The Puzzle of Recent Grain Price Behavior

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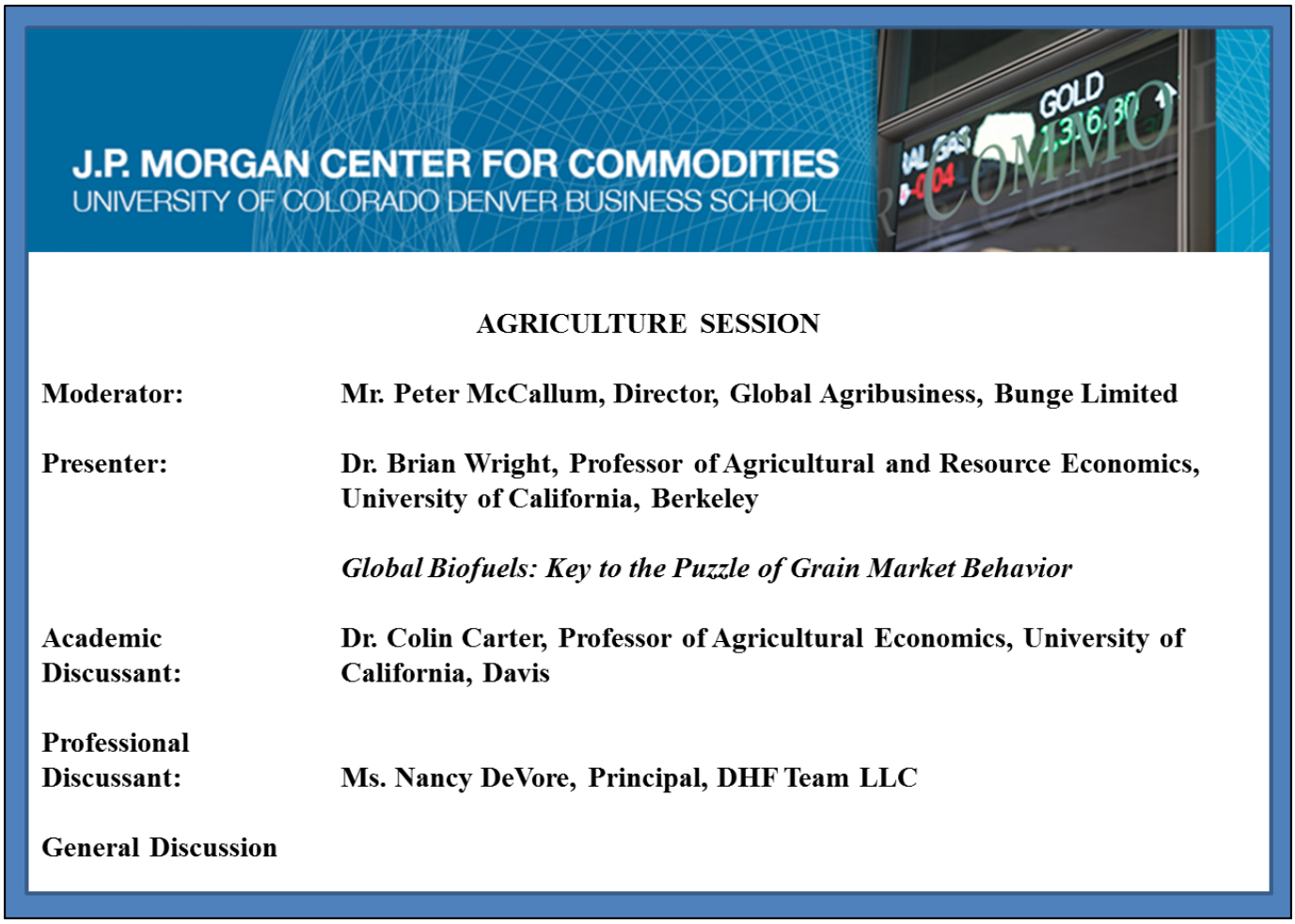
At the April 2015 J.P. Morgan Center for Commodities' (JPMCC's) Research Council meeting, Professor Brian Wright, University of California, Berkeley, discussed the puzzling behavior of grain prices during the last 10 years. Professor Wright's biography is at the end of this article. His Research Council presentation is based on Wright (2014). Mr. Peter McCallum, Bunge Limited, moderated the session while Professor Colin Carter, University of California, Davis, and Ms. Nancy DeVore, DHF Team, LLC, discussed Wright's research from both academic and practitioner perspectives, respectively.

Opening remarks by Mr. Peter McCallum (right), Director, Global Agribusiness, Bunge Limited, at the Research Council's Agricultural panel on April 18, 2015. Professor Brian Wright, Ph.D., University of California, Berkeley, is on the left. Both Mr. McCallum and Dr. Wright are members of the JPMCC's Research Council.

Professor Wright's presentation was during the Agricultural panel, whose agenda is in Figure 1. The Research Council meeting also included an Energy panel and a Metals-and-Mining panel. Articles on the other panels will appear in future issues of the JPMCC's *Global Commodities Applied Research Digest (GCARD).*

Figure 1
Excerpt from Research Council Meeting Agenda of April 18, 2015



Presentation from Professor Brian Wright, Ph.D.

Introduction

In summarizing Professor Wright's presentation, this article will draw from his paper, slides, and remarks at the Research Council meeting. This article will adopt the following conventions when referencing Professor Wright. When quoting Wright (2014), this article will include in parentheses, the page number from which the citation is drawn. When quoting Wright's April 2015 presentation, this article will include in parentheses, the slide number from which the citation is drawn. And when quoting Wright's

remarks at the Research Council meeting, this paper will include in parentheses, the timing of when the remarks were made during the afternoon session of the conference.

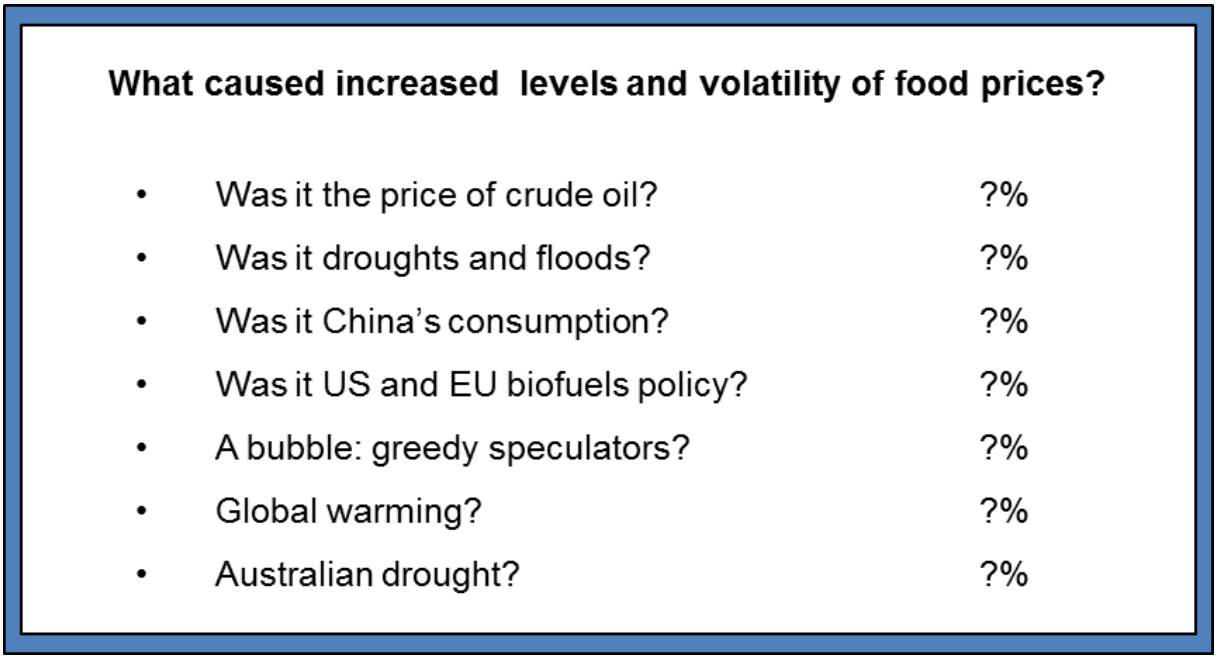
The Problem

"In the last half-decade," recounted Wright, there have been "sharp jumps in the prices of wheat, rice, and corn, which furnish about two-thirds of the calorie requirements of mankind …" (p. 73). In addition, [s]ince about 2005, international grain markets have seen several of the largest price jumps since the 1970s" (p. 84). And the problem isn't just the price spikes in 2007-2008 and in 2011. There has also been a "sustained large change in price level (Slide 7)." Compared to 2005, in 2014, the rice real price is 30% higher; the wheat real price is 40% higher; and maize (corn) prices are 75% higher (Slide 7).

Who is to Blame?

According to Wright, there has been a "bewildering list of factors," apportioning blame for the jumps in grain prices (p. 37). Figure 2 summarizes these factors.

Figure 2
The Blame Game in 2007



Source: Wright (2015a), Slide 2.

Is there an elegant theoretical model that does not treat this century's price spikes as due to a jumble of factors? Yes, and that is the subject of Wright's recent work.

The Puzzle

Wright notes that until 2004, a classic supply-and-demand model with two extensions had been successful in modeling grain price behavior at seasonal frequencies (p. 74 and Slide 4). But this enhanced model stopped working after 2005. Why? That is the puzzle.

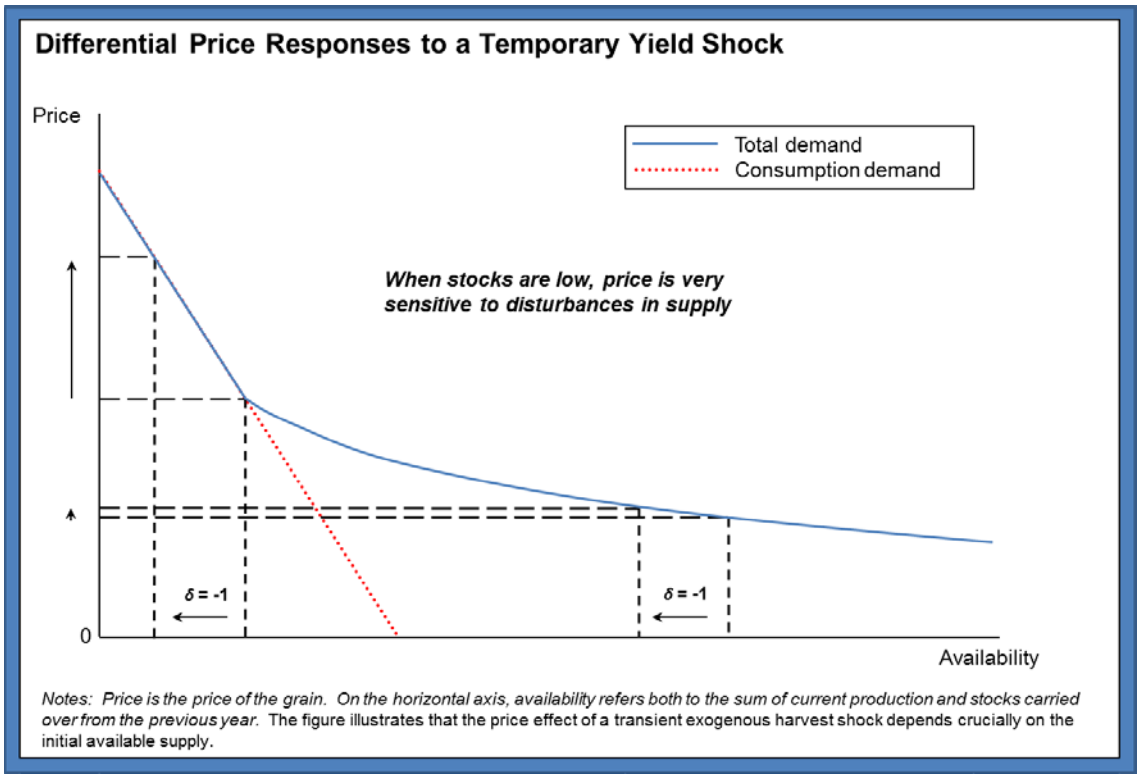
Pre-2005 Supply-and-Demand Models for Grains

In order to best appreciate the recent puzzle regarding grain price behavior, one must first have a basic understanding of the models that had formerly worked. First of all, one cannot analyze a specific commodity like rice solely on its own fundamentals such as its own quantity of inventories or harvest prospects. One has to also take into consideration, on the margin, what other grain might *substitute* for it in order to properly understand the price behavior of rice. Wright examines the market for "aggregate calories," combining the market for wheat, corn, and rice together rather than examining the market for each grain separately and independently (p. 81).

Secondly, one needs to also take into consideration another *substitution* effect, and that is the one across time: grain can be consumed now or in the future. In the latter case, this is the market for storage, which competes against the market for immediate consumption of grain.

From 1961 through 2004, as long as one incorporated the "substitution between grains as sources of calories, and [the] substitution between successive harvests via storage[,]" one could successfully model grain price behavior (p. 75 and p. 84). This model is graphically illustrated in Figure 3.

Figure 3
Storage Adds a Fundamental Nonlinearity to Demand



Source: Wright (2015a), Slide 64.

Wright clarifies that there is a meaningful kink in the demand curve in Figure 3. Demand consists of consumption demand *and* storage demand. The horizontal axis is available supply, which consists of "current production and stocks carried over from the previous year" (p. 78). When current prices are low, it is storage demand that determines prices. This demand is represented to the right of the kink in the graph. The steeply sloped line to the left of the kink is determined by consumption demand. Note how explosive (or not) the price response is to a supply shock depends on the "initial available supply" (p. 78). Note also that Figure 3 is a nonlinear function.

Wright (2015a) uses a delightful example from the popular Australian and New Zealand children's story, Who Sank the Boat?, to illustrate how a nonlinear function can make it difficult to apportion blame amongst various contributing factors (Slides 20 and 21). Please see Box 1.

Box 1

The Story of Who Sank the Boat?

"Imagine a pig carrying an umbrella, a sheep doing knitting, and a cow and a donkey and a mouse, all walking along on their back legs in single file.

What else is there to do on a fine sunny morning but to go for a row in the boat?

But there is one big question. 'Who sank the boat?'

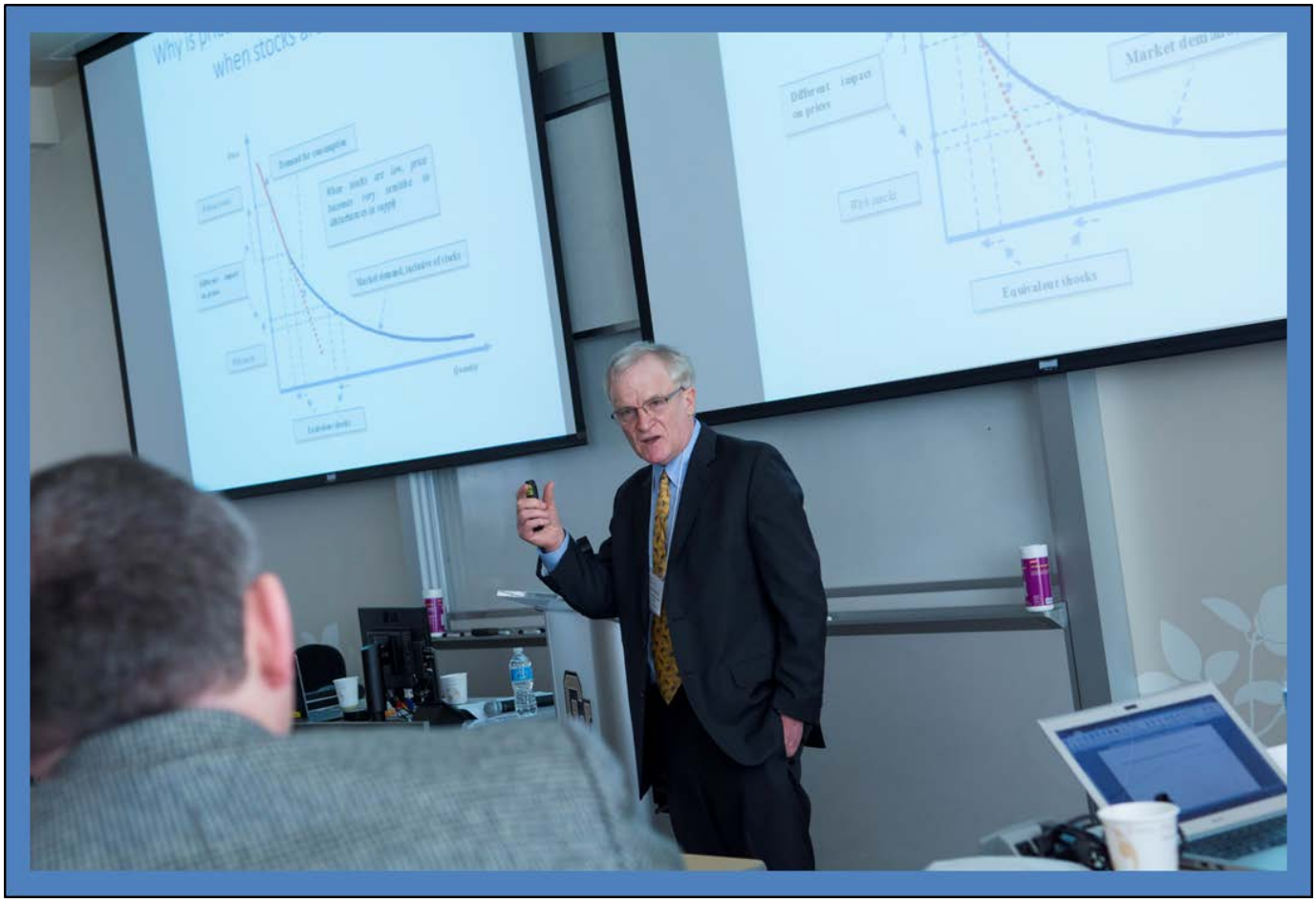
We are told the outcome right up front, but who was the culprit? The tension and suspense is fantastic as each creature in turn gets aboard. The donkey is a smart critter since he knew how to balance the weight of the cow. The sheep was just as smart since he got on the opposite side to the pig. We are now very low in the water now, but still afloat.

The smallest and the lightest of the friends [a naughty little mouse] now gets on board. … 'You DO know who sank the boat' - don't you?"

Source: "One Mouse Too Many" (2011).

In the Who Sank the Boat? story, would one entirely apportion blame on the incidental factor of the weight of the mouse, causing the boat to sink? "So is it 100% the mouse or 50% the pig" that is to blame? "It is … indeed … a nonsense question" when dealing with such a nonlinear function (Minutes 15:14 to 15:20 of Wright (2015b)).

The relevance of this children's story to grain price spikes is as follows. When there are low stocks (relative to consumption), any incidental factor can drive the price dramatically higher. At what price, would one choose not to have muffins in the morning? Wright (2011) had posed this question at a Commodity Futures Trading Commission research conference in explaining a nonlinear market model for grains. Just like with the children's story, one cannot assign a set percentage blame on any one factor when one is in the part of the price curve that is highly nonlinear. "[L]ow stocks make markets vulnerable to temporary harvest shortfalls" (p. 83).



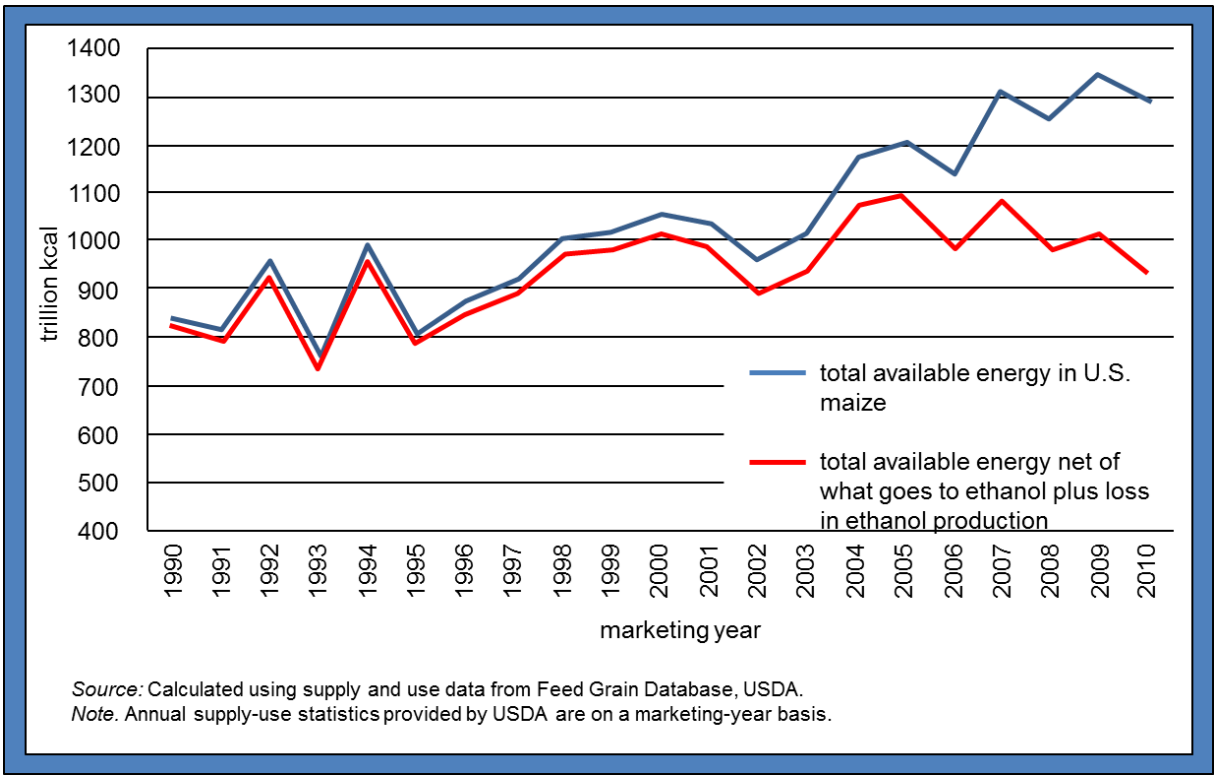
Professor Brian Wright, Ph.D., University of California, Berkeley, presenting at the Research Council's Agricultural panel on April 18, 2015.

A New Supply-and-Demand Model for Grains

"[M]arket observers were puzzled when prices, production, and stocks of grain calories all rose sharply between 2006 and 2008" (p. 87). These outcomes are not consistent with what would be expected based on the model represented by Figure 3.

What changed? "By the standards of agricultural policy changes, the introduction of grain and oilseeds biofuels for use in transport fuels was abrupt, and the effects of the balance between supply and demand were dramatic," especially after the introduction of "biofuel mandates as a policy instrument" in the 2005 Energy Policy Act (p. 85). Figure 4 illustrates how U.S. corn use for food and livestock feed eventually fell below its 1994 peak, as the use of ethanol (a biofuel) increased. Here, we see corn production increasing, but what is available for feed-and-feed eventually decreasing. "Currently, biofuels use accounts for about one-third of United States corn production (p. 86)."

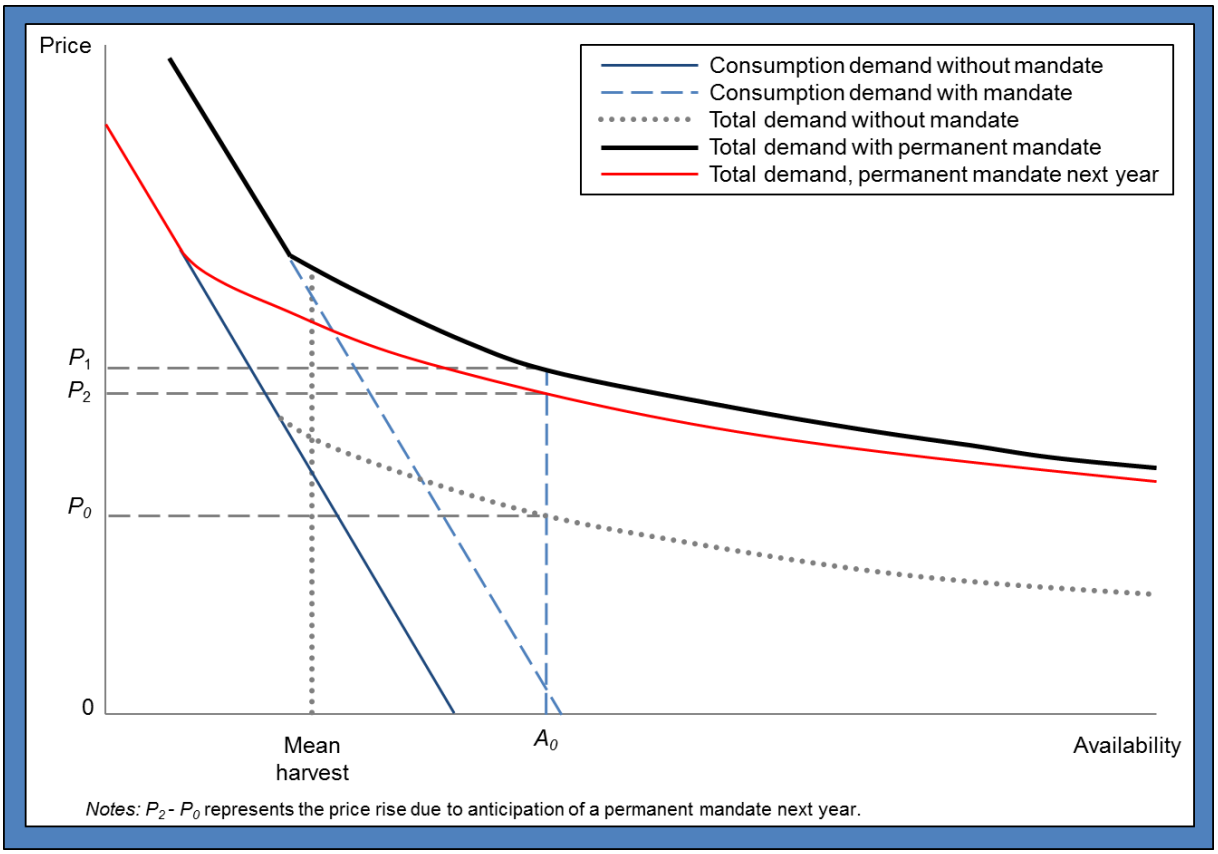
Figure 4
U.S. Maize (Corn) Energy for Food/Feed Fell Below 1994 Peak



Source: Wright (2015a), Slide 27.

Clearly, given the magnitude of this new demand factor, the market model described in the previous section needed to be updated to include biofuels. Specifically, "[t]o solve the puzzle of recent grain market behavior it is necessary to incorporate into the market model – in addition to substitution between grains as sources of calories, and substitution between successive harvests via storage – a third key substitution, that of biofuels for petroleum-based fuels (p. 75)." The updated model is graphically represented in Figure 5.

Figure 5
Why Stocks Rose as Prices Rose Circa 2007



Source: Wright (2015a), Slide 30.

The biofuel mandate is a (likely) *permanent* shift in demand and not a temporary shock so it is <u>not</u> appropriate to just trace along the old demand curve of Figure 3 in incorporating biofuel demand. "The opportunity to cushion the shock is limited by the fact that, by assumption, at any given price, the mandate increases total consumption in every future period (p. 86)." Wright expanded on this point in his remarks to the JPMCC Research Council: "When you have a permanent shift in demand," there will not be a reduction of stocks to meet this demand. These stocks will be increased "in anticipation of even greater demand later. That's exactly what happened. (Minutes 19:40 to 19:56)." Wright notes that the market model, incorporating biofuel mandates, satisfactorily explains the post-2005 behavior of grain prices, and therefore there is no need look further afield at other speculative hypotheses for explanations (pp. 87-88).

A New Link to Petroleum Prices

Wright clarifies that it is not only the biofuel mandates that have mattered. "[The] increases in permissible shares of biofuels in blending with gasoline or diesel[, which] … became attractive when petroleum prices were high[,]" has also mattered for grain prices (p. 94). Professor Colin Carter explained why this has been the case in his discussion of Wright's paper. Carter's discussion is covered in the next section of this article. In addition, Avalos and Lombardi (2015) verify the new statistical connection between corn and oil in post-2005 data. Their paper is summarized in the "Research Digest Articles" section of the Spring 2016 issue of the *GCARD.*

Conclusion

The "[f]ood-competing biofuels global expansion after 2005 led to [a] permanent demand shock [with a] short-run response [of a] price spike [and a] longer-run response [of] raised price levels" (Slide 47).

Policy Consequences

Wright observes that "[w]e have not seen anything even close to the 'worst case scenario' in global food markets" (Slide 45). "Corn ethanol, soy for diesel, and sugar ethanol can be expanded faster than yields can rise, *in response to mandate expansion or high oil price[s]*, keeping stock ratios low and food prices high and volatile for many years" (Slide 68). One might therefore conclude that the existing biofuel mandates should be tailored to realistic yield productivity estimates and to the prevailing oil-price environment. Ms. Nancy DeVore, DHF Team, LLC, covered related topics in her discussion of Wright's presentation. Her discussion is covered later in this article.

Presentation by Professor Colin Carter, Ph.D.

Professor Wright's presentation was followed by a brief discussion from Professor Colin Carter. The following is an edited transcription of Professor Carter's remarks and includes his slides.

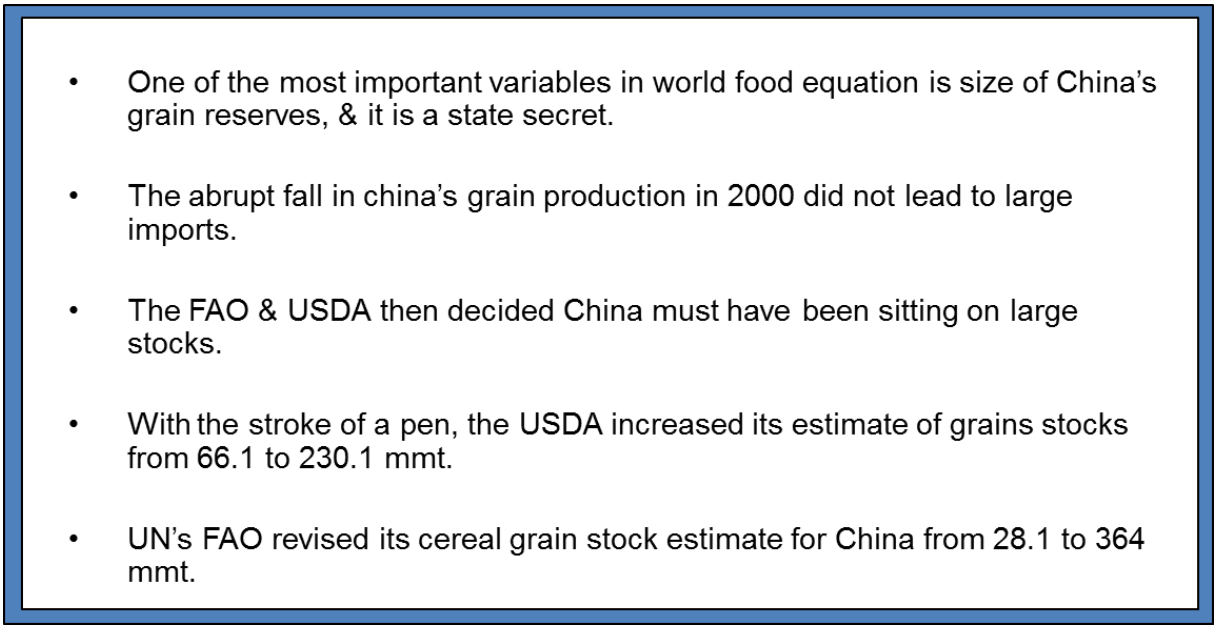
"It's a pleasure and honor to discuss Brian Wright's paper. There's a lot in the paper; I really encourage you to read it; it's very … good. I just wanted to try to make [several] … points …

The first has .. to do with the fact that unlike the oil market when you are studying grain markets, .. it's not even clear as to what a fact is, especially with some of the big players … [such as when] we're dealing with India [and] China.

… I'd also like to discuss where we are going with the renewable fuel standard, [which] Brian didn't really touch on… He talked about the impact of using corn, but my concern today is if we come back here in 3 years, Brian will be talking about the soybean market and biodiesel. …

So, first of all, Brian … alluded to this, and I just wanted to share it with you. We talked a lot about inventories, and his paper emphasizes the importance of modelling inventories properly. When it comes to China, we don't know what those inventories are … because it is a state secret." See Figure 6.

Figure 6
It's a State Secret

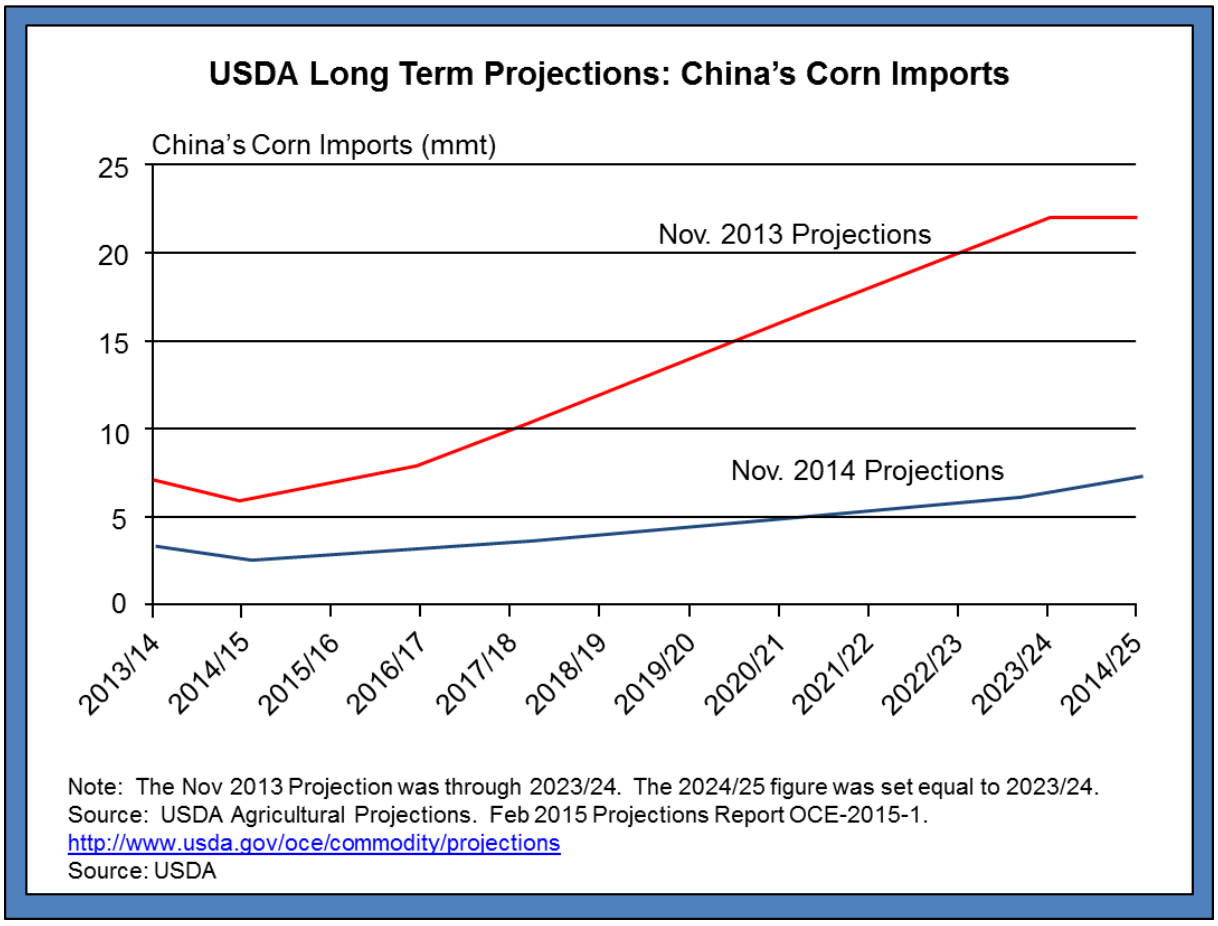


Source: Carter (2015b), Slide 2.

"Brian alluded to this: back in 2000, there was a drop in China's grain production. … It was a sharp drop. … Everyone was expecting imports to surge; it never happened, so guess what? [The] USDA revised its estimate of grain stocks from 66 to 230 million metric tons: that's … more than a small change. Not to be outdone, … FAO … changed their [grain stocks] number from 28 to 364 [million metric tons]. So keep in mind, that's a big number, so we don't really know what is happening in China with grain, livestock, and so on ..."

"This is a graph showing [the] USDA['s] … long-term projections. [See Figure 7.] Once a year, [they] release them in February. The red line shows their long-term projections of China's corn imports for the next 10 years. And you see that is was growing to over 20 million [metric] tons, which is a big change in the corn market. World corn trade is just over 100 million [metric] tons. So, an increase in trade of that extent would probably drive prices up 25 – 30%. This year, they lowered their numbers dramatically down to that blue line. There are alternative theories as to what has happened in the past year to justify that type of revision, and it would be interesting to find out [why]."

Figure 7
Most Recent USDA Projections of China's Corn Imports

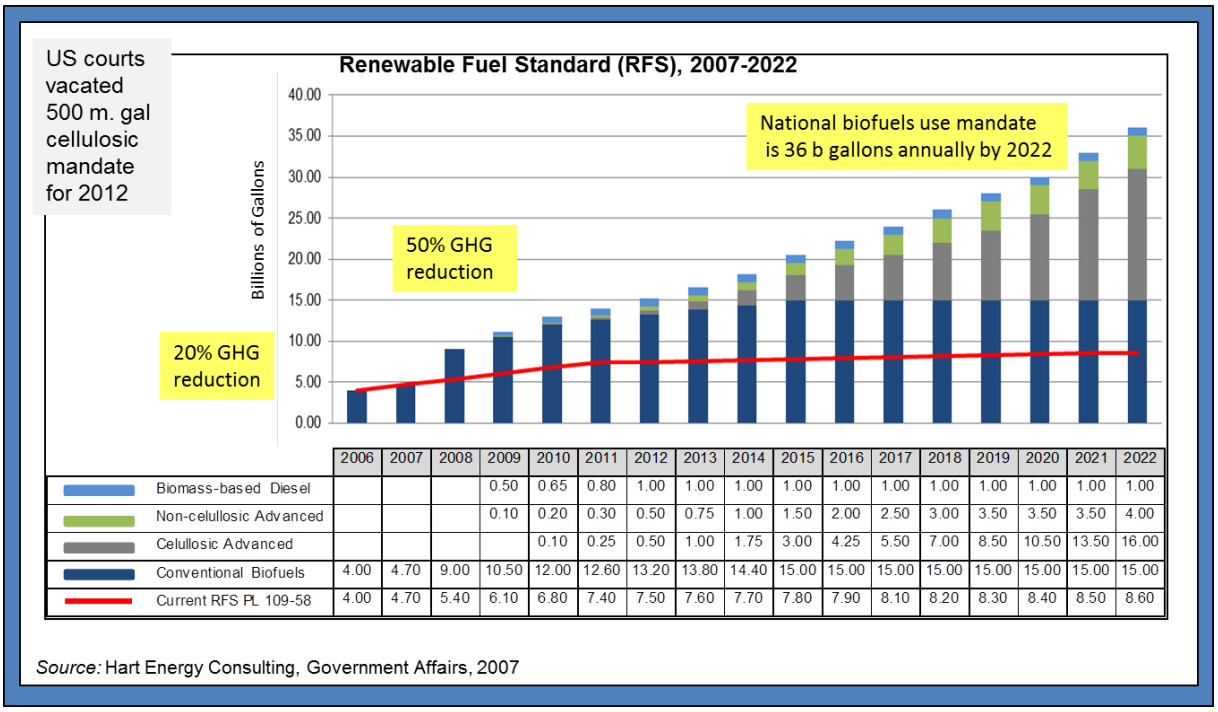


Source: Carter (2015a), Slide 3.

"… My next point is: where do we go with biofuels? Brian talked about the big impact that using corn for fuel has had on world food markets, and this graph shows a renewable fuel standard going through to 2022, which is not that far away. [See Figure 8.] We are looking at a requirement of 36 billion gallons of biofuel."

"The … [dark blue] portion of those bars is biofuels coming from corn; and the rest of it, as Brian said, would be cellulosic or … advanced biofuel. Well it turns out we don't have production of cellulosic. A couple of years ago the courts had to beat [the] EPA back because they were actually fining companies who were not buying cellulosic fuel even though there was no cellulosic fuel. So, my concern is, going forward, if nothing changes in our legislation, those bars are going to be filled with biodiesel and maybe … [using] soybeans. If you look at the economics of producing fuel from soybeans, it is pretty bad in terms of liters per acre, however you want to measure it, and we are currently using about 15% of our soybeans for fuel. My concern is what is going to happen in the next 3 or 4 years."

Figure 8
U.S. Goals re Renewable Fuels



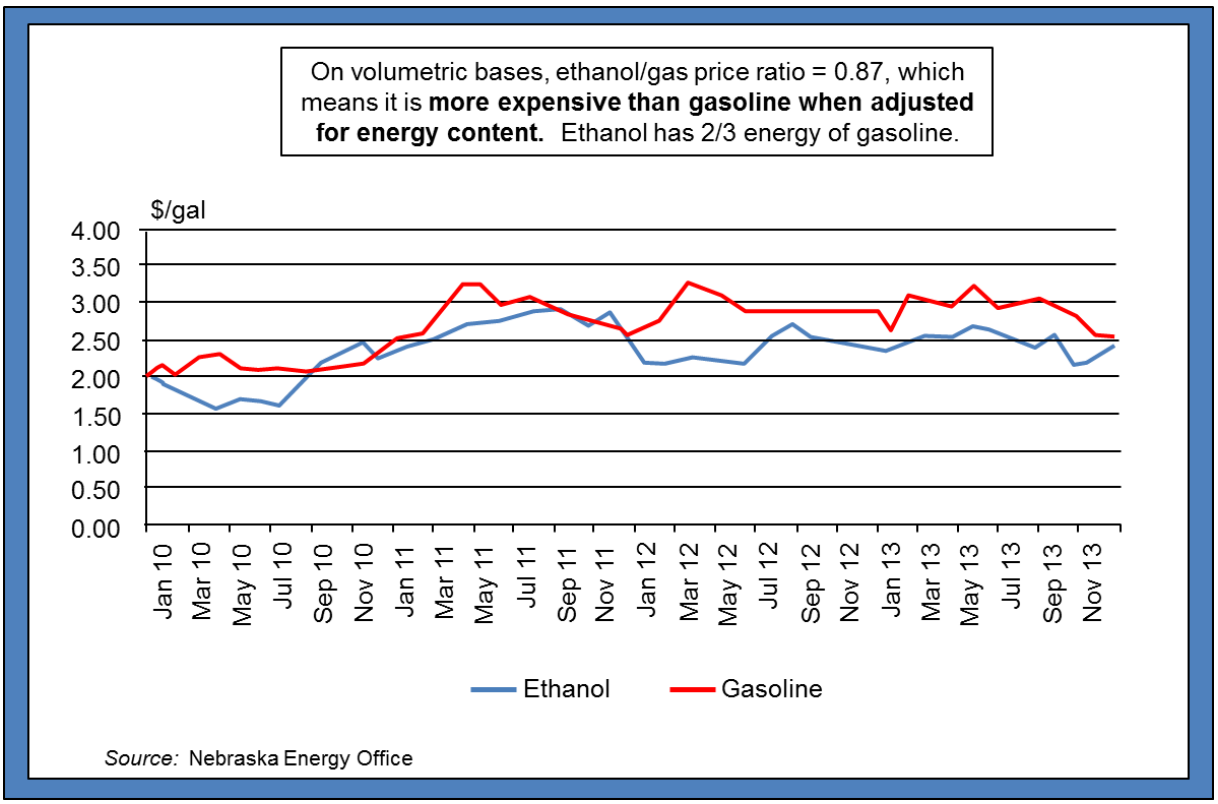
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Biomass-based Diesel				0.50	0.65	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Non-celullosic Advanced				0.10	0.20	0.30	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	3.50	3.50	4.00
Celullosic Advanced					0.10	0.25	0.50	1.00	1.75	3.00	4.25	5.50	7.00	8.50	10.50	13.50	16.00
Conventional Biofuels	4.00	4.70	9.00	10.50	12.00	12.60	13.20	13.80	14.40	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Current RFS PL 109-58	4.00	4.70	5.40	6.10	6.80	7.40	7.50	7.60	7.70	7.80	7.90	8.10	8.20	8.30	8.40	8.50	8.60

Source: Carter (2015a), Slide 4.

Professor Colin Carter, Ph.D., University of California, Davis, presenting at the Research Council's Agricultural panel on April 18, 2015. Professor Carter is also Chair of the JPMCC's Research Council. Dr. Bluford Putnam, Ph.D., CME Group, is on Professor Carter's left; and Professor Brian Wright, Ph.D., University of California, Berkeley, is on Professor Carter's right.

"One area I mentioned this morning that I am doing some research on is the impact of biofuels on the price of motor gasoline, and Brian talked a lot about the impact on the price of food. I think that the issue that is not discussed enough is the impact on gasoline when you fill up at the pump. And you probably know that corn ethanol has one-third less energy. So it's kind of nice when I go to Canada, I can pull into the pump and I can decide if I want to pump fuel with ethanol or without ethanol. In this country we don't have a choice. And as a result, you see the price of ethanol gets bid up relative to the price of gasoline above the price it should be, based on its energy content. It shouldn't be 87% of the price." See Figure 9.

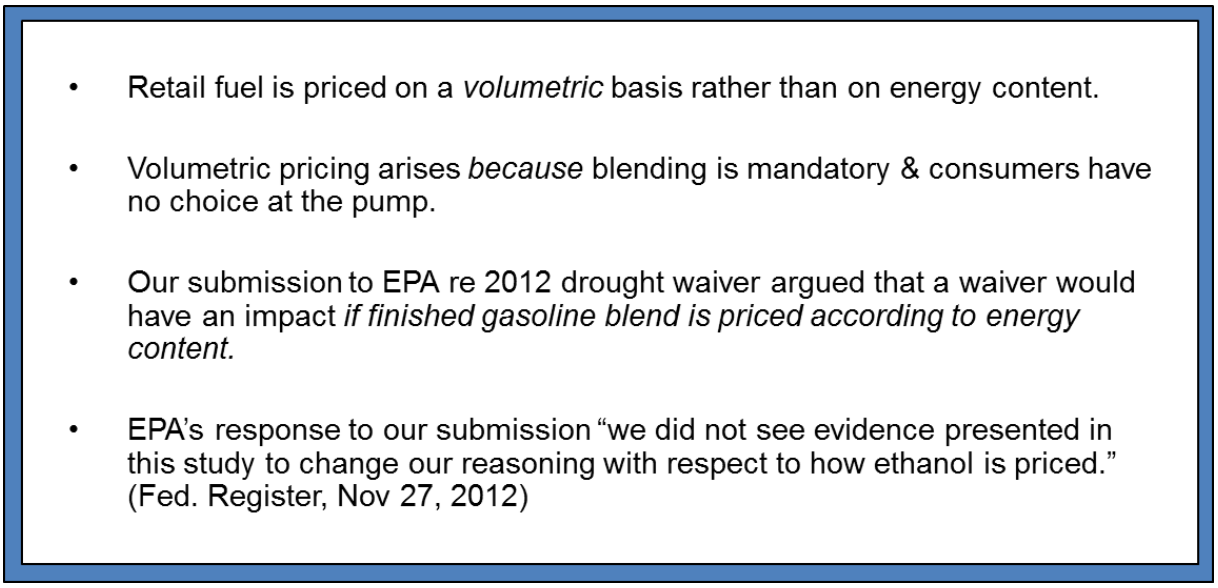
Figure 9
Price of Ethanol vs Gasoline (Rack Prices)



Source: Carter (2015a), Slide 5.

"So that [be]came … an issue a couple of years ago when we had the big drought in the U.S. Some of us, [including] Brian, … argued that the [impact of the] drought, which drove the price of corn to $8 a bushel, … could be modified if [the] EPA lowered its mandate on how much ethanol we have to put in the gas tank. … [A] group of us made a long submission to the EPA, and we said that if finished gasoline is priced according to energy content then if you lowered the mandate, there is going to be less production of ethanol. [Please see Figure 10.] I was a little surprised at first because people pushed us back on this argument. They said if we lower the mandate, if it's no longer required that we have to blend, at that time, 12 billion gallons, [and say] we lowered it to 10 or 8, they are still going to be producing ethanol because oil companies love ethanol."

Figure 10
Why is Ethanol Overpriced Relative to Energy Content in U.S.?



Source: Carter (2015a), Slide 6.

"Well I soon realized the reason they love ethanol is that they blend it into finished motor fuel, and they don't adjust the price for the energy content so they are basically cutting the product. … [This] means that we are [effectively] taxed at the gas pump … because … [ethanol] adds 33% less energy, and [yet] we are paying the same price for ethanol as we are for gasoline. …" The higher that oil and gasoline prices are, the more incentive there is for fuel producers to blend in ethanol to motor fuel, as Brian Wright had also noted earlier in his presentation to the Research Council.

Presentation by Ms. Nancy Devore, Principal, DHF Team, LLC

Professor Carter's presentation was followed by a discussion from Ms. Nancy DeVore. The following transcription is excerpted from her remarks.

"Moving forward I would like to suggest an alternative view … [regarding] the future role of biofuels in the global food picture. Now that capacity exists in biofuels, it actually can act as an equalizer to global supply rather than having sharp price fluctuations annually as we have historically seen in times of very high or very low production.

Biofuels can and do act somewhat as a silent store of grains. [When] weather is very good and yields are very high, biofuels can soak up some of the excess supply and keep grain prices from collapsing so much and impacting global farmers with reduced returns. On the other hand, when there are severe shortages, biofuels could quickly shut down and free up that grain supply, … smoothing out a potential price spike to consumers.

Ms. Nancy DeVore (with microphone), Principal, DHF Team, LLC, at the JPMCC Research Council meeting of April 18, 2015. Ms. DeVore is also a member of the JPMCC's Research Council.

But of course this can only happen if biofuel mandates are somewhat flexible. More governments are going to [have to] respond … [with] policy changes rapidly in times of need. Essentially the existence of [the] biofuels industry, [which] … has some flexibility to increase or reduce production when the economics warrant, … [could] have a price smoothing effect over the long run, … keeping prices from falling as much and softening price spikes and reducing the consumer impact in times of global grain shortages.

Most countries, though, are not that flexible: pretty much all the policies in the world are fairly strict [with] mandates except for Brazil, and I think that Brazil, … with their economic policy, comes closest to having something that is more ideal in terms of responding to the market conditions of the world. There are a lot of problems with the way the US and the EU mandates in particular were created [with] government trying to mandate technology. But the reality is that now we have these industries, … there is a way to turn this into an industry, which has a positive impact on the global food sector. This is … an area that we need more research in."

Conclusion

As Professor Brian Wright noted at the beginning of his presentation, "it's great to have the opportunity to really discuss the fundamental needs of humankind, energy and food, in this venue at a time when these markets are becoming more integrated (Minutes 3:07 to 3:20)." With this article, we are delighted to share some of the insights of the Research Council's distinguished presenters to a larger audience, regarding the recent puzzling behavior of grain prices.

Endnotes

Professor Brian Wright noted that his presentation was based on joint work with the following colleagues: Professor Eugenio Bobenrieth, Pontificia Universidad Católica de Chile; Professor Juan Bobenrieth, Universidad Del Bio-Bio, Chile; Dr. Di Zeng, Lawrence Berkeley National Laboratory; and Mr. Ernesto Guerra, University of California, Berkeley.

Katherine Farren, CAIA, Editorial Assistant for the *GCARD*, transcribed the April 2015 J.P. Morgan Center for Commodity's Research Council presentations in their entirety.

References

Allen, P., 1996, Who Sank the Boat?, New York: The Putnam and Grosset Group.

Avalos, F. and Lombardi, M., 2015, "The Biofuel Connection: Impact of US Regulation on Oil and Food Prices," BIS Working Paper, No. 487, February.
Available at SSRN: http://ssrn.com/abstract=2564242 and
Summarized in the *Global Commodities Applied Research Digest* of Spring 2016.

Carter, C., 2015, "Brief Comments on the Economics of Grain Stocks & Biofuels," Slide Presentation, Research Council meeting of the J.P. Morgan Center for Commodities, University of Colorado Denver Business School, Afternoon Session, Agricultural Panel, April 18.

Carter, C., 2015, Transcribed Remarks, Research Council meeting of the J.P. Morgan Center for Commodities, University of Colorado Denver Business School, Afternoon Session, Agricultural Panel, April 18, Minutes 28:28 through 36:22.

DeVore, N., 2015, Transcribed Remarks, Research Council meeting of the J.P. Morgan Center for Commodities, University of Colorado Denver Business School, Afternoon Session, Agricultural Panel, April 18, Minutes 37:20 through 55:20.

"One Mouse Too Many," 2011, Customer Review of Who Sank The Boat?, Amazon, February 27. Retrieved from:
http://www.amazon.com/review/R1KQXHE1FIBKKL/ref=cm_cr_pr_viewpnt#R1KQXHE1FIBKKL
on January 12, 2016.

Wright, B., 2011, Transcribed Remarks, "On the Economics of Grain Price Volatility," CFTC Conference on Commodity Markets, Washington, D.C., August 26.

Wright, B., 2014, "Global Biofuels: Key to the Puzzle of Grain Market Behavior," *Journal of Economic Perspectives*, Vol. 28, No. 1, Winter, pp. 73-98.

Wright, B., 2015a, "Global Biofuels: Key to the Puzzle of Grain Market Behavior," Slide Presentation, Research Council meeting of the J.P. Morgan Center for Commodities, University of Colorado Denver Business School, Afternoon Session, Agricultural Panel, April 18.

Wright, B., 2015b, "Global Biofuels: Key to the Puzzle of Grain Market Behavior," Transcribed Remarks, Research Council meeting of the J.P. Morgan Center for Commodities, University of Colorado Denver Business School, Afternoon Session, Agricultural Panel, April 18, Minutes 3:00 through 27:35.

BRIAN WRIGHT, Ph.D.
Professor of Agricultural and Resource Economics, University of California, Berkeley

Brian Wright's interests in economics of commodity markets, innovation and intellectual property rights date from his early experiences on his family's sheep station near Wakool in the Riverina district of New South Wales, Australia. He received a Bachelor of Agricultural Economics (First Class honors) from the University of New England, Armidale, and won a Frank Knox Fellowship to Harvard University, where he received a Ph.D. in Economics. He then joined Yale University's Economics Department and is now Professor of Agricultural and Resource Economics at the University of California, Berkeley, recently ranked top in its field in research and reputation by the United States National Research Council.

His research interests include economics of markets for storable commodities, market stabilization, futures markets, agricultural policy, industrial organization, public finance, invention incentives, intellectual property rights, the economics of research and development, and the economics of conservation and innovation of genetic resources. He has co-authored or co-edited several books, including Storage and Commodity Markets; Reforming Agricultural Commodity Policy; Saving Seeds: The Economics of Conserving Genetic Resources at the CGIAR Centers, and Accessing Biodiversity and Sharing the Benefits: Lessons from Implementing the Convention on Biodiversity. He has published extensively in the leading journals in Economics and Agricultural Economics and in *Nature*, *Nature Biotechnology*, *The Handbook of Plant Biotechnology*, and *Crop Science*.

Professor Wright is also a member of the J.P. Morgan Center for Commodities' Research Council at the University of Colorado Denver Business School.