A Model of Grains Prices with Application to the Impact of Biofuels

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Abstract

The paper reports preliminary results from an econometric model of world grains markets. The model is used to address the source of shocks (demand or supply?), the scale of their price impact (greater for corn than wheat) and the price impact of the growth of the use of corn as a biofuel feedstock (substantial for corn, less so for wheat). We also ask whether it makes sense to think of grains as a single composite commodity or whether idiosyncratic crop-specific factors remain important.

Keywords: grains, corn, wheat, biofuels

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1. Introduction

This paper is an exercise in the recent economic history of world grains markets. The food price boom started in the second half of 2006 and lasted until 2014. At their peak, nominal corn prices exceeded December 2005 levels by 180%, wheat prices did so by 189% and soybean price by 156%. By December 2015, wheat prices were only 4% above their level ten years previously although corn and soybean prices remained 42% and 33% higher respectively.[1] A large literature has discussed the causes of these elevated prices and many have speculated that both the price rises, and the associated higher volatility, might be permanent. We analyze three related questions:

a) What are the main shocks that have driven the world grains economy over the past three decades?
b) To what extent was the growth of corn use for biofuels production a driver of grains prices over the period since 2004?
c) Does a "law of one price" hold such that we can think of a single grains price and ignore differences between specific grains?

2. Model description

We address these questions through simulation of an econometrically estimated model of the world grain economy. Grains are governed by an annual planting and harvesting cycle and this makes it natural to use annual (crop year) data. The consequence is that a long sample is required to obtain precise parameter estimates. The model in this paper is estimated on annual data covering the period 1960-61 to 2015-16 (56 observations) although a subset of equations is estimated over the shorter sample 1981-82 to 2015-16 (35 observations) because of reduced data availability or apparent structural change. Except where otherwise stated, data are taken from the Production, Supply and Distribution (PSD) data files made available by the USDA Foreign Agricultural Service.[2] The sample we have used is the longest sample available for the PSD dataset.

[1] Source: IMF, *International Financial Statistics*. Deflation is by the UD Producer Price Index (all items).
[2] https://apps.fas.usda.gov/psdonline/app/index.html#/app/downloads . Although the crude PSD data satisfy the market clearing identity for each region, world net exports are non-zero. We redefine RoW net

The basic model has a similar structure to that reported by Westcott and Hoffman (1999) who also confine their attention to wheat and corn. It differs from their model in its more pronounced focus on interactions between the wheat and corn markets and in the longer sample (1960-61 to 2015-16 against their 1974-75 to 1995-96). Use of a long sample obliges the modeler to allow for the possibility of structural change. Specifically, we follow Abbott (2014), Avalos (2014), Al-Maadid et al. (2017) and Gilbert and Mugera (2017) in arguing that growth of the use of corn as an ethanol feedstock has affected the functioning of the world grains markets. On this basis, we extend the basic model to accommodate the biofuels-induced structural evolution of the markets. The extended model is discussed in section 4, below.

The different grains compete with each other for planting area and also for the consumer dollar. Consumer preferences can be relatively rigid but farmers and merchants hive greater flexibility in adjusting the mix of grains that goes into animal feed. As the consequence, the markets for the different grains are closely linked and, to be useful, a model must reflect these links. Corn (maize), wheat, soybeans (strictly an oilseed) and rice are the four most important grains in international commerce. The current version of the model contains a corn and a wheat sector. A third sector, covering soybeans, will be included in the next (conference) version of the paper. Rice is largely produced in countries which are also important in rice consumption. Trade is less important and so the rice price is less closely linked to the other three prices.

The most important futures markets for corn, wheat and soybeans are in Chicago. The Chicago market sets the benchmark prices which are either used as a pricing basis in the rest of the world or are closely related to regional benchmark prices. We therefore use US dollar grains prices and also the US (WTI) price for crude oil. All prices are deflated by the US PPI.[3]

We use a three-way geographical disaggregation (USA, China, Rest of World, henceforth RoW) and model planted area, yield, food, feed and biofuels consumption, net export and stocks. We distinguish the US from the rest of the world in part because the PSD data for US stocks and flows are almost certainly accurate than those for the rest of the world, because stocks held in

exports as the negative of US and Chinese net exports and adjust RoW closing stocks to ensure the identity is maintained.

[3] Source: IMF, *International Financial Statistics*. Crop year (October – September) averages are constructed from the reported monthly prices.

the US are more easily deliverable on Chicago markets than those held outside the US and are therefore potentially more relevant to price determination, and because many governments hold stocks for purposes of food security and these stocks will not normally be available on international markets. These considerations relate particularly strongly to China which has been broadly self-sufficient in corn and wheat (but not soybeans) over the period we examine and which has seen, perhaps as a consequence, large stock movements which have had little impact on world markets. We therefore treat China separately. Although we model Chinese stocks and flows we do not find any link between Chinese and other markets. By contrast, trade between the United States and the rest of the world, exclusive of China, results in a global market.[4]

The structure of the model is as follows. The planted area A_{jkt} (j = corn, wheat; k = USA, China, RoW) in year t depends on prices expected to prevail at the time of harvest. We suppose that these expected price in year t depends on the previous year's price $P_{j,t-1}$ and the ratio of stocks at the end of the previous crop year to the consumption trend $S_{jk,t-1}/T_{jkt}$ in the region in question.[5] The equation is specified as a partial adjustment on the price in the previous crop year together with a time trend. We do not find any evidence of cross-price effects.

- Yield Y_{jkt} is defined as H_{jkt}/A_{jkt} where H_{jkt} is the harvest quantity. It is modeled as a first order autoregression augmented by a time trend. The equation for RoW corn yield also contains the current year corn price.
- Grains consumption C_{jkt} distinguishes food, feed and, for US corn, biofuels uses. Food consumption is total consumption less consumption in feed or biofuels. Food and feed consumption are modeled on a per capita basis for both the USA and China and US consumption is related to real per capita household consumption.[6] Cross-price effects are

[4] Westcott and Hoffman (1999) include the stock-consumption ratio in the four major non-US exporting countries (Australia, Argentina, Canada and the EU) for each of corn and wheat but appear to take these ratios as exogenously determined. Pfuderer (2015) argues that the Chinese markets are partially integrated with world markets in that China imports when it experience a grains deficit but adds any surplus to inventory.

[5] The consumption trend is generated by fitting a smooth trend to the total domestic consumption series allowing for a single stochastic cycle. Measuring stocks relative to a flexible trend eliminates potential endogeneity concerns which would arise in use of the simple stock-consumption ratio. The stock variable is dropped from the Chinese area equations where the coefficient is poorly determined.

[6] Source for population and household consumption data (calendar year basis): IMF, *International Financial Statistics*.

included where these are correctly signed. The Chinese wheat consumption equations also contain the stock-trend consumption ratio since it appears that the availability of wheat for food consumption may have been determined directly by availability. US consumption of food for biofuels is discussed in section 4 below.

- Chinese net exports $X_{j,China,t}$ are determined by a trend splined in 1991. US net exports $X_{j,USA,t}$ depend on closing stocks at the end of the previous year and, in the case of wheat, the current year balance between production $H_{wheat,USA,t}$. and consumption $C_{wheat,USA,t}$ using a partial adjustment structure.
- The corn and wheat price equations have an identical structure and relate the current logarithmic (deflated) dollar price $\ln P_{jt}$ to world closing stocks outside China at the end of the previous crop year to smooth trends T_{jkt} in total consumption. These variables are defined as $Z_{jt} = (S_{j,USA,t-1} + S_{j,RoW,t-1})/(T_{j,USA,t} + T_{j,RoW,t})$. The exclusion of Chinese stocks, which is supported by the data, may stem either from the lack of availability of these stocks on world markets or from the fact that they are poorly measured by the USDA. Competitive storage theory implies that this relationship should be nonlinear and we therefore enter the variable into the equation as the reciprocal $1/Z_{jt}$.[7] Both reciprocal stock-consumption ratios enter both equations. The equations also contain the WTI price and the value of the US dollar against the euro.[8]

Equations are estimated by Ordinary Least Squares or, where there are endogenous regressors, Instrumental Variables.[9]

Table 1 reports the estimated price elasticities. The supply response elasticities are modest in the range 0.1 to 0.3, higher in the United States than outside. Wheat consumption has a low price responsiveness except in China while consumption in feed is very sensitive to price.

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[7] The nonlinear specification gives a better fit than the corresponding linear specification but the extent of curvature is poorly defined. Irwin and Good (2016) also adopt a reciprocal specification.

[8] DM prior to 1999. Source: IMF, *International Financial Statistics*. Data are on a crop year basis.

[9] Instruments are the lagged reciprocal stock-consumption rations, the log of the euro exchange rate against the US dollar, the log of the delated WTI price both a level and interacted with the lagged share of biofuels in US corn demand. Roberts and Schlenker (2015) both lagged prices and lagged stocks may be correlated with current period disturbances as the result of farmers' planed planting decisions. They advocate the use of lagged shocks as instruments. We will test this in a future revision of this paper.

Since wheat is predominantly consumed as food, the overall consumption elasticity is around 0.3 but lower outside the USA and China. By contrast, corn is consumed more in feed than in food and except in the United Sates, the overall responsiveness is dominated by the own feed elasticities of around 0.6. The elasticity of total consumption is again around 0.3. The flexibility (reciprocal of elasticity) of the prices with respect to supply and demand shocks, which depends on the sum of the production and consumption elasticities, is around 1.5.[10] (We acknowledge that differences in elasticity estimates across the three regions may reflect data mismeasurement or equation misspecification as well as differences in behavior).

Table 1
Estimated elasticities

		Wheat			**Corn**		
		US	China	RoW	US	China	RoW
Area planted	short term	0.066	0.068	0.017	0.096	0.085	0.027
(own price)	long term	0.299	0.259	0.050	0.129	0.229	0.069
Yield		0.000	0.000	0.000	0.000	0.000	0.068
Consumption	own price	-0.015	-0.311	-0.044	-0.679	0.000	-0.224
in food	cross price	0.000	0.000	0.050	0.489	0.000	0.368
Consumption	own price	-1.562	-1.158	0.000	-0.099	-0.570	-0.626
in feed	cross price	0.000	1.377	0.000	0.000	0.000	0.839
Total	own price	-0.289	-0.351	-0.034	-0.244	-0.318	-0.473
consumption	cross price	0.000	0.065	0.039	0.123	0.000	0.660

The total consumption elasticity is a weighted average of the food and feed elasticities using the ratio of food and feed consumption at the sample mean.

There are two important features of the estimated elasticities reported in Table 1. First, the supply of and demand for wheat is generally more elastic than those for corn. In particular, the elasticity of harvest of area planted in the US is more than twice that of corn. Higher elasticities imply a lower price response to shocks. There are substantial cross-elasticities of demand between wheat and corn outside the United States. Substitution across the two grains implies that shocks are transmitted across markets.

[10] The estimated equations will be made available in an online appendix once the final version of the paper is completed.

The model remains under development. The current version of the model is structurally recursive. This specification eases estimation and simulation but prevents price developments from affecting consumption within the same crop year. This deficiency will be addressed in the next revision of the model which will also include a soybean sector and introduce fertilizer prices.

3. Shocks

The model contains 22 behavioral equations plus a further four identities.[11] It is also nonlinear both because the identities hold in levels while the behavioral equations (except those for net exports) are specified as logarithmic and because the stock-consumption ratio enters the price equations as a reciprocal. These complexities make it difficult to understand and evaluate model performance except through simulation.

Simulation results are summarized in Table 2. These show the price impacts of one standard deviation shocks to the US and Rest of World planted area, yield, consumption in food and consumption in feed equations. (The impact of shocks to the Chinese equations remain confined to China and hence do not affect world prices). The model is nonlinear and so shock impacts depend on the year in which they are administered. The table reports the impacts of shocks administered in the 1999-2000 crop year. The table excludes impacts coming through consumption of corn in biofuels uses which are discussed in section 4 of the paper.

[11] Market clearing and net export identities for each of corn and wheat.

Table 2 Estimated impact of one standard deviation shocks							
				Wheat price		Corn price	
			Shock	Response	Year	Response	Year
Planted area	Wheat	USA	7.8%	-2.1%	3	-1.8%	3
		Rest of World	2.1%	-3.6%	3	-3.1%	3
	Corn	USA	6.4%	-4.1%	1	-7.5%	1
		Rest of World	2.1%	-2.3%	2	-4.2%	2
Yield	Wheat	USA	7.2%	-1.0%	2	-0.9%	2
		Rest of World	5.8%	-7.8%	3	-6.9%	3
	Corn	USA	10.0%	-5.9%	1	-10.7%	1
		Rest of World	3.6%	-2.3%	1	-4.2%	1
Consumption in food	Wheat	USA	5.3%	0.3%	2	0.3%	2
		Rest of World	1.6%	1.2%	1	1.2%	2
	Corn	USA	13.7%	1.6%	1	2.9%	1
		Rest of World	4.8%	1.7%	1	3.1%	1
Consumption in feed	Wheat	USA	7.8%	0.1%	2	0.1%	2
		Rest of World	2.1%	0.4%	1	0.4%	2
	Corn	USA	6.4%	3.1%	1	5.8%	1
		Rest of World	2.7%	1.7%	1	3.0%	1
US per capita household expenditure			1.6%	3.1%	3	5.2%	3
Value of US dollar against euro			10.8%	-6.1%	0	-5.3%	0
WTI crude oil price			21.1%	5.2%	1	5.0%	1

The table reports the maximum impact of a one standard deviation shock to each listed variable on the wheat and corn price respectively and the year in which the maximum impact is attained. Because the model is nonlinear, shock impacts will depend on the year in which they are administered. The table reports the impacts of shocks administered in the 1999-2000 crop year. The table excludes impacts coming through consumption of corn in biofuels uses which are discussed in section 4 of the paper.

The main qualitative conclusions of this analysis are as follows:

- Supply shocks are more important than demand shocks. Averaging across the USA and the Rest of the World, the impact of planted area and yield shocks averages 3.6% for wheat and 6.6% for corn. The corresponding averages for the demand shocks are 0.5% for wheat and 3.7% for corn. The greater importance of supply shocks is a standard contention of agricultural economics.
- Shocks have a greater proportional impact on corn prices than on wheat prices. Averaging across the entire set of shocks, the average price impact is 5.2% for corn against 2.1% for wheat. This difference is only partly explained by differences in the size of the shocks (6.2%

for corn against 5.0% for wheat). The same is true of the impact of shocks to US per capita household expenditure. The more important factor is the greater price responsiveness in the estimated wheat supply and demand equations.

- Wheat market shocks appear to impact the corn market (average impact 1.8%) less than corn market shocks affect the wheat market (2.8%).
- The pass through of a change in the value of the US dollar is around 50%, slightly higher for wheat than for corn prices,

The reported impact of crude oil (WTI) price shocks should be interpreted with caution as this factor interacts with biofuel demand which we discuss in the following section.

Table 3
Estimated impact of one standard deviation stocks shocks

			Wheat price		Corn price	
		Shock	Response	Year	Response	Year
Wheat	USA	29.5%	-2.1%	1	-1.7%	2
	Rest of World	45.6%	-18.7%	1	-14.2%	2
Corn	USA	14.1%	-6.3%	1	-11.5%	1
	Rest of World	15.3%	-8.7%	1	-15.7%	1

The table reports the maximum impact of a one standard deviation shock to stocks on the wheat and corn price respectively and the year in which the maximum impact is attained.

The shocks discussed in Table 2 are correlated. Since the production and consumption shocks all impact prices through their effects on stocks, we can obtain summary measures of price impact by shocking stock levels. The results, again using one standard deviation shocks, are reported in Table 3. They confirm both the vulnerability of the corn market to shocks and the fact that shocks in each market generalize to the other market. In the wheat market, non-US developments appear much more important than events in the US itself whereas in the corn market the US and non-US markets are of comparable importance.

4. Biofuels

The use of corn for the production of biofuels grew from less than 1% of total US corn consumption in crop year 1980-8, the first year for which the USDA published these data, to a peak of over 48% in 2012. Figure 1, which charts the growth of this usage, shows that the growth was sharpest between 2000 and 2010.[12] There is now a large literature on the US policy developments that generated this rapid growth. The most important were the 2005 Renewable Fuels Standard (RFS) Energy Act, which mandated minimum production levels for ethanol, largely produced from corn on the US, and the ban on the use of the MTBE additive, effective in 2006, which constrained gasoline companies to use ethanol to meet clear air standards. See Abbot et al. (2008), de Gorter and Just, (2009), Tyner (2008, 2010), Serra and Zilberman (survey, 2013), Abbot (2014), Wright (2014) and de Gorter et al. (2015).

Diversion of corn into biofuels usages impacts corn, and thence also wheat, prices through three channels.

i) Ethanol production is an additional component of US corn demand. A rightward shift in the corn demand curve will raise both corn and wheat prices at least until production has risen to the same extent.
ii) Ethanol competes with crude oil in petroleum production. Ethanol prices move in line with gasoline. Ethanol refiners are interested in the conversion margin between corn and ethanol. A rise in crude oil prices feeds through into a rise in gasoline prices, thence a rise in the ethanol price which puts upward pressure on the coal price. This effect increases the pass-through from the crude oil price to corn and hence also wheat prices.
iii) Corn is used for human consumption (food), for animal feed, and as an ethanol feedstock. Feed demand is considerably more price elastic than either food or ethanol demand (Wright, 2014). A shift in the composition of corn demand towards ethanol therefore reduces the overall price elasticity.

These impacts are qualified by two constraints on corn use in ethanol production. First, ethanol production is limited by refining capacity which takes time to construct. However, once capacity is installed, refiners will wish to operate at full capacity or, in extremis, to close or mothball. Abbott (2014) argues that the impact of ethanol on corn prices differs depending on whether refiners are operating at full or less than full capacity. Gilbert and Mugera (2017) discount this argument noting that US ethanol refiners have been able to operate well in excess of nameplate

[12] Source: USDA, Economic Research Service. https://www.ers.usda.gov/data-products/us-bioenergy-statistics

capacity at time of high crude oil prices. The second constraint, in this case on ethanol consumption, is generated by the "blend wall" (Tyner and Viteri, 2010) that limits the ethanol content of US gasoline. Gilbert and Mugera (2017) find that this constraint has been hard and has limited the pass-through from crude oil to grains prices since 2013.

Consistently with the foregoing account we extend the basic model by specifying a third component for US corn demand and by modifying the way the crude oil impacts grains prices. The biofuels demand for corn is seen as depending negatively on the current corn price but also on lag distributions of corn and WTI prices over the previous five years. These lagged price effects pick up the impact of investment in refining capacity. The result is to generate a degree of inertia in biofuels demands for corn absent from the food and feed demand functions in which only current prices enter. The modification to the two price equations consists of including the logarithm of the current WTI price both on a stand-alone basis and interacted with the (lagged) share of biofuels consumption of corn in total US corn consumption.

Structural non-constancies imply that impulse responses calculated from the extended model will vary over time. Figure 2 shows the differing price impact of a 10% WTI price shock in the early 1980's and the mid-2000's. The dark lines graph the corn impulse response function (IRF) and the lighter lines those for wheat. The solid lines show the IRFs corresponding to a 10% WTI shock in 1981-82 and the broken lines to the same shock in 2004-05. The initial pass-through is higher for the later simulation both for corn (2.5% against 2.0%) and wheat (2.7% against 2.3%). These increases result from the increased biofuels share in US corn consumption. However, the adjustment patterns differ, the slow decay in the earlier simulation, when world corn stocks were relatively high, contrasting with the much more rapid decay in the later sample when corn tock levels were much lower.[13] These differing patterns illustrate the non-constancy or responses in complex environments – see Abbott (2014) and Gilbert and Mugera (2017).

[13] Gilbert and Mugera (2017) use a monthly model to provide a more focused discussion of the pass-through from crude oil to corn prices. Use of monthly data allows more precise tracking of the pass-through evolution. However, their model does not take the wheat market into account and takes harvests as exogenous. The longer sample utilized in this paper allows us to supply responses and examine cross-mark effects.

5. Counterfactual simulation

We evaluate the impact of the growth of diversion of corn into US biofuels production by counterfactual simulation of the model. We do this by constraining the growth of corn use for ethanol production starting in crop year 2000-01, immediately prior to the period of rapid growth – see Figure 1. The effects of this constraint will depend on the counterfactual assumption. One possibility would be to freeze corn use in biofuels at the 1999-2000 level but this seems extreme since consumption was already growing prior to the turn of the century. Our counterfactual is therefore set constraining corn use for biofuels to grow at its average rate over the previous decade (1989-90 to 1999-2000) of 5.65%. This assumption results in a consumption level of 35.5 m tons in 2015-16 against an actual level of 132.2 m tons.

The counterfactual simulation results are charted in Figure 3. Historical prices are charted with broken lines and counterfactual prices with solid lines. The darker lines relate to corn and the lighter lines to wheat. The historical price line is well above the counterfactual lines in both charts. Averaging over the decade 2005-06 to 2014-15, the diversion of corn into biofuel uses is seen as having raised corn prices by 35% and wheat prices by 23%. The inflation due to biofuels is particularly acute over the three crop years 2010-11, 2011-12 and 2012-13. Over those three years, the actual price exceeded the base counterfactual by 54% for corn and 37% for wheat.

Absent biofuels demand, prices over these three years would have been at normal levels. By contrast, biofuels are not seen as accounting for more than a part of the grains prices in 2006-07 and 2007-08. Real wheat prices were 86% in 2007-08 above their average level over the five years 2000-01 to 2004-05. Biofuels are only seen as accounting for 23% of this rise. Corn prices rose somewhat less over this interval. Biofuels demand is seen as accounting for 30% of the overall 63% price rise.

The overall conclusions from this exercise are that biofuels demand for corn was an important factor in generating high grains prices over the past decade, more so for corn than for wheat. It was possibly the dominant factor over the three years from 2010-11 but only explains less than half the price rises at their 2007-08 peak. The explanation for the jump in wheat prices over that period is much more prosaic. The US opening stock-consumption ratio fell from 47% at the start of the 2005-06 crop year to 25% at the start of the 2007-08 crop year, its lowest level since 2000. Although the US corn stock-consumption ratio also fell over the same period to 16% at the start of the 2007-08 crop year, this remained well above the level of 11% reached in 2003-04 and the 7% level reached in 2012-13. The prime cause of the fall in wheat stocks was two successive poor US harvests. Although the price impacts generalized to the corn markets, their major impact was on the wheat market just as the major biofuels impact was on the corn market.

The counterfactual, described above, uses historical crude oil prices. The extent of the grains price impact of changes in the crude oil price is dependent on the importance of corn as a biofuels feedstock. We investigate this by holding the WTI price constant at its 1999-2000 (real) level of $40.20 per barrel. Figure 4 charts these counterfactual price paths leaving biofuels demand for corn unconstrained. The price impacts are much less dramatic than those charted for the biofuels counterfactuals charted in Figure 3 and moreover are largely confined to the high oil price period prior to 2009-10. These simulations see the oil price as accounting for 34% of the 86% increase in the wheat price from its 2000-01 to 2004-05 average to 2007-08, and 28% of the 63% rise in the corn price over the same period.

A higher oil price makes it more attractive to use corn for ethanol production and the price impacts of oil price rises on grains prices increase with the share of biofuels in total US corn consumption. As the consequence, the combined price impact of biofuels and the crude oil price is less than the sum of the separate effects listed above. Joint imposition of both the constraint on the sue of corn in biofuels production and the constant WTI price shows that the combined effect of these two factors accounts for a total of 52% of the 86% increase in the wheat price from its 2000-01 to 2004-05 average to 2007-08, and 54% of the 63% rise in the corn price over the same period. (Interaction leads to a double counting in summing the two separate effects of 5% for wheat and 6% for corn).

These additional simulations strengthen our earlier judgment allowing us to conclude that biofuels and high oil prices largely account for the high corn prices observed over the past decade but only offer a partial explanation for high wheat prices.

6. The Law of One Price?

De Gorter et al. (2015, page 16) assert a “law of one international price of grains and oilseeds” that allows aggregation of corn, wheat, soybean and rice prices into a single (calorie-weighted) composite grain. They imply that biofuel developments have had an impact that is not only qualitatively but also quantitatively similar across all four major grains markets. Our results suggests that this view is exaggerated.

This evidence takes two forms. First, the estimated corn price elasticities reported in Table 1 are generally lower than those for wheat and the price impacts reported in Table 2 are correspondingly higher. The corn market is more responsive to shocks than the wheat market. Second, the counterfactual analysis reported in section 5 shows that while biofuels and oil price developments explain the largest part of the recent corn price history, this is not true of wheat prices, in particular over the two crop years 2006-07 and 2007-08. De Gorter at al (2015) quote Roberts and Schlenker (2013) as providing evidence for this claim but the evidence in the latter paper (see page 2289) is in line with our results that the impact of biofuels on corn prices is greater than that on wheat prices.[14]

7. Conclusions

We set out to answer three questions. The first question related to the source of grains market shocks. Our analysis confirms the conventional wisdom that supply side shocks are more important than those form the demand side. What has been less widely noted is that corn market elasticities tend to be lower than those in the wheat market and consequently price impacts are greater.

The second question we addressed was that of the price impact of diversion of corn into biofuels production. Our simulations support the claim that biofuels have been a major driver of high grains price over the past twelve years. The price impact of rises in the crude oil price interact with those of biofuels demand making it difficult to separate the two in a clear way. Nevertheless, oil price effects were lower than those from biofuels which probably formed the dominant

[14] de Gorter et al. (2015) also cite de Gorter et al. (2013). The latter paper reports correlations but does not test hypotheses.

influence on the corn price. This is not true of the wheat price which would have been high in 2007 and 2008 even in the absence of biofuel factors. This responds to the third question we asked. Grains prices do move together but not to an extent that allows us to differences across markets.

Finally, we note that these results are all based on a preliminary and partial model and should therefore be taken as tentative.

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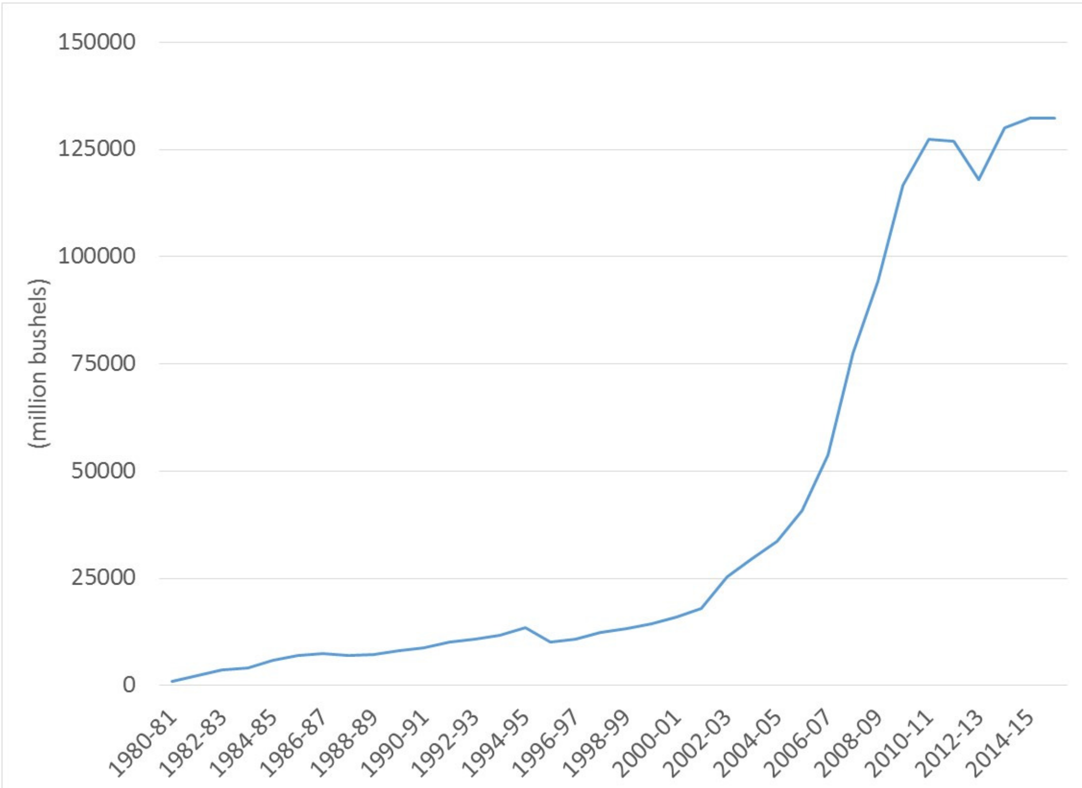

Figure 1: US corn use in ethanol production

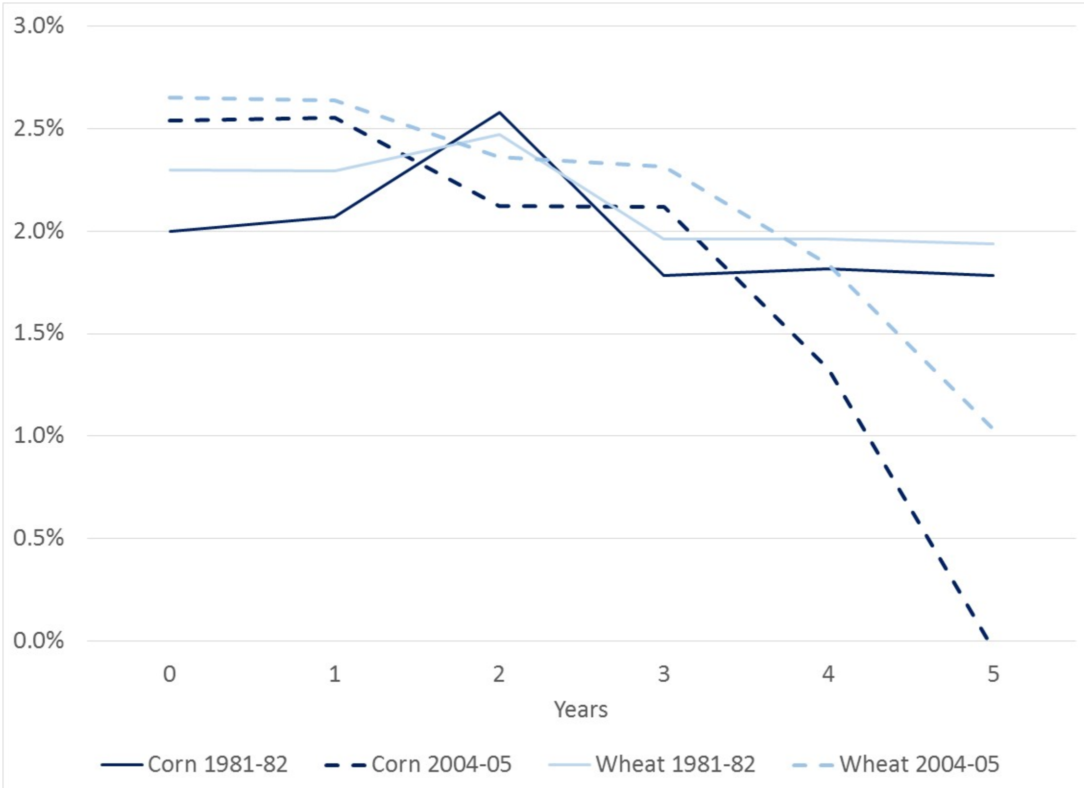

Figure 2: Impulse response functions for a WTI shock

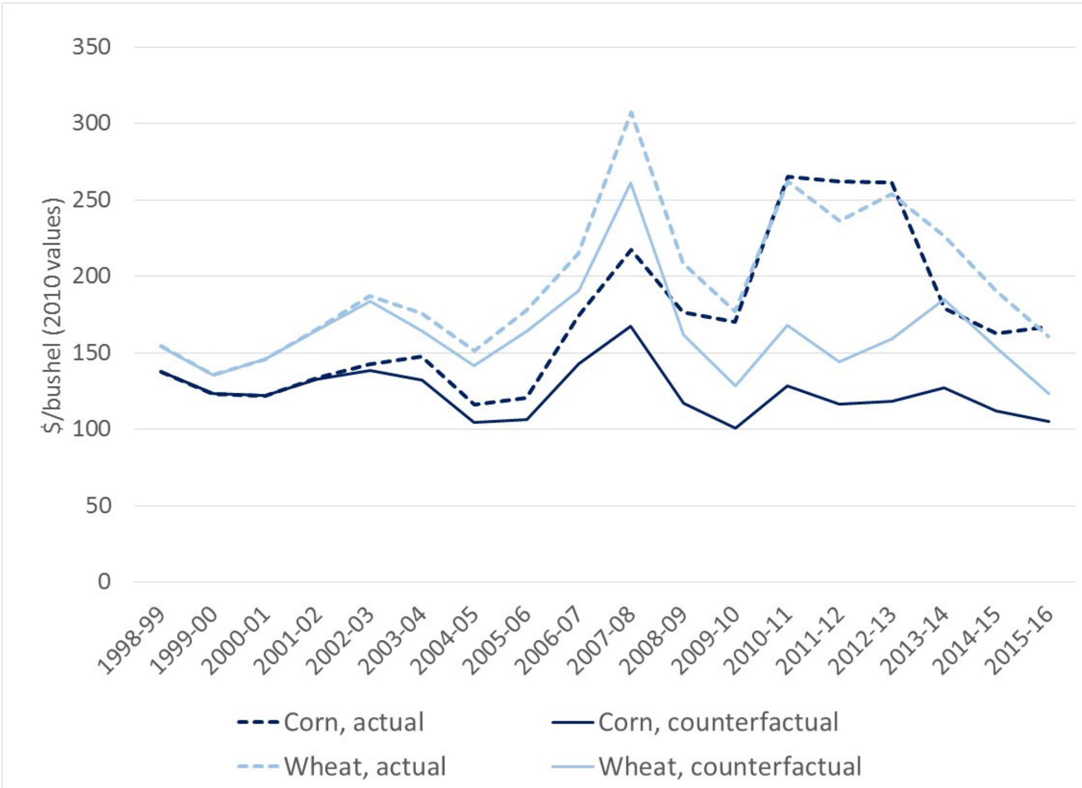

Figure 3: Counterfactual simulations (no biofuels shock)

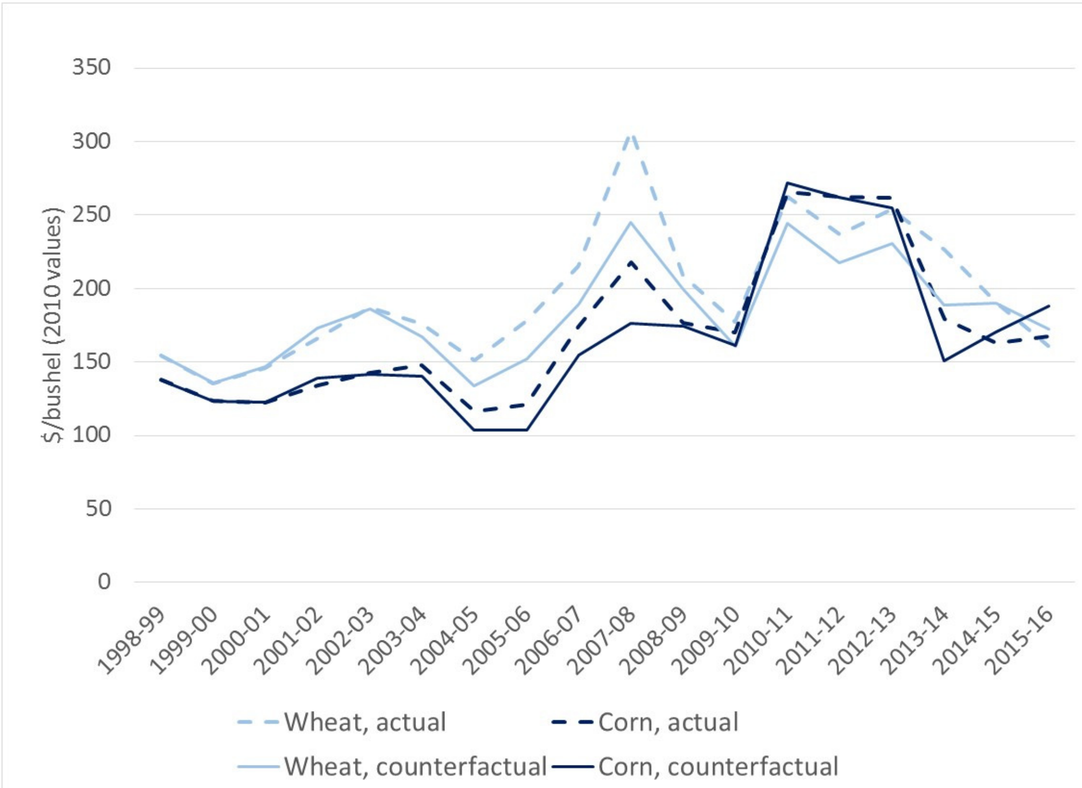

Figure 4: Counterfactual simulations (no WTI shock)