

Grain price volatility - a problem, a necessity, and cause for reform

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Abstract

High global grain prices and price volatility have generally been perceived to cause food supply chain insecurity and monetary inflation problems. Whilst acknowledging that grain price spikes are caused by perceived product shortages, this paper argues that the occasional high price is essential to alleviate farmer poverty, induce farm investment, and thus protect future food production.

Paradoxically, the research found that it was not price volatility that was jeopardizing grain production but basis volatility that eroded the ability of farmers to manage price and supply chain risks. Rather than advocating more government intervention, price controls and farmer subsidies, this paper proposes that clearer pricing signals, improved price benchmarking, and reforms such as the introduction of a port-based Black Sea wheat futures contract are required to ensure future food production security.

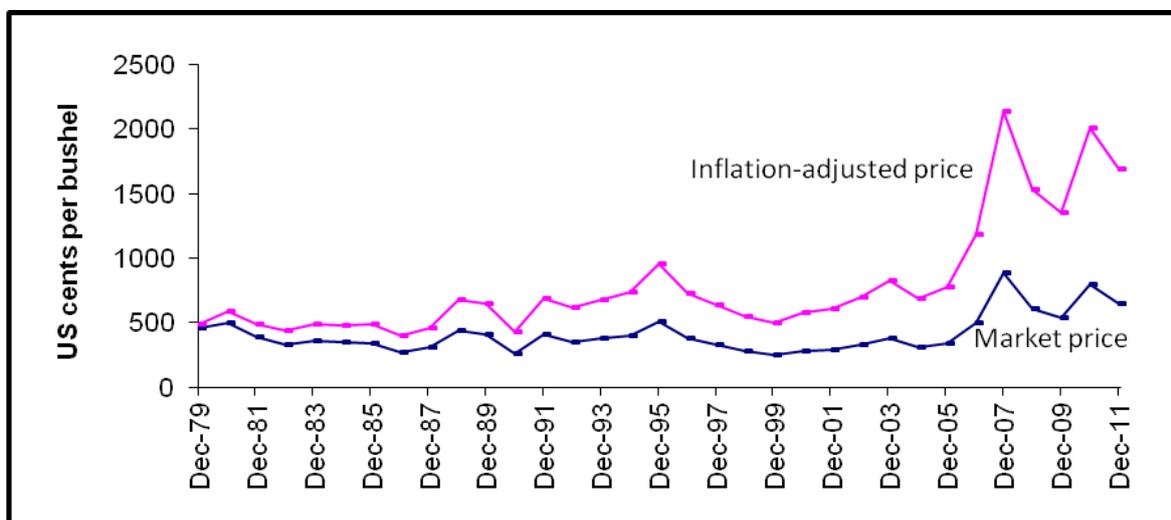
Key words: Price volatility, skewness, basis risk/benchmarking, hoarding, deregulation.

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Background

Williams (2012) indicated that global wheat market prices have lagged inflation-adjusted prices over the past 30 years (Figure 1). If wheat price increases had matched annual inflation adjustments, then current annual average spot wheat prices should be above US 1500 cents per bushel (US\$551 per tonne) instead of actually being below US 1000 cents per bushel (US\$367 per tonne).

Figure 1. CME wheat annual inflation-adjusted price verses market price: 1979-2011.



Source: Williams based on CME wheat futures prices and US Bureau of Labor Statistics, 2011

Despite the global concern over 'high' food prices during 2007-08 (Tokgoz *et al* 2008), the average daily wheat price between 1979-2011 was only US 399 cents per bushel (US\$147 per tonne), at a time of high fuel, fertilizer, and transport costs. The commodity poverty trap (Coote 1996) for wheat growers caused by falling real prices and rising costs is apparent in some countries, particularly when exporting countries incur high domestic currency exchange rates against the US dollar. There is a real cost-price squeeze that is increasingly forcing many large and small farmers out of business, compared to previous decades (Williams 2012).

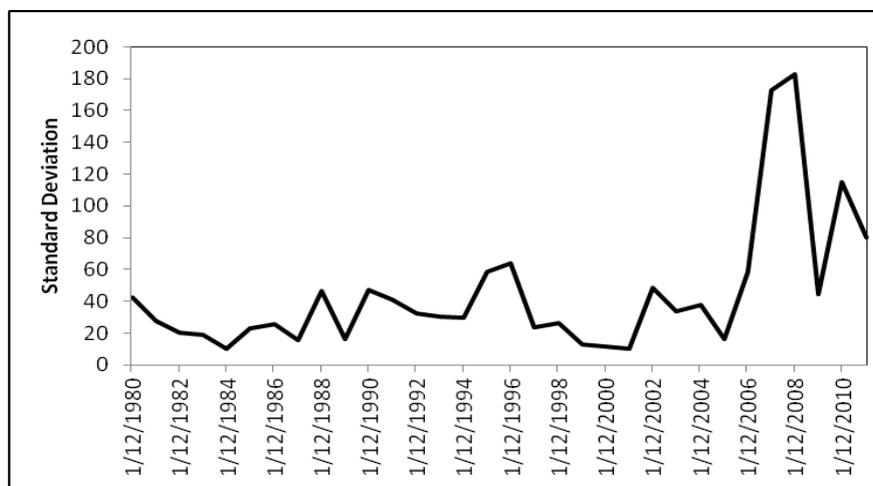
A high proportion of Australian wheat farmers failed to make a profit in 2011 because of the high currency exchange rate and input costs, combined with average yields and high fuel-driven transport and shipping freight costs. This was a repeat of the same concern over farm profitability in 2005 (FAO 2006). On-farm wheat prices during late 2011 were less than US 400 cents per bushel (US \$147 per tonne), even for milling wheat, which was below cost of production for many farmers. Argentinean growers claimed that wheat prices were too low in 2012 to justify buying seed to plant wheat (Brugler 2012). This implies that any future global food insecurity could be caused by inadequate rewards to farmers rather than any weather-driven production risk.

This farm unprofitability is likely to lead to production decreases and possible short-price spikes, as it did after 2005 (Piesse and Thirtle 2009). The alternative response by farmers to low profitability is to withhold supply (hoard), either in the speculative hope to gain from higher prices, or an attempt to force prices higher. One serious problem for wheat growers is the continuous global planting and harvesting in many countries in both the north and south hemispheres for at least eleven months of the year. It is very difficult for any farmer group or a single country to influence the global wheat price for any length of time (Schap 1993).

From an annual perspective, the 2007-08 wheat ‘spike’ was much less than the consumer price indexed inflation for the same period (Figure 1). The ‘spike’ was initially weather driven by drought in eastern Australia, wet conditions during spring planting in the USA, and spring-thawing problems in Eastern Europe (Piesse and Thirtle 2009), but then was politically driven in an US election year (2008) when alternate fuel policies such as corn-based ethanol became an important issue, and then was economically driven by government acquisition panic and export bans (Williams, 2012). It is hypothesized that prices were also psychologically driven by farmer hoarding in an effort to achieve longer-term farm profitability.

The question arises as to whether price volatility, as experienced during 2007-08, can be beneficial for farmers. Figure 2 depicts annual standard deviations on CME average annual wheat prices during 1979-2011 as one measure of price volatility. During 1980-2006, standard deviation ranged from 10 to 60; however it reached 182 during 2008 before declining once again. The standard deviation for 2011 was below 80.

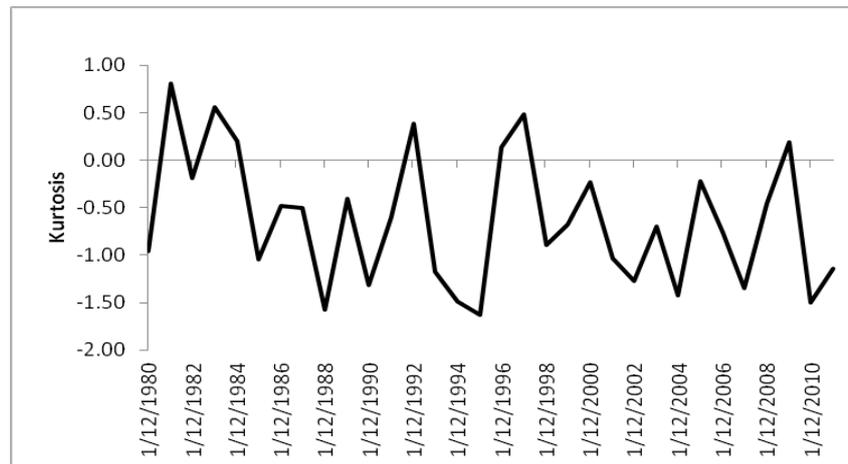
Figure 2. CME average annual wheat prices: Annual standard deviation for 1980-2011.



Source: Williams based on CME/CBOT wheat futures prices sourced from PremiumData

Alternatively, when prices increase, the question arises as to whether prices remain high for any length of time to allow farmers to benefit from such opportunities. A study of kurtosis indicates that positive kurtosis occurred in 1981, 1983, 1992, 1996, and 2008 (Figure 3). This suggests that high prices peak for only very short periods of time, with most of the time being flat at low prices.

Figure 3. CME average annual wheat prices: Annual kurtosis for 1980-2011.



Source: Williams based on CME/CBOT wheat futures prices sourced from PremiumData

Based on the low probability of high standard deviation and the low frequency of positive kurtosis, global grain farmers have very little opportunity to capture high prices in any price risk management strategy. As well, there is high basis and currency risk incurred by global farmers whenever they undertake price risk management strategies that have relevancy weaknesses (Irwin *et al* 2009). There is a need for reform in the risk-offsetting mechanisms to make price risk management more relevant for global grain producers. Such reforms would also benefit merchants and end users.

Research questions arise as to whether there has been a fundamental change to the global grain market that might benefit farmers and future production; whether 2007-08 was a statistical outlier and therefore should be ignored in any risk analyses; whether price volatility could alleviate farmer poverty and thus ensure future adequate production and global food security; and whether there is cause for reform within the food supply chain by government, industry organizations and risk managers.

Method

The research focused on analysing farmer decision-making behaviour, price skewness, price regression analyses, and basis analysis with the aim to draw conclusions on seller psychology, price characteristic changes, the impact on supply in the food supply chain, and market efficiency. There were four research objectives:

- 1. To study the selling and pricing decision making of medium to large scale Australian wheat farmers in a deregulated supply chain environment under production uncertainty with a focus on identifying hoarder behavioural characteristics.*

The study focused on the 2005 Australian wheat year that mostly had average yields and lower prices, and tested the behaviour of northern NSW users and non-users of five selling methods and six pricing-hedging strategies against eighteen management and seventeen risk attitude-adoption questions using the Fisher Exact Test (Williams 2009). The ninety-six question survey resulted in forty wheat grower returns from a general survey population of 277 (14 percent response rate). This survey response may be compared with Musser's Canadian behavioural study (Musser *et al* 1996) with 62 survey returns from a targeted top-farmer established group (75 percent response rate), a similar 1993 Canadian behavioural

decision-making study had only forty usable responses from actual workshop participants (Xu *et al* 2005), while the AFFA (2003) Australian-wide behavioural study had only forty survey returns for NSW grain growers from a total survey population of 229 Australian grain growers. Surveys on farmer behavioural decision-making in both Canada and Australia have generally resulted in much lower survey response rates than US surveys because of the much higher production risk and decision-making uncertainties, as well as the complexity of the psychological focus of the survey questionnaire (Williams and Malcolm 2012).

The five selling methods studied were the National export pool (single-desk), farmer storage (either warehoused or on-farm), forward contracting (either with a merchant or end-user), cash sale at or near harvest, and privately-managed pools (either by private companies or cooperatives). Pricing-hedging strategies included over-the-counter (OTC) bank pricing products, futures hedging using futures advisers, futures hedging directly through futures brokers, merchant forward pricing products offered to growers, private pool price management, and 'do-nothing' such as no forward selling or pricing/hedging.

An associated pilot study by Williams, Sounness, Park, and Price (2006) questioned why wheat growers stored on-farm. The survey was mailed out to 400 wheat growers in the Wimmera district of Victoria based on the 2005 wheat crop using an existing DPI Victoria farmer data-base. Fifty-one questionnaires were returned fully completed, representing 13 per cent.

2. Objective: To test Mandelbrot's theory of positive agricultural price skewness with a focus on the likely impact on grain growers.

The study used 30-year (1981-2011) spot-month continuous monthly futures price data for CBOT/CME wheat, corn, and rice to determine skewness as measured by percent rank, based on the percentage of price occurrence above a particular price. It then focused on three sub-periods (1981-1990; 1991-2000; and 2001-2011) to determine any fundamental shift in price skewness on spot-month continuous monthly futures price data for CBOT/CME wheat.

3. Objective: To test the theories of Davis (1938) and Keynes (1939) that granary hoarding is the key to successful storable food supply chain outcomes.

Regression of standard deviation against annual averaged futures price data for CBOT/CME wheat was used to determine any recurring high price periodicity during 1980-2011. As well, regression of skewness against annual averaged futures price data for CBOT/CME wheat during 1980-2011 was used to determine the annual characteristics of wheat surplus and shortage years. Non-recurring and short high price periodicity might suggest that wheat surpluses could erode the profitability of any granary hoarding in most years.

4. Objective: To test international market price efficiency through basis analysis with a focus on the need for reform.

Monthly basis differences between port-based Dalian ex-warehouse No 2 corn and up-country CME ex-warehouse No 2 corn were examined in USD per tonne. Low basis volatility would indicate efficient international price benchmarking mechanisms, price hedging effectiveness, with little need for reform. Alternatively, high basis volatility would indicate inefficient international price benchmarking mechanisms, price hedging ineffectiveness, and a need for reform.

Results

There were key results for all four research objectives.

Results 1. Survey responses from the Pilot Study included 6 percent of wheat growers who stored on-farm due to speculating on price rises, 6 percent hoped for a better price, while 6 percent used on-farm storage for price averaging and risk spreading (Williams, Sounness, Park, and Price 2006). Because the responses were not mutually exclusive, the conclusion from this sample was that the percentage of farmers who hoarded for the purpose of achieving a better price ranged from 6 - 18 percent.

Full research results of the major survey are included in Williams (2009) and Williams and Malcolm (2012). Those growers who used post-harvest storage methods were found to be:

- more likely ($p = 0.05$) to make decisions alone
- more likely ($p = 0.06$) to make decisions spontaneously
- more likely ($p = 0.06$) to change their risk attitude depending on their role
- more likely ($p = 0.06$) to be reluctant or sceptical in adoption of new selling/pricing ideas
- more likely ($p = 0.01$) to perceive that they achieve realistic targeted prices

The perception of achieving realistic targeted prices was strong from a p-statistic perspective, relative to the other characteristic findings. On the assumption that most of those growers who stored after harvest did so because of the expectation of a higher price, empirical evidence supports the findings that hoarders make spontaneous decisions alone and that they actually believe in achieving realistic target prices.

Regardless of how the ‘targeted’ price was determined or achieved, it is the intrinsic belief system that prices will rise sometime after harvest which appears to be important in sustaining the hoarding activity. However, the secretive behaviour of the hoarder belies any research attempt to accurately determine decision making characteristics relating to the psychology of storing and selling. Much of the actual hoarding success would seem to depend on the frequency of pricing and selling opportunities as reflected in price skewness and kurtosis.

Results 2. There was positive skewness for CME wheat, corn, and rice (Figure 4), with asymmetric tails extending towards higher prices. Mandelbrot’s theory of positive price skewness for agricultural products was upheld. Low prices predominated for long periods and high prices existed only for short periods.

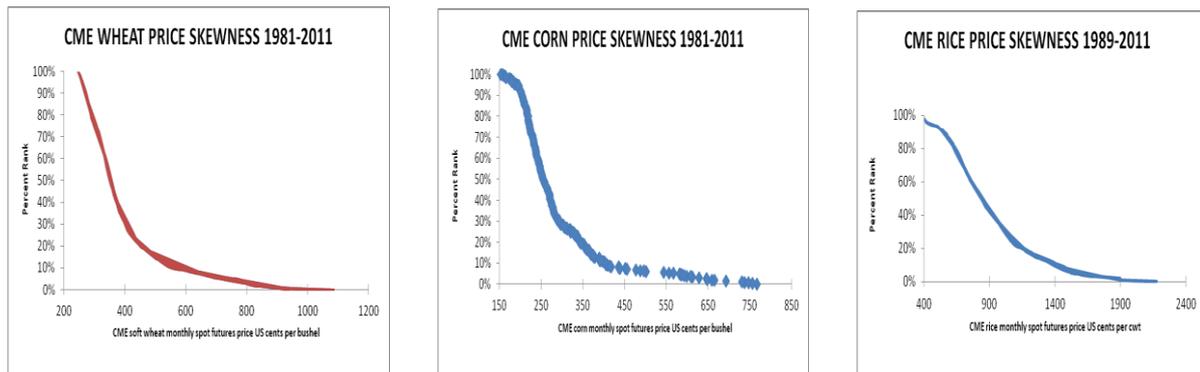
The concavity was strongest for wheat and weakest for rice, with the mean price exceeding the median price as follows:

Wheat: Mean US 394 cents per bushel > Median US 354 cents per bushel

Corn: Mean US 290 cents per bushel > Median US 254 cents per bushel

Rice: Mean US 904 cents per cwt > Median US 831 cents per cwt

Figure 4. Commodity price skewness - CME monthly wheat, corn, and rice: 1981-2011.

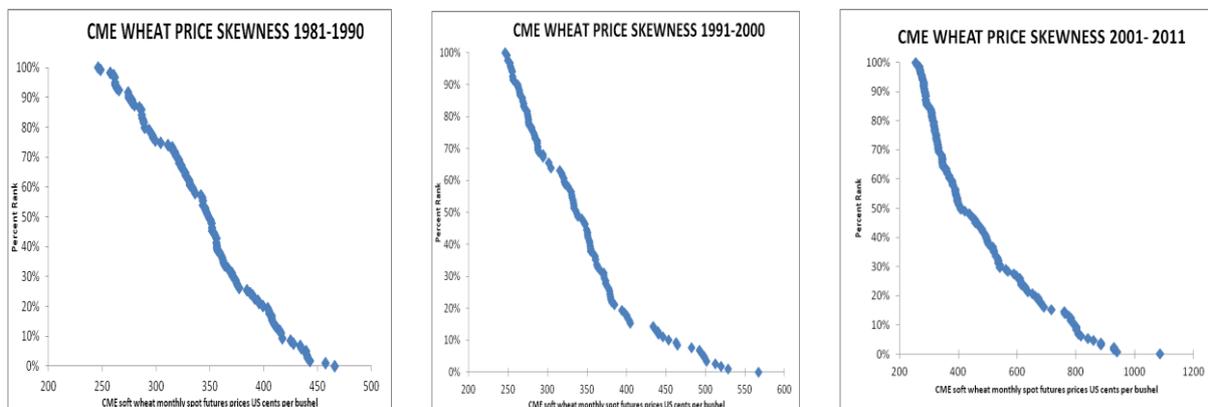


Source: Williams based on CME/CBOT wheat futures prices sourced from PremiumData

These results indicated that wheat growers were more disadvantaged with low prices than compared with corn and rice. If the commodity poverty trap is to occur, then it would be more likely to occur with wheat rather than with coarse grains. Hoarding was likely to offer very few opportunities for wheat growers to become profitable. The question remained as to whether this concave positive price skewness for wheat is increasing or decreasing. This would indicate whether successful outcomes from wheat hoarding were increasing or decreasing over time.

An analysis for changes in wheat skewness over three ten-year periods since 1981 indicated that the positively-skewed concavity for wheat was intensifying rather than decreasing (Figure 5). The concavity was weakest for 1981-1990 and strongest for 2001-2011.

Figure 5. Price skewness - CME monthly wheat: 1981-1990; 1991-2000; 2001-2011.



Source: Williams based on CME/CBOT wheat futures prices sourced from PremiumData

Wheat skewness was negative for the period 1981-1990, and then reverted to positive for 1991-2000 and 2001-2011, with the mean and median price relationship as follows:

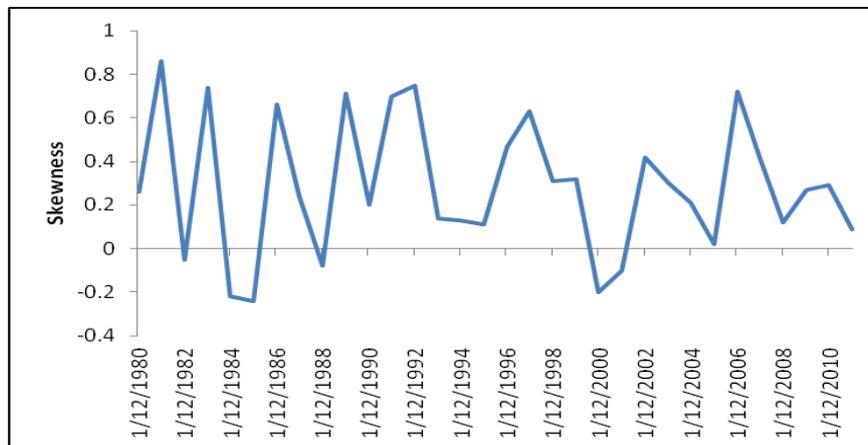
1981-1990: Mean US 347 cents per bushel < Median US 349 cents per bushel (negative)

1991-2000: Mean US 344 cents per bushel > Median US 336 cents per bushel (positive)

2001-2011: Mean US 483 cents per bushel > Median US 407 cents per bushel (positive)

There was positive skewness in all years during 1980-2011, except for 1982, 1984/85, 1988, and 2000/01, with only two occurrences (1984/85 and 2000/01) of any lengthy negative period (Figure 6). The prolonged periods of positive skewness decreased the opportunities for successfully hoarding wheat, either by individual farmers or through public granaries.

Figure 6. Skewness: Annual CME wheat prices: 1980-2011.

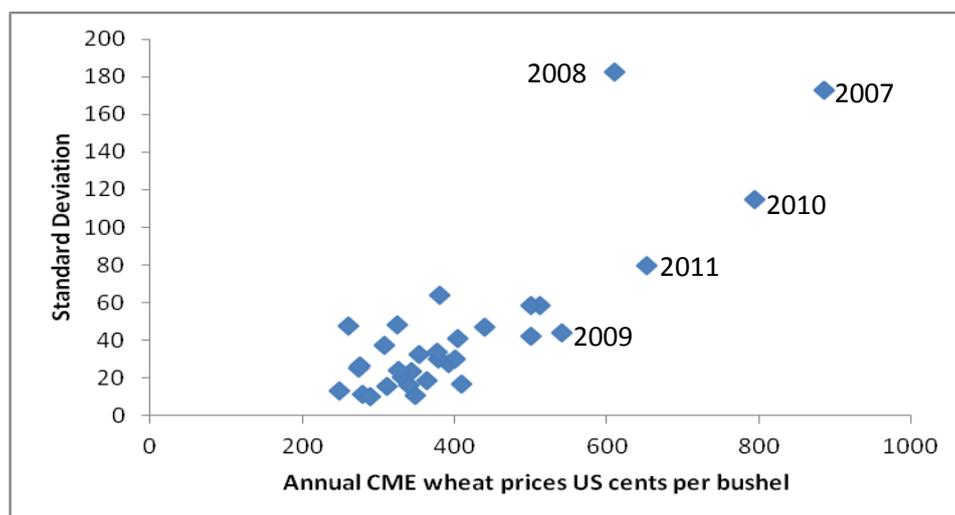


Source: Williams based on CME/CBOT wheat futures prices sourced from PremiumData

Results 3.

The regression of standard deviations against CME annual wheat prices is depicted in Figure 7. There was a clustering of relationships at prices below 600 cents/bushel with small standard deviations. There were four statistical outliers above 600 cents/bushel and all occurred since 2007.

Figure 7. CME average annual wheat prices: Standard deviations regressed against price for 1980-2011.



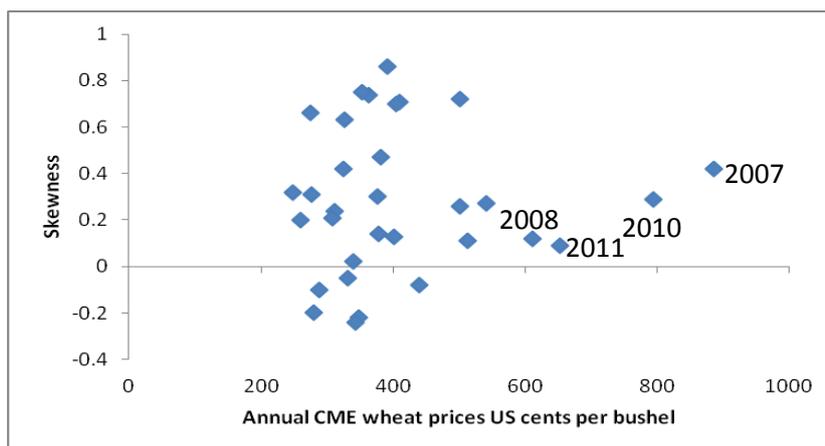
Source: Williams based on CME/CBOT wheat futures prices sourced from PremiumData

Based on this regression analysis, there was no finding of any recurring periodicity during 1980-2011, as evidenced by the irregular group clustering below 600 cents/bushel between

1980 and 2006. The outlier period of 2007-2011 suggested that this irregularity also occurred at higher prices as well.

The results of the regression of CME annual wheat prices against price skewness are depicted in Figure 8. Previous positive skewness at low prices was merely extended with the 2007-2011 outlier period. The clustering occurred below US 600 cents/bushel until 2006, which was the year of FAO concern over low grain prices (FAO 2006). The 2007-2011 outlier periods might be technically described as a breakout before returning to normal, similar to Lorenz's chaotic 'butterfly' effect (Lorenz 1963).

Figure 8. Skewness regressed against annual CME wheat prices 1980-2011.



Source: Williams based on CME/CBOT wheat futures prices sourced from PremiumData

On the assumption that positive skewness with a high probability of low prices is indicative of global wheat surpluses in most years, then the successfulness of granary hoarding in terms of pricing is very limited. Unless the timing coincided exactly with an increasing price shortage, hoarding will result in price falls in most years and be unprofitable. An end user could defer purchasing by using substitute products until the high price period quickly dissipated, as evidenced by the kurtosis in Figure 3. Alternatively, a grower could sell early into the commercial 'trade' market at higher prices, thus avoiding the risk of hoarding losses in a falling price market.

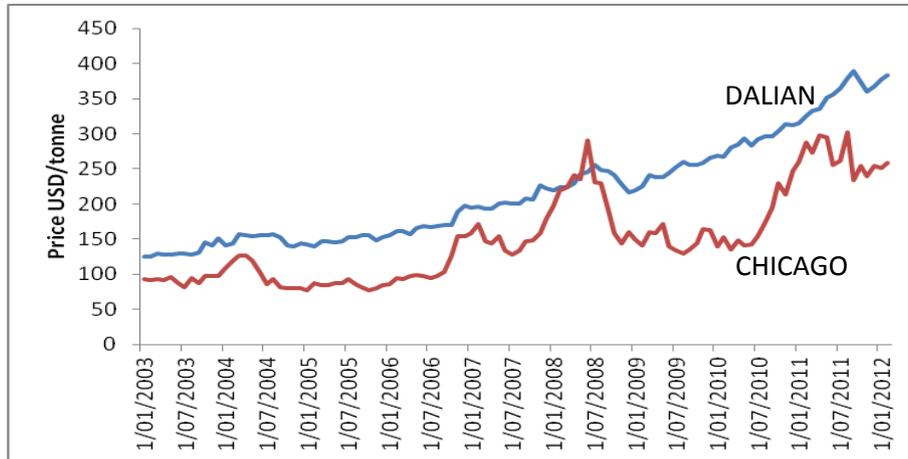
Results 4.

Monthly price differences between port-based Dalian ex-warehouse No 2 corn and up-country CME ex-warehouse No 2 corn were examined in USD per tonne. The problem with the Dalian corn prices is that they can reflect up-country China prices whenever there are domestic corn surpluses, and reflect international port-based prices whenever there are domestic corn shortages, as well as being affected by domestic government purchases/sales and hoarded stocks. The problem with the Chicago corn prices is that they can reflect up-country supply and demand conditions and not port-based realities, despite the predominance of exports, and be very dependent on domestic subsidy and barge freight influences (Irwin *et al.*, 2009).

From 2003 to 2006, the Dalian and Chicago corn prices moved approximately parallel (Figure 9), with Dalian prices above Chicago mostly to reflect the barge freight differential from Chicago to New Orleans. Price variance ranged from US \$30-80 per tonne and this included currency movement (Figure 10). Chinese imports of corn ranged from 2000 tonne

per annum during 2003-2005 to 62,000 tonne for 2005/06, and were classified as relatively low. Standard deviation of the difference between the two prices (basis) during 2003 to 2006 was only 8. The parallelness between the two prices was therefore within the minimum risk limits to offset positional risk in a price hedge.

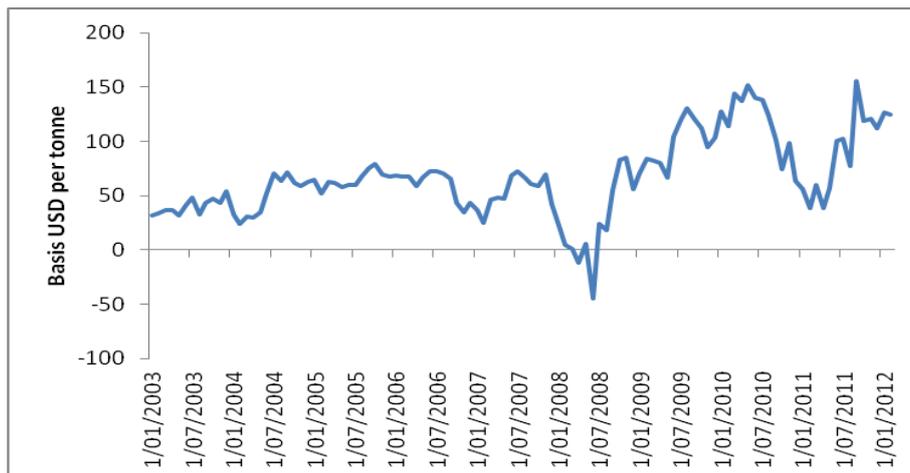
Figure 9. Corn No 2 ex-warehouse monthly futures prices at Dalian and Chicago in USD/tonne during 2003-2011.



Source: Williams based on CME data from PremiumData and Dalian data from Bloomberg

During the period 2006-2009, Chinese imports of corn ranged from 16,000 tonne in 2006/07 to 41,000 tonne in 2007/08 to 50,000 tonne in 2008/09. However, despite this relatively low import effect, the parallelness between Dalian and Chicago corn prices disappeared, with basis volatility as measured by the standard deviation increasing to 62. This is well beyond maximum risk limits to offset positional risk in a price hedge. A graph of basis movement between Dalian and Chicago corn prices is depicted in Figure 10.

Figure 10. Corn No 2 basis: ex-warehouse monthly futures prices at Dalian and Chicago in USD/tonne during 2003-2011.

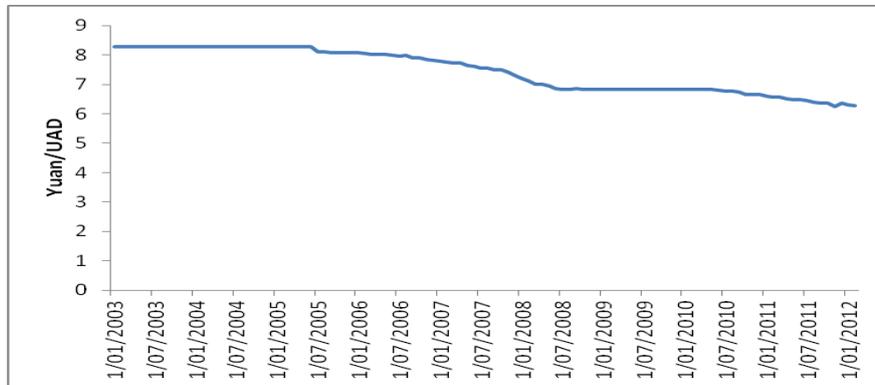


Source: Williams based on CME data from PremiumData and Dalian data from Bloomberg

Chicago prices rose higher than the Dalian price during 2008 (negative basis), and then reverted to a very volatile positive basis during 2009-2011 (Figures 9 and 10). Dalian corn prices appeared to be following official domestic Chinese inflation rates, as compared to

unofficial rates, while Chicago corn prices more likely reflected the volatility in US domestic corn-ethanol manufacturing caused by changes in ethanol subsidies, taxation, tariffs, trade restrictions, and crude oil-ethanol relativity. The basis volatility has not been influenced by the Yuan/USD exchange rate that has been steady, albeit slowing declining (Figure 11).

Figure 11. Yuan:US dollar exchange rate: 2003-2011.



Source: Williams based on Bloomberg data

This research outcome on basis volatility supports the findings on CBOT/CME corn by Irwin *et al* (2009) and Liu and Wang (2009). The extremely high basis volatility since 2007 indicates inefficient international price benchmarking mechanisms and price hedging ineffectiveness for corn. Irrelevancy of international pricing/hedging is a major issue, and has seriously worsened since 2007. The evidence suggests that reform is required.

Implications

Grain price volatility may be a problem, but paradoxically not in the usual manner in which it is currently portrayed. High grain prices occurred during 2007-2008, but there was short periodicity and it merely extended the positivity of wheat price skewness. The concave skewness for wheat prices has worsened over the last decade, which has resulted in an increasing commodity poverty trap for many grain growers. What many growers need is the prolonging of higher prices and greater price volatility rather than less, so as to ensure future farming profitability and food supply chain product security.

Despite the high pricing opportunity for producers, empirical evidence suggests that the positive kurtosis during the 2007-2008 price spike was of little benefit to the overall profitability of farmers. Many experience production shortfalls, which contributed to contract defaults on forward contracts and huge cash settlements on commodity price bank swaps, while others did nothing and lost any pricing opportunities. This suggests that high prices need to have a larger periodicity than what has been experienced, before any real positive benefits can accrue to farmers. However, given the Mandelbrot's positive skewness characteristic of commodity prices, any such periodicity is unlikely to occur in commodity markets.

It is not price volatility that is jeopardizing farmer's viability and global food security but rather basis volatility that destroys the effectiveness of producer hedging and price risk management opportunities. Farmers can survive prolonged periods of positive price skewness, provided that there are occasional or seasonal high prices combined with low basis risk. Alternatively, high basis risk as characterized by corn during the period 2007-2011

destroys the ability of farmers to hedge price effectively. If basis risk is worsened by up-country domestic influences and price distortions, then there is a need to reform the basis upon which price risk management is structured.

The introduction by CME of a port-based wheat futures contract on Black Sea grain ports must be perceived a major reform towards global port-based futures pricing, similar to that occurring for sugar and coffee. This reform needs to be applied to other grains. Fund speculators can synergize with global hedgers and provide forward market liquidity, provided that basis risk is minimal.

There is a need for general public acceptance of higher prices rather than lower prices to ensure future farmer profitability and global food product security. Farm subsidies are not the answer, given artificial price distortions to the food supply chain, the continual drain on fiscal expenditure at a time of high government debt, and the propensity for subsidies to encourage further surpluses and low prices (Williams 2012). The period 2007-2008 should not be considered a statistical outlier, but rather an important occurrence to ensure the viability of production in the global food supply chain.

Global wheat demand increased during the period 1979-2005 due to population increases and rising incomes (International Grains Council 2011), yet this made little apparent difference to the periodicity of standard deviations during this period. This suggests that 2007-2008 was not longer-term demand driven, but rather shorter-term driven by temporary supply shortages that were either real due to production difficulties, or were artificially induced through hoarding, government acquisition panic, and export bans.

Public and private hoarding of grain is unlikely to be profitable in most years, given the positive skewness of price, the increasing concavity of the skewness, and the low frequency of positive kurtosis. This undermines the public granary hoarding theories of Davis (1938) and Keynes (1939) because of the high probability of unprofitability (buying high-selling low), the encouragement of private hoarding whenever government purchases occur, and the high probability of low prices when old crop poor quality unaligned commodity is dumped onto food supply chains (Williams, 2012). The occurrence of private hoarding in response to government granary purchases was evidenced in Stalin's Russia, Hitler's Germany, Mao's China, and continues in North Korea, which contributed to food inflation, artificial shortages, and rationing (Williams, 2012).

Government intervention and price controls are also not the answer. Public intervention can result in removing price signals in the food supply chain, destroy the forward market mechanism that is required for managing price risk, cause the exiting of domestic end users resulting in greater dependence on international trade, remove the incentive for cluster industries, increase the occurrence of unwanted non-aligned low quality commodity, worsen farmer poverty, and increase the dependence on government largesse at a time when government fiscal budget balance is of primary concern under global economic uncertainty (Williams, 2012). The end result can be more private hoarding activity and speculative opportunistic behaviour. This is not conducive to risk management and security in the food product supply chain.

Possible solutions include increased competitive and contestable practices within storable food supply chains that can lead to greater food supply efficiency through the formation of commercial 'trade' markets and liquid forward markets, reform of the benchmarking of international basis to encourage relevant forward-futures price discovery, as well as

transparent pricing mechanisms that can provide effective supply chain signals to farmers, end users, and consumers so as to reward them whenever the correct supply chain decisions have been made. The end result can be less supply chain risk, more ability to offset risk, and greater reward for producer supply chain alignment with end users and consumers.

Conclusions

Price volatility has often been the reason most cited for government intervention, buffer stocks, and price controls. Yet it is the essence of food production, and without it, farmers would not be profitable and there would be acute food shortages. Consumers and policy makers must consider higher prices and volatility as being essential for longer term food security, and quite independent of monetary, inflationary and political pressures.

It is not grain price volatility that should be of current concern, but rather basis volatility that has eroded the ability to manage price risk and enhance price for farmers who have increasingly incurred poverty over the past few decades. The ability of grain growers to become profitable through the occasional price rise has been undermined by basis risk caused by the irrelevancy of current global grain price benchmarking mechanisms. There is a need for better global price benchmarking structures for grains, and the introduction of a Black Sea port-based CME wheat futures contract is a belated attempt to make the required reforms.

The positive skewness of grain prices, the increasing concavity of the skewness, and the low frequency of positive kurtosis are all biased against farmers who are being squeezed by lower real prices for output at the same time as rising input costs. When combined with irrelevant offsetting price risk management mechanisms, the situation has become untenable for many grain producers. This double impact on farmers is contributing to the uncertainty over future food production and supply chain product security.

Hoarding through public granaries and private storages of unwanted deteriorating quality commodity that is not specifically aligned to food supply chains is highly likely to result in price losses, encourage even greater private hoarding, distort the price signalling mechanism, and destroy domestic end users who are required to buy specific product. Historically, much government hoarding has resulted in artificial shortages that can induce price inflationary pressures, but destroy the food supply chain and increase the reliance on food imports and international aid. Private hoarders are likely to make selling and pricing decisions alone, spontaneously, and have a high perception of achieving realistic target prices.

Government intervention, price controls, and subsidies can result in the abundance of unwanted non-aligned low quality commodity, increase farmer poverty, encourage private hoarding, and increase the dependence on government for income. Speculative opportunism is likely to increase while the ability to manage price and supply chain risks diminishes because of price distortions that prevent the formation of effective forward-futures markets.

One possible solution is increased competitive and contestable practices within storable food supply chains that can lead to greater food supply efficiency through the formation of commercial 'trade' markets, cluster industries, and liquid relevant forward-futures markets, as well as transparent pricing that can provide effective supply chain signals to farmers so as to reward them whenever the correct supply chain decisions have been made.

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