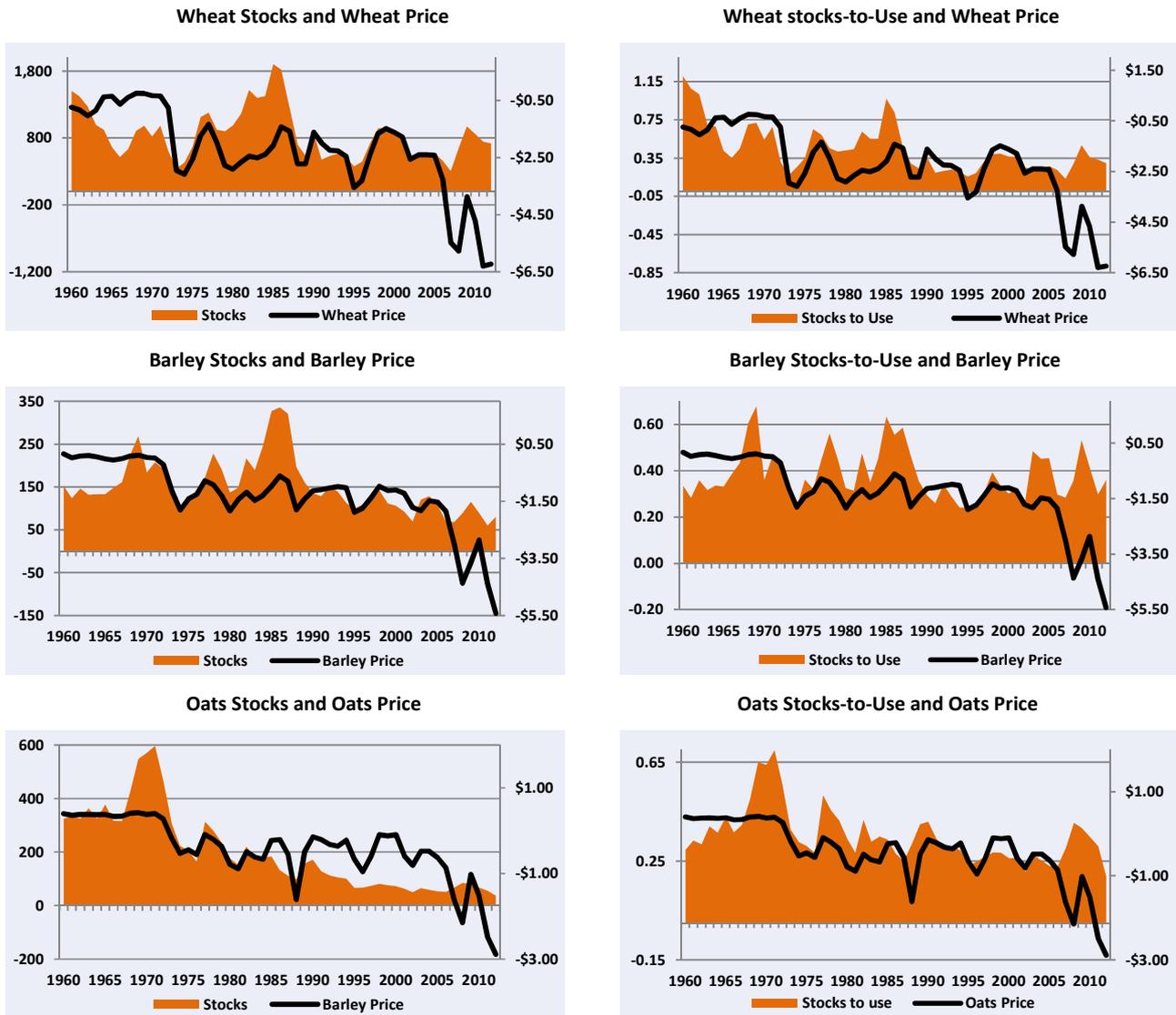


Source: USDA, Quandl.com

While the discussion thus far has focused on corn, the comparable charts for the other crops in the study are shown in **Figure 11**. They have a similar relationship between stocks and inverted prices as discussed for corn, yet theirs are generally weaker, especially for the Barley SUR and the Oats stocks.

<sup>4</sup> As stocks-to-use data goes back only to 1960, the SU from 1929 to 1959 was calculated by taking stocks as a percentage of production instead of use. This was deemed a sufficient proxy for SU because production and use changes and the magnitude of the changes are nearly identical through time.

**Figure 11:** Co-movements between price and both stocks and the stocks-to-use ratio for the four crops, in both nominal values and their annual percentage change values.



Source for all charts: USDA, Quandl.com

The takeaway from this section is that stocks and the SUR move very much inversely with price, but by much different magnitudes through time. The level of stocks or prices usually do not say anything about the level of the other. Further, the effect of changes in the quantity of money is once again shown to be a factor affecting both the volatility and level of prices.

## Standardized Stocks-to-Use Graphical Analysis

This analysis tests, in a different way, whether changes in the stocks-to-use ratio seem to have a dominant effect on changes in price. The assumption being made is that if it did, annual changes in the SUR would lead to annual changes of comparable magnitude in price. For example, if the SUR falls by 10 percentage points (1,000 basis points) while the price rises 5% in response, it should be expected that if the SUR then rises by 5 percentage points that price would fall by 2.5% in response. Indeed, the previous analysis did a good job of answering the question, but the results here are perhaps even more persuasive.

To conduct the test, historical SUR moves in the four crops were normalized such that each annual change in the SUR represented a *positive* 10 percentage point move. For example, if the SUR rose by 5 percentage points while the price correspondingly fell 2%, the 5 percentage point increase was adjusted to be a 10 percentage point increase while the 2% fall in price was also doubled, to become a 4% fall. The proportions were always kept the same. Similarly, if the SUR *fell* by 5 percentage points while price correspondingly rose 2%, the negative 5 percentage points were converted to *positive* 10 percentage points while the (positive) price was converted to a negative 4% decrease. Doing this for all data points for all years results in all SURs being exactly the same (a 10 percentage point rise), with price being left to be whatever it may. Thus, the only thing needing to be assessed is the series of resulting price movements.

Given this set-up, if prices respond to changes in the SUR by about the same magnitude, we would expect the chart to show a series of negative price moves in response to the static *positive* 10 percentage point SUR that are about the same through time, as in the sample chart in **Figure 12A**. Instead, the actual data/charts in **Figures 12B-12E** show that the price response to changes in the SUR is wildly variable, and in no way consistent. For the very same positive 10 percentage point change in the SUR, the price might fall by 2%, 20%, or even 200+%. Not only that, the SUR often moves in the *same* direction as price, not in the opposite direction as would be expected.

**Figure 12:** Charts showing price moves resulting from the very same percentage move in the stocks-to-use ratio in each year.

**Figure 12A:** Sample—rough approximation of expected chart pattern

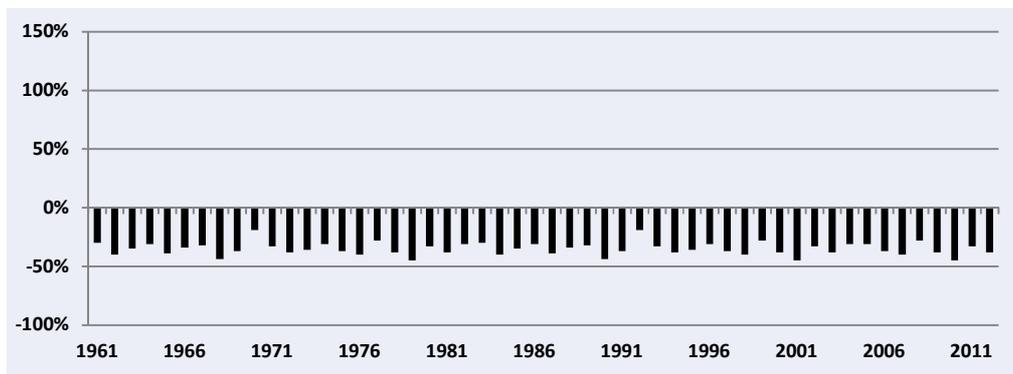


Figure 12 B: Corn (expanded time frame)

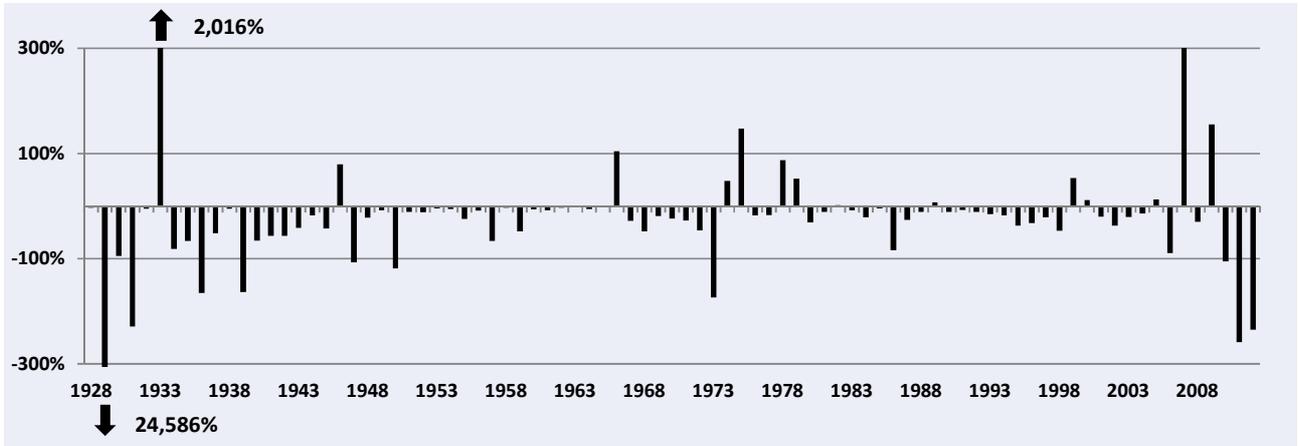


Figure 12C: Wheat

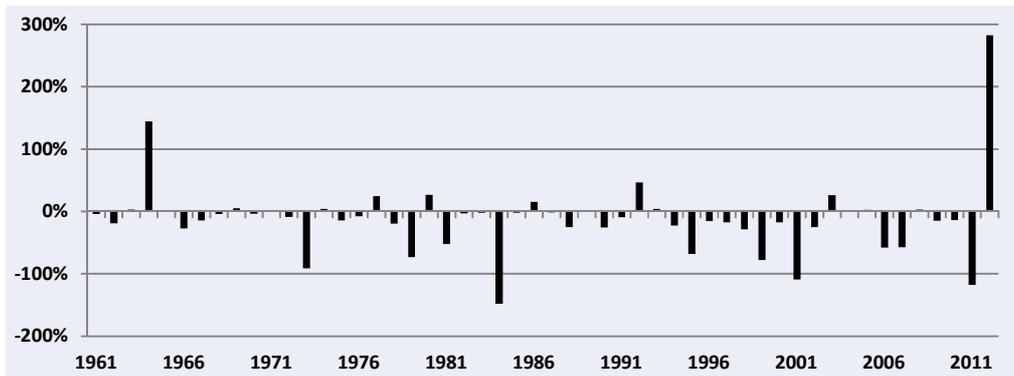
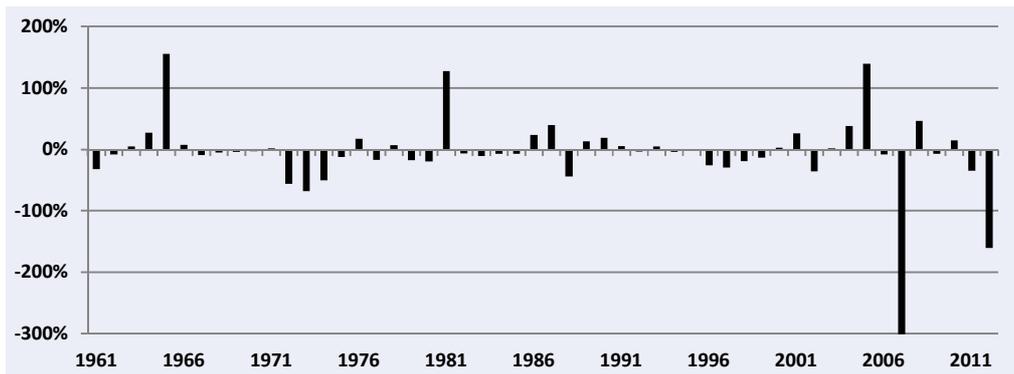
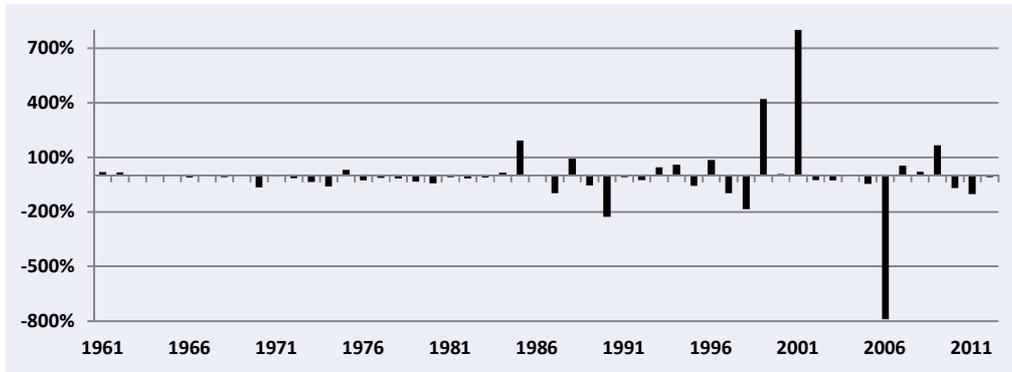


Figure 12D: Barley



Source for all charts: USDA, authors' calculations

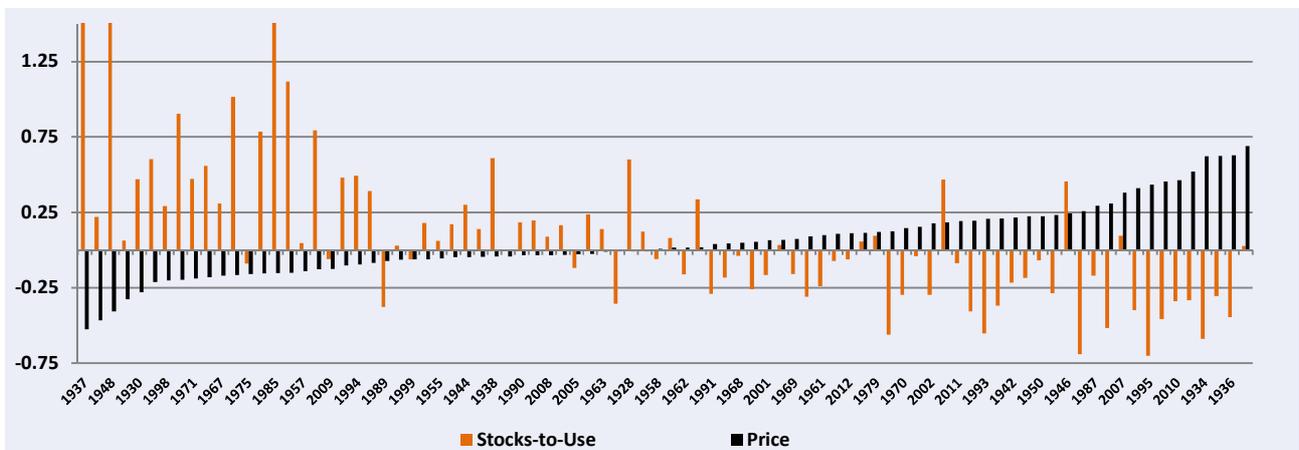
Figure 12E: Oats



Source: USDA, authors' calculations

Figure 13 shows the same data viewed from the reverse angle, where the price changes are sorted by their percentage change. The only difference is that this chart does not show the standardized values, but the original nominal values. The chart reveals that changes in prices are not accompanied by changes in SURs of similar extents. For any given price change, changes in the SUR could be of any size and in either direction.

Figure 13: The relationship between changes in the stocks-to-use ratio and changes in corn price.



Source: USDA

The conclusion, therefore, is that a given change in the stocks-to-use ratio gives no indication about the expected change in prices.

## Imports/Exports Analysis

As discussed earlier, the most logical solution to a crop shortage is to increase imports or reduce exports, as they are a source of supply. It should therefore be instructive to observe whether imports and exports tend to adjust for low stocks/supplies/production. The analysis focuses mostly on corn.

### *Imports*

For corn, not only do imports not tend to increase during years in which there are shortages of supply or low stocks, but they are irrelevant altogether since they are of such small magnitude that they would have no significant impact. Corn imports have never reached more than three tenths of one percent of total use, except during 2012, when they climbed to 1.5%, a still insignificant number in terms of a quantity of corn imports large enough to make up for a reduction in production.

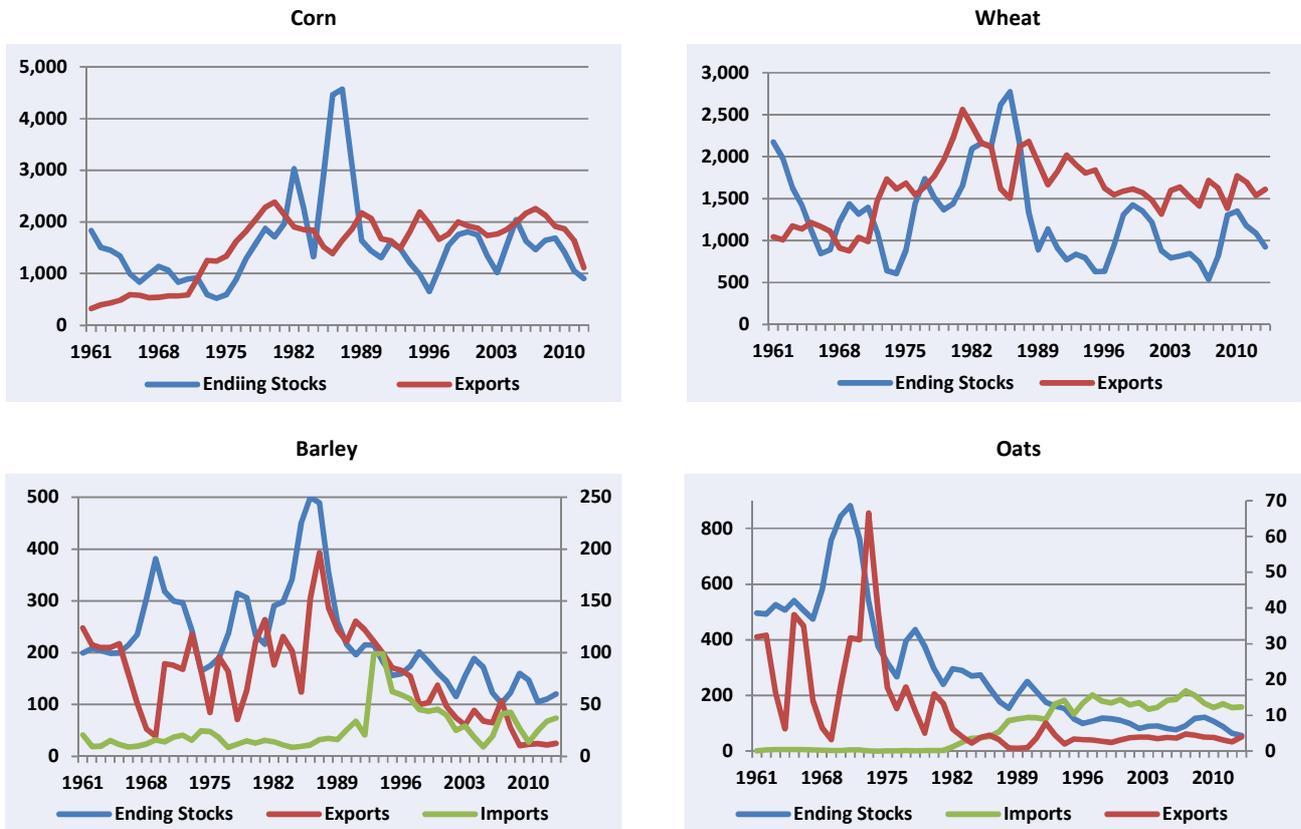
The same scenario applies to wheat. Barley imports show no sign of compensation. Oat imports provide compensation through time as oat production domestically declines. Thus, it's difficult to distinguish between normal years and those of of supply crises based on import changes.

### *Corn Exports*

In contrast to imports, there is a large enough quantity of corn exports that they could compensate for low supplies by outbidding foreign buyers. It is perhaps best to begin the export analysis with an overall view of the relationship between exports and ending stocks (**Figure 14**). The scale does not matter in these charts, as they are set such that the movements of the different variables show up as similar magnitudes, so that they can each be visually compared with the other variable(s). If exports are a strong source of compensation for low stocks, we would expect to see an inverse relationship between exports and stocks.

The charts show that except for some fleeting periods for different crops, stocks and exports do not generally have any relation to each other. Imports are also shown for barley and oats, since they have been a significant source of supply in recent decades. However, they too show a lack of relationship with ending stocks, and don't appear to increase significantly when stocks fall.

**Figure 14:** The relationship between ending stocks and exports and imports (2-yr average, bushels, in millions).



Source for all charts: USDA

The level of exports in years of low supply, production, stocks and SURs were assessed to determine whether exports were lower in those years than other years, so as to make up for the missing supply.

For years of low supply for corn (down more than 10% YOY), exports decline by 9% on average (median) while they rise 5% on average in years where supply is not short. This tends to indicate a very small compensation for a short supply. However, the response by year varies considerably, with a couple of years seeing exports actually *increase* by more than 15%, thus not compensating at all for low supply.

For years of low absolute levels of stocks, exports fall a mere 3% on average as compared to a rise of 1.9% during years of adequate stocks. Here again, the 3% number appears rather random, as there were just about as many years that exports rose during short supplies (6 years) as they fell (7 years). For years of low SURs (below 12%), exports *rose* 2% while rising 1% during non-problem years.

For years of low production, exports once again actually increased by 1%, compared to neither increasing or decreasing in years of normal production.

So while in the aggregate there sometimes appears to be a very slight tendency to reduce exports so as to compensate for a low stocks and low supply, the response of reduced exports is highly variable, occurring in some years but not others. Based on both the subtleness and randomness of this effect, it cannot be ruled out that the results might be occurring purely by chance. Because there is no clear evidence of exports compensating for short supply, that there is no clear evidence that market participants feel that they are truly short of corn.

#### *A Closer Look at Corn Exports*

Industry experts noted that it is not necessarily a single year of short production and supply that rattles the markets, but instead two or three years in a row. Because of this, more detailed analyses were undertaken. The production, supply, stocks, and stock-to-use changes over multiple-year periods were assessed within the 54-year time frame under consideration. The focus was on years where these variables—particularly supply, stocks, and the SUR—fell significantly and/or were at low levels relative to prior years for at least two years straight.

There were six times in the 54-year period where this occurred: 1970, 1983, 1988, 1993, 1995, and 2012. Most, but not all, of these years saw higher corn prices than prior years. Export responses were widely variable and without a specific pattern or apparent relationship to the “missing” supply. What was assessed was not only *whether* there was a response of reduced exports to compensate for low supplies, but the *magnitude* of that response relative to the magnitude of the “missing” supply.

For 1970, exports fell 9.35% from the average of the prior two years. This, however, was enough to compensate for only 13% of the 37.6% reduction in stocks from the previous two-year average. Thus, the reduction in exports did not begin to make up for the loss of stocks. In 1983, exports actually increased by 13%, and thus in no way made up for the missing stocks. In 1993, exports made up for 44% of the missing stocks. However, in 1995, exports once again increased instead of decreasing. It should be noted that in 1996, though supply was not low on a relative basis, stocks were very low for a second year. Exports savings then represented a whopping 326% of the missing stocks relative to trend. In 2012, stocks saw another 394% of savings. It was the only year where exports were cut by almost half (to 6.5% of use as compared to 12.1% and 13.6% in the two prior years).

It must be wondered why exports reacted so dramatically in these two particular years. And as well why they not only compensated for lost stocks, but compensated by a factor of 3 and 4 times what was needed. The fact that there were five other years where exports rose by between 200% and 1,000%, as well as the fact that they fell by 200% to 2,000% during years where there were no notable supply or stock changes once again points to the idea that such large changes are rather random. This is especially true considering that the magnitude of the export responses listed above were themselves so variable.

#### *Compensation Response Summary for Wheat, Oats and Barley*

During years of low supply for wheat, exports tend to increase slightly, but again the data is not reliable. For years of low stocks, exports actually increase in most years by 17% on average. Exports do tend to make up for about half of the missing supply in about two-thirds of low supply years.

Oat exports averaging 1% are not large enough to be meaningful (even if they do tend to be higher during low supply years).

Though Barley exports average only 12.3%, they do fall about three times more during low supply years (40% decline) than normal years. There is also a tendency for exports to decline during most years of low barley stocks, averaging almost twice the decline (20.6%) of normal years. Additionally, that size of export reduction does tend to make up for about 50% of the missing supply (on average), about two-thirds of the time. It is difficult to reconcile this relatively significant export compensation response with the fact that stocks never fall to very low levels (24% in the lowest year).

#### *Overall Imports/Exports Summary*

Because of such subtle and variable export responses, it cannot be concluded that conserving on exports is a confirmed means of action the market uses to compensate for low supplies and low stocks of most crops, with barley being the exception. This, combined with the fact that the market makes no attempt to compensate with imports suggests that market participants are not frightened to a large degree by the levels of low supplies of corn that sometimes occurs in that market.

#### **Production/Supply and Price Analysis**

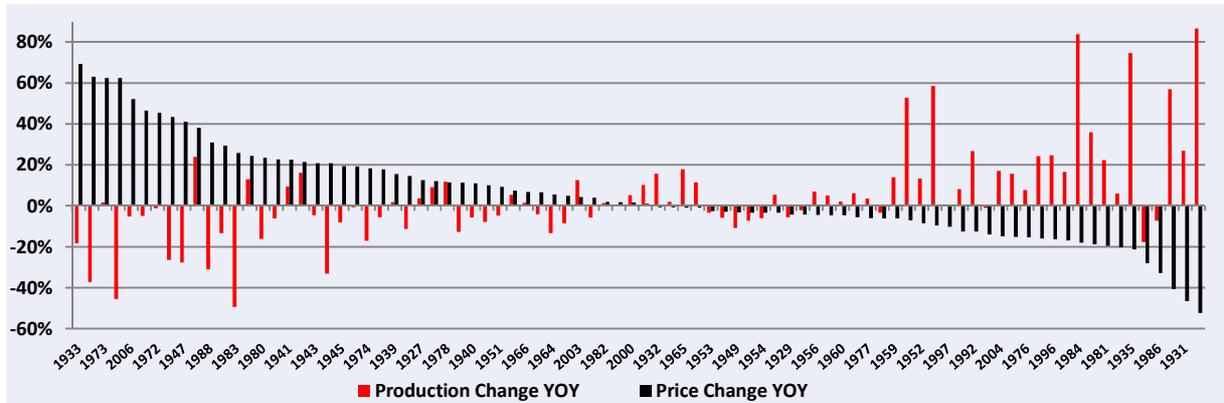
The underlying driver of low stocks and stock-to-use ratios is a lower than expected level of production. The fear of scarcity cannot be from the usage side, as that would just mean that people have decided to go ahead and use the crop instead of leave it as stocks. Therefore, a true shortage is less likely because there would be less need for the stocks due to the fact that they have already been employed by those who need them. Plus, the data show that usage virtually never increases when production does not increase. Shortages are a function of low production and supply, not increased usage.

With this in mind, an analysis was undertaken to understand the relationship between both production and supply with respect to prices. The analysis assessed whether prices move in alignment with production and supply changes.

The results of the analysis showed that the largest and smallest *supply* changes were not generally associated with the largest and smallest price changes. However, the largest and smallest *production* changes were, generally, associated with the largest and smallest price changes. However, this was far from being the case year by year, as shown in **Figure 15-1**, which demonstrates that in many years price changes and production changes appear to have little or nothing to do with each other.

It should once again be observed (in **Figure 15-2**) that the years that experienced the smallest changes of *both* production levels and prices were during the two decades of the Bretton Woods gold standard. The median standard deviation of both production and prices across non-gold standard years was 24% (each year happened to be the same number). The median standard deviation of both variables during the gold standard years was reduced by almost a third, to 9%.

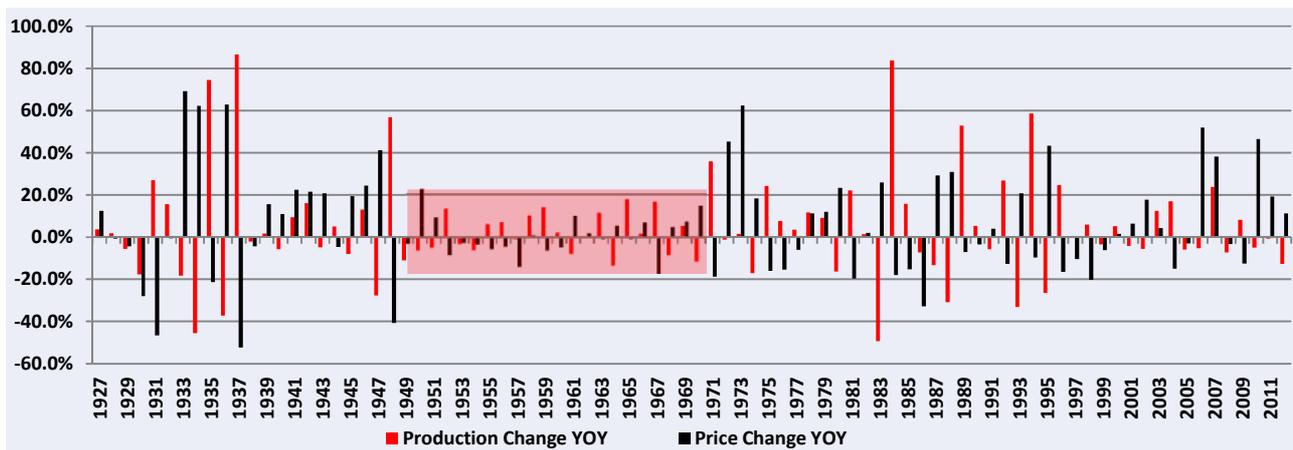
**Figure 15-1:** The relationship between changes in corn production and changes in corn price (ordered by magnitude of prices).



Source: USDA

Again, when the volumes of money and spending are relatively calm, there are not large, volatile changes in monetary demand—and subsequently crop profitability—causing volatile changes in planting decisions (or by other mechanisms through which price changes affect production). One only needs to look at the 1980s to see the extreme in these volatility conditions. As the Federal Reserve choked off the money supply and raised interest rates, “demand” (i.e., spending) for agricultural products—along with all other commodities—collapsed. The reduction in spending (i.e., perceived demand) caused a reduction in profitability and production levels, and an increase in stocks—even if not continuously.

**Figure 15-2:** The relationship between changes in corn production and changes in corn price (ordered by year).



Source: USDA

Another portion of this analysis showed that during calm monetary periods where there were not large changes in spending year by year (1950-1970, 1984-2005), prices changed solely in accordance with supply changes. In

other words, prices rose by an amount commensurate mathematically with a decline in production levels, along the lines of what was explained in the beginning of this paper regarding the 1800s.

But during those years where significant amounts of money flowed in to the commodity markets, price movements were way out of line with production changes—due precisely to the new money itself driving prices higher. The top five years where prices moved in excess of the amount justified by production changes were 1972, 1973, 1984, 2006, and 2007. 1972 and 1973 were the years following the collapse of the gold standard and the resulting 35% depreciation of the dollar, where money pured into *dollar-settled* commodities from dollar denominated deposit accounts around the world. 2006 and 2007 were during the period where Wall St. money entered the commodities markets in force (again, all commodity markets, not just agricultural markets). 1984 was during the period in the early 1980s where where both money flows and production changes were volatile due to the prior collapse of monetary inflows in the early 1980s.

### 3. The Marketplace Perception of Supply Risks

To get a feel for what actually transpires during the year in terms of production, supply, stocks and prices, the GROWMARK research team interviewed current and former processors and feed manufacturers to better understand what buyers and sellers on the ground are thinking as market conditions evolve. The discussions were about corn, specifically, as it is one of the most popular agricultural commodities, and one with relatively low SURs in general. Those insights are shared in this section.

Processors acquire corn in proportion to production: as production increases about 2% per year, processors expand their capacity and expected usage of corn by about 2% per year, over time. Thus, if overall production increases more than expected and prices are low, processors would be unlikely to buy additional corn supplies to take advantage of the price, since they are not able to rapidly increase production (this alone is an excellent explanation for how stocks fluctuate, as well as for the very existence of stocks, because it shows that they are a residual between supply and usage). But if production falls from what is expected, processors will be short of corn by that finite percentage amount. Further risks of being unable to obtain corn stem from the fact that processors do not purchase their total annual corn supplies at one time. Rather, they tend to source the needed quantity month by month or have a certain portion of their annual corn supplies on hand at any given time.

During years of low production, processors usually adjust to a short supply by way of shutting down plants instead of competing for corn. This usually happens with plants futherest from the source of the corn when transportation costs exceed the processor's breakeven point. The ability to cease production provides a cushion against a possible fall in production. The fact that processors feel secure not stocking up ahead of time, might be an indication that they are not desperately concerned about such a possibility.

As with the processors, feed manufacturers and farmers also tend to purchase feed ingredients short term: daily or every other day. Generally, corn is the first choice as an energy source. But when corn supplies drop and prices rise, two general scenarios can occur. The first scenario is ingredient substitution, where the feed manufacturer finds an alternate form of energy (e.g. wheat, fat, outdated cookies) or chooses to use a by-product of the preferred energy source (e.g. corn gluten meal, dry distiller's grain). The second scenario is a reduction of herd size through selling/slaughter of animals or reducing the number of offspring in the herd (this is a longer

process). Both scenarios work as “shock absorbers” in the market, helping to reduce the amount of corn taken from the market.

One commenter reported that another shock absorber for low supply years is a reduction in exports. But as our analysis has shown, that means of compensation is sporadic, and of little significance size-wise when it does take place. The same interviewee said that that it was difficult to access some of the would-be exports due to the high price that would have to be paid. It’s likely unprofitable, arguably, because selling prices could not be raised to compensate for the higher purchase price. If that’s the case, it really means that the end user of the corn (the consumer, or at least the wholesale buyer) is not seen as willing to pay a higher price, which in turn means that they can go without the missing quantities. They too likely have substitutions for the product.

One former feed processor said that he indeed saw many price spikes due to the competition for corn. But the context of the price spikes he was referring to were smaller spikes over a matter of days or weeks, not a matter of multiple months during the year where prices rise, say, 100% as stocks are falling closer towards zero at the end of the marketing year.

Without a doubt, when supply and stocks are extremely short, there is competition for the limited corn that bids up the price to ration supply. The best example is probably the 1995-1996 time frame—when money flows were calm before and after—where prices spiked very high before falling back to their previous level once production and stocks returned to a normal level. But a study of the data shows that there simply aren’t many years when supply is extremely short and where stocks go extremely low—or prices extremely high as a result.

Because of this last point, as well as the lack of significant imports or exports, and the shock absorbers of plant shutdowns and alternative feed sources, it is difficult to conclude that fears in the market of actually running out of stocks are a very common or very strong sentiment most years, even when stocks are low.

## 4. The Monetary Effect on Prices

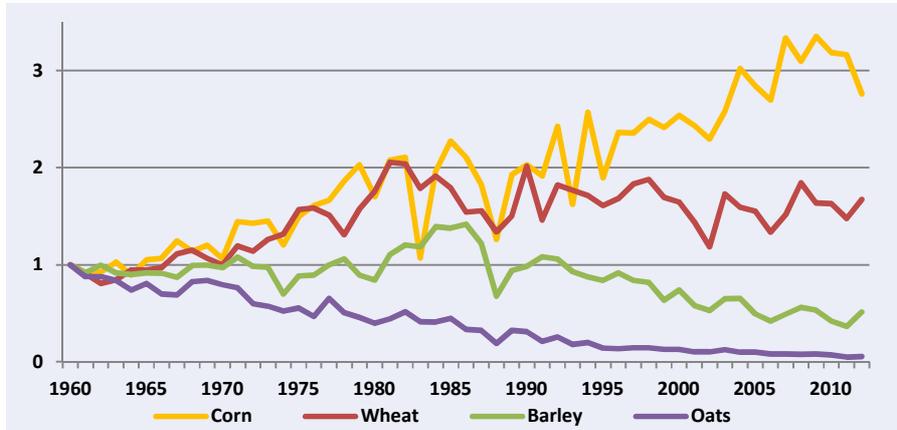
Since the influence of money has been a theme in this research, it should be instructive to assess more closely the effect it has on prices. As indicated already, since production moves prices lower, and since stocks and SUR changes could affect prices within a range, it can be only additional quantities of money which move prices consistently higher through time.

Simply looking at the evolution of crop prices and how they tend to move together over time should reveal that there is some other force that prices seem to respond to more than production and stocks—especially since different crops have different patterns of production and stock levels.

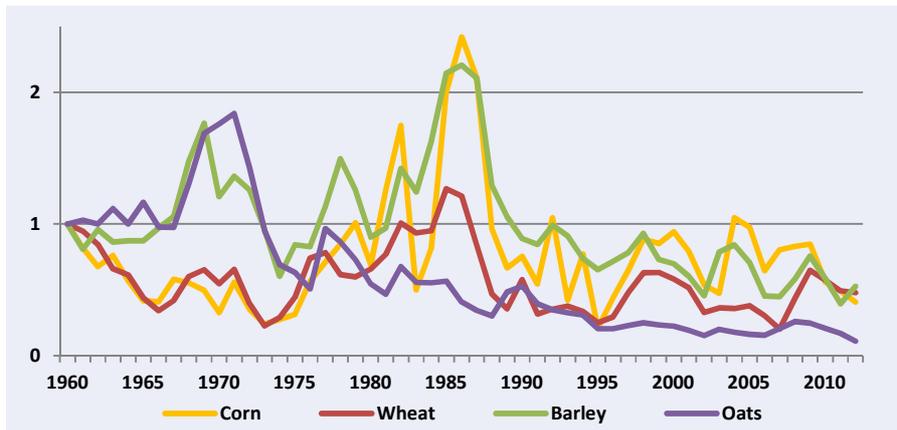
**Figure 16A** and **Figure 16B** show how the four crops in this study have very different production and stock levels from each other. Yet **Figure 16C** illustrates how much the prices of these four disparate crops move almost in tandem with each other over the long run. Regardless of their different production or stock levels at different points in time, they each move to new highs, fall from new highs, or flatline at nearly the very same time. The inverse movements between stocks and price shown in Section 2 are taking place within the different ranges of price levels the crops find themselves in at particular points in time, but but the oscillations of stocks do not *cause* the prices to move to higher or lower elevations.

**Figure 16:** The evolution of production, stocks and (farm) prices of the four crops in the study.

**Figure 16A: Production**

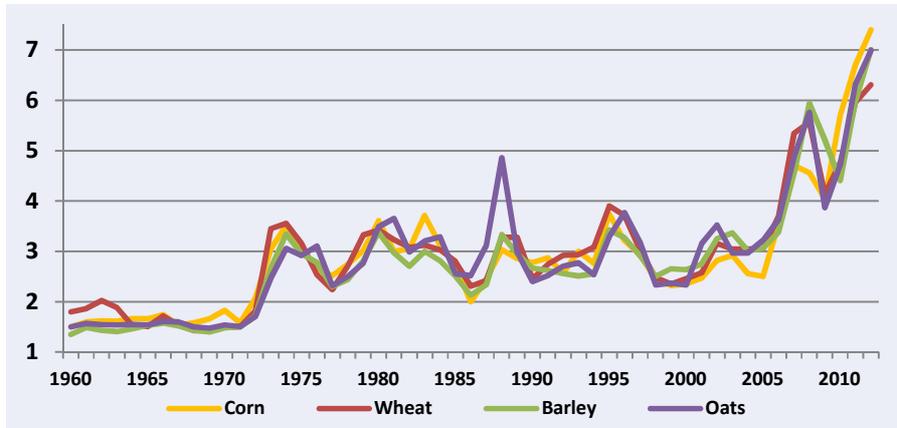


**Figure 16B: Stocks**



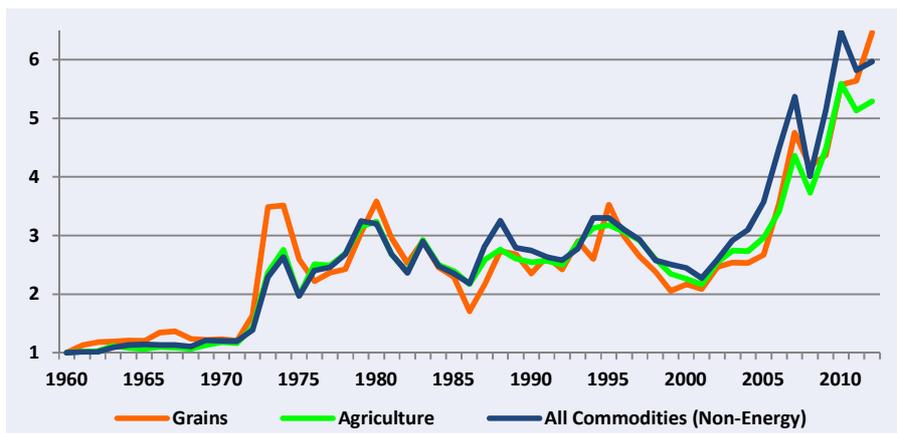
Source for both charts: USDA

Figure 16C: Prices



Source: Quandl.com

Figure 17: The evolution of (futures) prices of grains, agriculture and all commodities, showing the uniformity of price movement of different commodities.



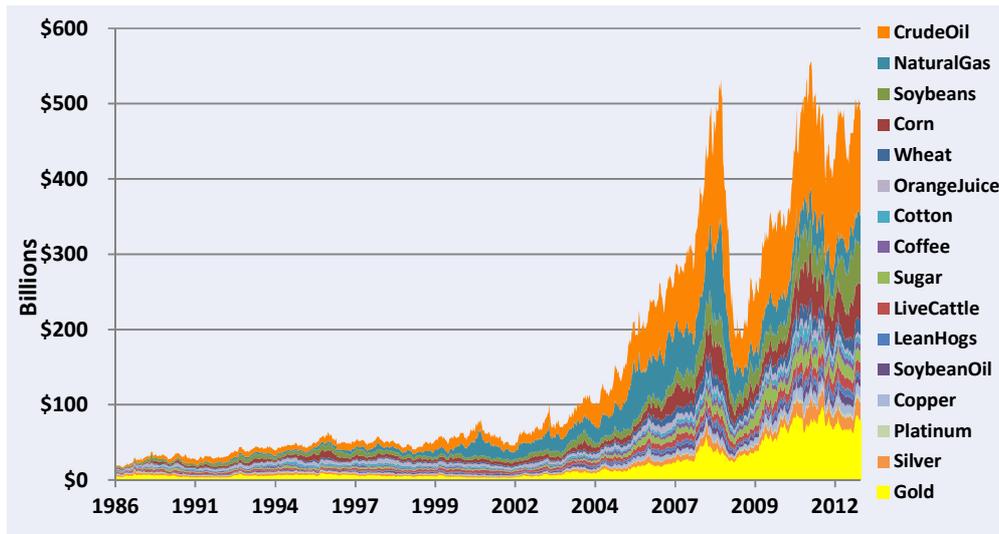
Source: Quandl.com

As further evidence that a different force besides production or stocks are driving the shared price pattern of the crops, consider that the same price pattern applies to most commodities. **Figure 17** shows the same price pattern shared by the entire grain complex, the entire agriculture complex, and all commodities in general. What all of these commodities share are commodity price inflation resulting from new and additional money spent in the commodity market.

The money flows affecting U.S. dollar-based commodity prices in recent years are those instigated predominately by Wall Street investors, i.e., banks, investment firms, hedge firms, broker-dealers and the like, who, cumulatively, far outspend other buyers. Though Wall Street money has always been in the commodity futures markets to a smaller degree, unprecedented quantities of money flowed into the market between 2002 and 2006 (1998 for the energy markets), as investors sought “new” markets that were less correlated with other asset classes.

Over this period the total volume of spending in the futures markets increased by a factor of four to six times its prior level (**Figure 17**). Wall Street money flows cause most commodities to move more or less in sync with each other, as investors tend to buy across all commodities when they invest, and sell across all commodities when they quickly deleverage. Perceived—and real—increased financial risk in 2008 caused investors to suddenly shed commodities, sending prices 40-60% lower, along with all other financial asset prices—even as the world remained “hungry.”

**Figure 17:** Total futures market spending since 1986 on the commodities listed in the chart.



Source: CFTC, authors' calculations

Although these financial investors/speculators have nothing to do with the various industries that produce or use commodities, they nonetheless are buyers of commodities and they compete against traditional buyers (i.e., users of commodities) with their investment dollars. Thus far, they have outbid a majority of traditional commodity buyers.

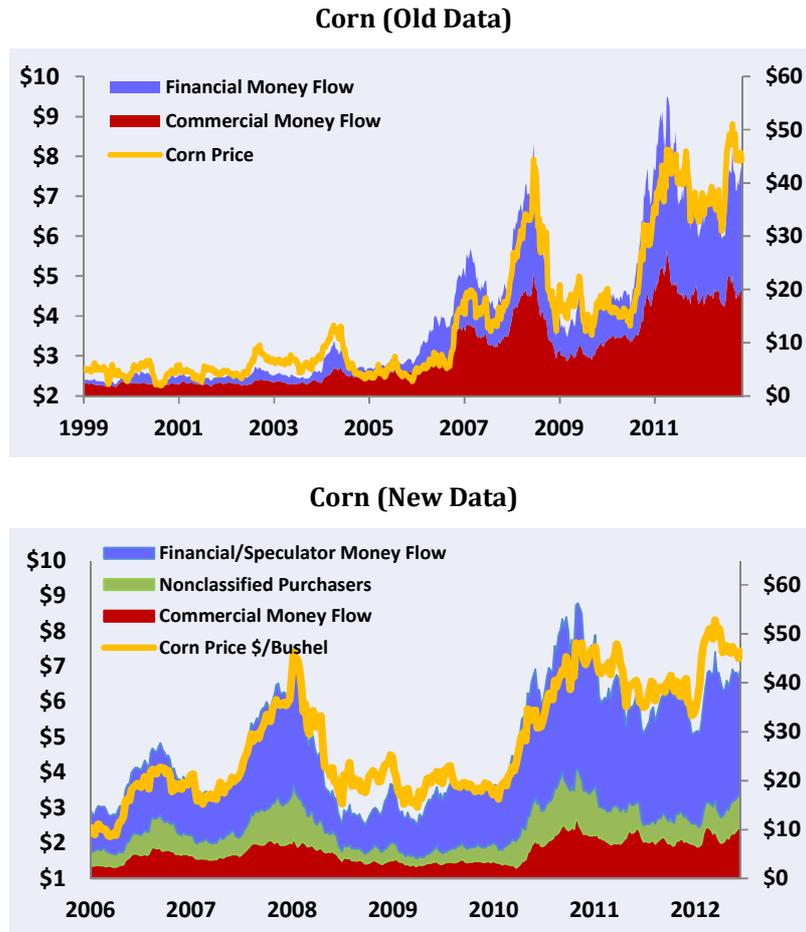
In fact, in recent years financial/speculator purchasing has represented the vast majority of spending in the futures market. For example, since 2006, over 65% of transactions in the corn futures market have consisted of investor money, and 40% of those transactions come from index investors specifically. Similarly, 82% of spending in the wheat market is done by Wall Street, as is 87% in the oil futures market. Additionally, 80% of trades on the futures market consist of day trading, not long-term purchases. Clearly, Wall Street dominates the commodity markets.

The charts in **Figure 18** give a visual depiction of the vast volumes of Wall Street spending by showing the money flow of both commercial-oriented traders and of Wall Street in the corn, live cattle and cotton markets.<sup>5</sup> The information is based on CFTC Commitment of Traders (COT) data. The first chart uses the old CFTC reports while the other three charts use the newer, more accurate and detailed data. Whereas commercial spending used to be

<sup>5</sup> Money flow is equal to price times open interest, since price times quantity equals total revenues/total spending.

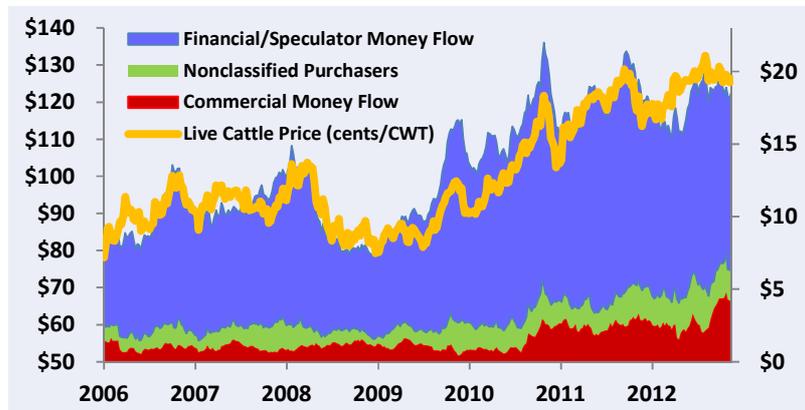
between 75-90% of the spending in these markets, it now averages 20-30%—even as its nominal volume has increased, not decreased. It is monetary factors outside of the the agriculture world that are most affecting agriculture prices.

**Figure 18:** Futures market spending divided between Wall Street and non-Wall Street players (left-hand side is price, right-hand side is billions of dollars in spending)<sup>6</sup>

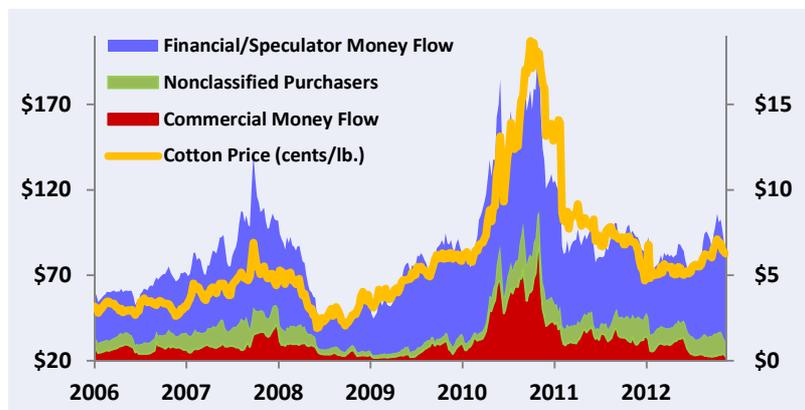


<sup>6</sup> Cotton and live cattle charts contain futures prices, while corn contains cash price. Detailed data was not kept prior to 2006.

### Live Cattle



### Cotton



Source for all Fig. 18 charts: U.S. Commodity Futures Trading Commission, authors' calculations.

### Conclusion

While short-term changes in production, supply, stocks, and the stocks-to-use ratio do correlate with and often cause price changes, they do not set or alter the overall level of prices. What affects the overall level of prices is the quantity of money spent on the product relative to the amount of product sold (which does not include the product kept off the market in stocks).

As supply slowly increases through time, the reason it does not lead to falling prices is that spending outpaces supply growth. The result is commodity price inflation, which most people attribute to the fundamentals instead of its true source—the banking system and the central bank. Sometimes the rate of increased spending is low, sometimes it is high.

Since increased production and supply could never be responsible for *higher* prices, and since most of the price volatility in the commodity market are caused by monetary changes, focusing solely on the traditional fundamentals and ignoring monetary factors will result in an inability to understand and forecast prices.

Significant attention should be paid to central bank policies as well as Wall Street's access to new and additional money and the extent to which it includes commodities in its asset allocation decisions.

**This paper is the fourth in a series of five:**

"4 Reasons Why Ethanol Doesn't Drive Corn Prices," January 2013

"Demand from China: Fact or Fiction?" August 2013

"Food, Hunger and Commodity Prices," December 2013

"The Stocks-to-Use Ratio: Is it Meaningful For Price Determination?"

"News, Fundamentals, Money, and Prices," Forthcoming



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## About GROWMARK

GROWMARK is a \$10 billion regional agricultural cooperative based in Bloomington, Ill. GROWMARK is owned by local member cooperatives and provides those cooperatives and other customers with fuels, lubricants, plant nutrients, crop protection products, seed, structures, equipment, and grain marketing assistance. In addition, GROWMARK provides a host of services from warehousing and logistics to training and marketing support. The GROWMARK System serves customers in more than 40 states and Ontario, Canada.

