NCCC-134

APPLIED COMMODITY PRICE ANALYSIS, FORECASTING AND MARKET RISK MANAGEMENT

How Do Agricultural Futures Prices Respond To New Information About Drought Conditions?

by

Kathleen Brooks, Fabio Mattos,
and Karina Schoengold

Suggested citation format:

Brooks, K., F. Mattos, and K. Schoengold. 2014. "How do agricultural futures prices respond to new information about drought conditions?" Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, MO. [http://www.farmdoc.illinois.edu/nccc134].

How do agricultural futures prices respond to new information about drought conditions?

Kathleen Brooks

Fabio Mattos

Karina Schoengold *

Paper presented at the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management

St. Louis, Missouri, April 21-22, 2014

* Kathleen Brooks (kbrooks4@unl.edu), Fabio Mattos (fmattos@unl.edu), and Karina Schoengold (kschoengold2@unl.edu) are assistant professors in the Department of Agricultural Economics, University of Nebraska-Lincoln.

How do agricultural futures prices respond to new information about drought conditions?

This study tests whether information provided by the U.S. Drought Monitor impacted futures prices for commodities between 2000 and 2012. Results based on the November futures prices for soybeans indicate that there is a statistically significant difference in mean and variance of absolute percentage price changes between days when the Drought Monitor is released and other days. Further analysis suggests that the effect of the Drought Monitor information varies during the year. In particular, absolute percentage price changes are generally smaller on report days than on non-report days during the winter and spring, but are larger on report days than on non-report days during the summer. Finally, focusing on the impact on prices of the magnitude of drought conditions, there is evidence that larger areas under extreme drought conditions lead to larger absolute price changes.

Keywords: drought, price expectations, futures prices, Drought Monitor

INTRODUCTION

In the summer of 2012, the U.S. experienced one of the worst droughts in its history. During that period the popular media frequently reported about the deterioration of weather conditions and alerted to its potential impact on commodity prices. According to media articles, the negative impact of the drought on yields and production would limit the supply of grains by harvest and hence cause higher prices. Indeed, futures prices for corn and soybeans increased consistently during the summer, reflecting market expectations for harvest prices during the fall. Between June and August 2012 the futures prices for corn (December 2012 contract) and soybeans (November 2012 contract) increased 57% and 40%, respectively.

The notion that drought conditions, or weather in general, impact commodity prices is not new. Many studies have discussed the ex-post effect of weather conditions on agricultural prices. Piesse and Thirtle (2009) and Baffes and Haniotis (2010) investigated the behavior of commodity prices in 2006-2008 and discussed how drought and other weather events in that period contributed to harvest failures and thus rising grain prices. Hao et al. (2013) explored the relationship among spot prices in grain, livestock and biofuel markets, specifically discussing the influence of the 2012 drought on these prices. They found that the drought did affect grain and beef prices, but only after a certain level of dry conditions was reached.

Furthermore, the idea that expectations on prices are affected by research reports with updated information about commodity markets is also not new. Several studies have investigated how futures prices react to the release of agricultural reports. The impact on grain futures prices of crop reports released by the USDA has been studied by Fortenberry and Summer (1993), McNew and Espinosa (1994), Garcia et al. (1997), Isengildina-Massa et al. (2008) and Lehecka (2013), among others. Similarly, Colling and Irwin (1990), Isengildina et al. (2006) and other researchers conducted studies on how livestock futures prices respond to new information. All studies generally find evidence that new information affects expectations on commodity prices through futures markets.

There is evidence that drought conditions affect commodity prices and that public information is one of the drivers of price expectations, but no study has investigated these two dimensions together. It remains to be explored how price expectations respond to public information on drought conditions, particularly in a year with severe conditions such as 2012.

The objective of this research is to investigate the influence of new information about drought conditions on price expectations in commodity markets. More specifically, this study will test whether information provided by the U.S. Drought Monitor impacted futures prices for corn, soybeans, wheat, live cattle, feeder cattle and lean hogs between 1999 and 2012. Data consist of weekly releases of the U.S. Drought Monitor with index numbers indicating drought conditions in the entire country and also in each state, and daily futures prices for grains (corn, soybeans, wheat) and livestock (live cattle and lean hogs) obtained from the CME Group. Futures prices are based on expiration months representing harvest time, so we will use the November contract for soybeans, December contract for corn and wheat, and nearby contracts for livestock.

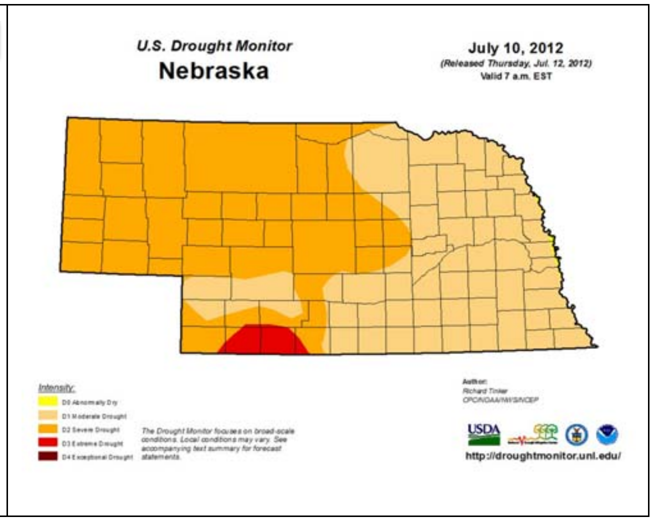
Even though the Drought Monitor was established in 1999, it was still relatively unfamiliar to futures markets until last year, when it emerged as a frequently cited source for information about the drought in the financial media. A comprehensive analysis of how the release of the Drought Monitor affects futures prices will help us better understand how this kind of information is used and how it can change expectations, bringing new insights to discuss the value and influence of the report along with its role in futures markets.

THE DROUGHT MONITOR

The U.S. Drought Monitor is a composite index produced by the National Oceanic and Atmospheric Administration, the U.S. Department of Agriculture, and the National Drought Mitigation Center at the University of Nebraska-Lincoln. The index is based on measurements of climatic, hydrologic and soil conditions as well as reported impacts and observations from more than 350 contributors around the country. Drought conditions are evaluated in a given area and the index reports the percent of the area in a certain drought category. There are 6 categories: nothing, D0–abnormally dry, D1–moderate, D2–severe, D3–extreme and D4–exceptional. Figure 1 shows an example of the data for the state of Nebraska in 2012. The table presents the percentage of the state area in each category, while the map identifies the exact location of the areas in each category. The index is calculated for each state of the country and also aggregated for six regions (high plains, midwest, northeast, south, southeast and west).

Figure 1: Data provided by the Drought Monitor – example using the state of Nebraska

Week	Nothing	D0	D1	D2	D3	D4
10/2/2012	0.00	0.00	0.00	2.06	20.33	77.61
9/25/2012	0.00	0.00	0.00	2.06	24.68	73.25
9/18/2012	0.00	0.00	0.00	2.06	26.99	70.94
9/11/2012	0.00	0.00	0.00	2.06	27.00	70.94
9/4/2012	0.00	0.00	0.00	2.06	27.36	70.58
8/28/2012	0.00	0.00	0.00	2.79	73.88	23.33
8/21/2012	0.00	0.00	0.00	1.70	75.78	22.53
8/14/2012	0.00	0.00	0.00	8.60	68.88	22.53
8/7/2012	0.00	0.00	0.00	8.83	87.72	3.46
7/31/2012	0.00	0.00	0.00	17.00	79.54	3.46
7/24/2012	0.00	0.00	0.00	35.93	61.27	2.80
7/17/2012	0.00	0.00	24.54	70.53	4.93	0.00
7/10/2012	0.00	0.19	45.23	52.54	2.03	0.00



The Drought Monitor is released every Thursday at 8:30am EST, based on data collected through 7:00am the preceding Tuesday. The index has always been released on Thursdays, but the current announcement time was introduced in June 2000. Previously, announcement times were 10:00am EST between October 1999 and June 2000, and 2:30pm EST before October 1999.

RESEARCH METHOD

Following previous work (e.g. Fortenberry and Sumner, 1993; Isengildina-Massa et al., 2008; Lehecka, 2013), the research method relies on the notion that updated information about drought conditions, especially during planting and growing periods, can change perceptions about market supply when crops are harvested and hence affect price expectations. The direction of changes in price expectations is unclear a priori, but the average of absolute changes in price expectations will probably be positive. Therefore, it is anticipated that the variability in futures prices would be larger on days when new information on drought conditions is released compared to the 'normal' variability observed on days when no information is released.

Since open outcry prices are used, the U.S. Drought Monitor is released when the futures market is not trading. It is possible that its major impact happens at the opening of the market rather than at the closing of the trading day after the release of the report. Besides, other pieces of information that reach the market during the trading day can make it harder to isolate the effect of the drought report. Thus both opening and closing futures prices will be used in the analysis. Absolute price changes are calculate based on closing prices in *t-1* and open prices in *t* (equation 1) and also closing prices in *t-1* and *t* (equation 2). Then it can be investigated how new information impacted the market by looking at closing prices before and after the Drought Monitor was released, and also by looking at the closing price before the Drought Monitor was released and the opening price after it was released.

$$\left|\Delta p_t^{oc}\right| = \left|\ln\left(p_t^{open} / p_{t-1}^{close}\right)\right| \quad (1)$$

$$\left|\Delta p_t^{cc}\right| = \left|\ln\left(p_t^{close} / p_{t-1}^{close}\right)\right| \quad (2)$$

Two procedures will be used to explore this idea. First, differences in absolute price changes on report and non-report days will be tested with parametric and non-parametric tests for means (Welch F-test), variances (Levene test and Brown-Forsythe test) and medians (Kruskal-Wallis test and van der Waerden test).

Regression analysis will also be adopted to investigate the price impact of new information on drought conditions. Initially a simple model with absolute price changes as a function of a dummy variable will be estimated, where the dummy variable equals 1 on days when the Drought Monitor is released (equation 3)[1]. An extension of this model will also be estimated, including an interaction term with two dummy variables, one for days when the Drought Monitor is released and another for months of the year (equation 4). This model accounts for the notion that new information on drought conditions may be more relevant in specific times of the year, such as planting and growing periods.

$$\left|\Delta p_t\right| = \alpha + \beta \cdot D_{report} + \varepsilon \quad (3)$$

$$\left|\Delta p_t\right| = \alpha + \beta \cdot D_{report} + \sum_i \gamma_i \cdot D_{report} \cdot D_{month_i} + \varepsilon \quad (4)$$

Further, the analysis will focus only on days when the Drought Monitor is released and explore whether changes in drought conditions affect futures prices. It is assumed that "extreme" drought conditions would affect futures prices, thus absolute price changes are regressed against the change (in percentage points) in the value of drought categories D3 and D4 (equation 5). For example, if the percentage of the area in the entire country under categories D3 and D4 changes from 61.27% in one week to 79.54% in the next week, the value of $\Delta D_{3,4}$ is 18.27 percentage points. In addition, two dummy variables are included in the model; one representing years from 2001 to 2013 (2000 is left out) and another representing seasons within the year. The year dummies account for the idea that the Drought Monitor may be more relevant in recent years, and not as much in the early 2000's right after it was created. The season dummies try to capture distinct effects during the year as the impact of drought conditions on prices may differ across seasons. Three season dummies are used: spring (March to May), summer (June to August) and fall (September to November).

$$\left|\Delta p_t\right| = \alpha + \beta \cdot \Delta D_{3,4} + \sum_{i=2001}^{2013} \gamma_i \cdot D_{year_i} + \sum_k \theta_k \cdot D_{season_k} + \varepsilon \quad (5)$$

This last regression model will be estimated more than once according to the source of ΔD_j. It will be estimated using changes in drought conditions by category based on the entire country, and also based on state-level changes. The purpose is to explore whether drought

[1] Equations 3, 4 and 5 show just one model with absolute price change, but two models with open-close and close-close change will be estimated.

conditions in specific states, particularly the larger producers of agricultural commodities, may have distinct impact on futures prices.

DATA

In this first stage of the research the focus will be on the soybean futures market. The other commodities will be included later. Two datasets are used in this study for the 2000-2012 period. The Drought Monitor index was collected from The National Drought Mitigation Center and provides weekly information on percent of area in different drought categories for the entire U.S. and also individual states. The other dataset contains daily futures prices for soybeans collected from the Commodity Research Bureau (CRB). Soybean futures prices refer only to the November contract, which represents new-crop prices. In addition, futures prices were based only on open outcry, which traded from 9:30am to 1:15pm during the 2000-2012 period.

Summary statistics for daily absolute price changes (both close-to-open and close-to-close) are shown in Table 1. There are 3,472 observations in the sample: 702 for report days and 2,770 for non-report days. Preliminary analysis of summary statistics suggest generally larger close-to-close price changes compared to close-to-open price changes for both report and non-report days. Results of a more detailed analysis focusing on report days compared to non-report days will be discussed in the next section.

Table 1: Daily absolute percentage price changes – summary statistics

	Report days[(a)]	Non-report days[(b)]	All days
Close-to-open			
Mean	0.63%	0.70%	0.69%
Std. deviation	0.64%	0.79%	0.76%
Minimum	0.00%	0.00%	0.00%
1^{st} quartile	0.20%	0.20%	0.20%
Median	0.44%	0.48%	0.47%
3^{rd} quartile	0.84%	0.94%	0.92%
Maximum	5.47%	8.35%	8.35%
Observations	702	2,770	3,472
Close-to-close			
Mean	1.07%	1.12%	1.11%
Std. deviation	0.97%	1.05%	1.04%
Minimum	0.00%	0.00%	0.00%
1^{st} quartile	0.35%	0.38%	0.38%
Median	0.81%	0.83%	0.82%
3^{rd} quartile	1.45%	1.51%	1.51%
Maximum	6.54%	7.41%	7.41%
Observations	702	2,770	3,472

(a) Days when Drought Monitor was released; (b) days when Drought Monitor was not released.

RESULTS

The first part of the analysis concentrates on hypothesis tests for the means, variances and medians of absolute percentage price changes for report and non-report days. Table 3 presents the results of the Welch F-test (mean), Levene and Brown-Forsythe tests (variance), and Kruskal-Wallis and van der Waerden tests (median) using both close-to-open and close-to-close price changes. Findings for close-to-open price changes suggest that means and variances are smaller on days when the Drought Monitor is released compared to other days. However, no statistical difference is found for the median close-to-open price change between report and non-report days (Table 3). With respect to close-to-close price changes, the null hypotheses that means, variances and medians are the same for report and non-reports days cannot be rejected (Table 3). Thus there is no evidence that closing prices change differently when the Drought Monitor is released compared to other days.

Table 3: Tests for means, variances and medians of absolute percentage price changes

	Close-to-open	Close-to-close
Mean		
report days	0.63%	1.07%
non-report days	0.70%	1.12%
Welch F-test statistic [(a)]	6.28 (0.01)	1.4528 (0.23)
Std. deviation		
report days	0.64%	0.97%
non-report days	0.79%	1.05%
Levene test statistic [(a)]	9.48 (0.00)	1.20 (0.27)
Brown-Forsythe test statistic [(a)]	5.91 (0.02)	0.67 (0.41)
Median		
report days	0.44%	0.81%
non-report days	0.48%	0.83%
Kruskal-Wallis test statistic [(a)]	1.94 (0.16)	0.82 (0.37)
Van der Waerden test statistic [(a)]	2.35 (0.13)	0.91 (0.34)

(a) p-values in parentheses.

The second part of the analysis adopts regression models. Initially, a simple model is estimated with only a constant and a dummy variable for days when the Drought Monitor is released. Consistent with the hypothesis test for the means in Table 3, regression results indicate that close-to-open absolute percentage price changes are 0.07 percentage points smaller on report days compared to non-report days (Table 4). However, for close-to-close absolute percentage price changes, the estimated coefficient for the dummy variable is not statistically distinguishable from zero (Table 4).

Table 4: Estimated coefficients for the model $\left|\Delta p_t\right| = \alpha + \beta \cdot D_{report} + \varepsilon$ [a]

	Close-to-open	Close-to-close
Constant	0.0070 (0.00)	0.0112 (0.00)
D_{report}	-0.0007 (0.01)	-0.0005 (0.20)
R^2	0.001	0.000
F-statistic	4.980	1.3212
Observations	3,472	3,472

(a) p-values in parentheses.

The regression model is now expanded to incorporate interaction terms between dummy variables for report days and months of the year (January to November). Results are qualitatively similar for close-to-open and close-to-close absolute percentage price changes (Table 5). The estimated coefficients for the dummy variable for report days is negative and statistically distinguishable from zero. In addition, estimated coefficients for the interaction terms with the months are positive and statistically distinguishable from zero for March, June, July, August, September, October and November. In particular, in July and August they are greater than the estimated coefficient for the dummy variable for report days, indicating that the total effect of the release of the Drought Monitor on futures prices in those two months is actually positive. Findings from this model suggests that the impact of the Drought Monitor may not be homogenous during the year.

Table 5: Estimated coefficients for the model $\left|\Delta p_t\right| = \alpha + \beta \cdot D_{report} + \sum_i \gamma_i \cdot D_{report} \cdot D_{month_i} + \varepsilon$ [a]

	Close-to-open	Close-to-close
Constant	0.0070 (0.00)	0.0112 (0.00)
D_{report}	-0.0029 (0.00)	-0.0042 (0.00)
D_{report} x D_{month}		
January	0.0011 (0.15)	0.0018 (0.16)
February	0.0002 (0.79)	0.0020 (0.17)
March	0.0030 (0.01)	0.0044 (0.06)
April	0.0009 (0.25)	0.0026 (0.12)
May	0.0008 (0.25)	0.0035 (0.03)
June	0.0031 (0.00)	0.0049 (0.00)
July	0.0052 (0.00)	0.0079 (0.00)
August	0.0037 (0.00)	0.0053 (0.00)
September	0.0023 (0.03)	0.0037 (0.01)
October	0.0026 (0.01)	0.0030 (0.04)
November	0.0030 (0.01)	0.0047 (0.01)
R^2	0.009	0.007
F-statistic	2.703	2.105
Observations	3,472	3,472

(a) p-values in parentheses.

So far it has been investigated whether or not the release of new information about drought conditions affects futures prices. The next step is to explore how the magnitude of changes in the Drought Monitor index impact prices. The regression model focuses only on days when the Drought Monitor is released, and one of the independent variables is $\Delta D_{3,4}$, representing the change in the area of the entire country under the two highest drought categories (D3 and D4). The model also has dummy variables to control for price changes over the years and also over seasons within the years. Estimated coefficients for $\Delta D_{3,4}$ are positive and statistically distinguishable from zero, indicating that larger areas under extreme drought conditions leads to larger absolute percentage changes in prices (Table 6). If the proportion of U.S. area under categories D3 and D4 increases by 1 percentage point, absolute price changes will increase by 0.07 (0.12) percentage points in the close-to-open (close-to-close) calculation. With respect to the control variables for year and seasons, close-to-open absolute percentage price changes have become larger after 2004, while there is no evidence of differences in the magnitude of close-to-close price changes over the years. In terms of seasonal effects within the year, both close-to-open and close-to-close price changes are larger in the spring, fall and particularly in the summer compared to the winter.

Table 6: Estimated coefficients for the entire country for the model
$\left|\Delta p_t\right| = \alpha + \beta \cdot \Delta D_{3,4} + \sum_{i=2001}^{2013} \gamma_i \cdot D_{year_i} + \sum_k \theta_k \cdot D_{season_k} + \varepsilon$ (a)

	Close-to-open	Close-to-close
Constant	0.0014 (0.13)	0.0075 (0.00)
$\Delta D_{3,4}$	0.0007 (0.03)	0.0012 (0.02)
Dummies for years		
2001	0.0017 (0.15)	0.0005 (0.78)
2002	0.0009 (0.45)	-0.0014 (0.46)
2003	0.0017 (0.17)	-0.0003 (0.86)
2004	0.0039 (0.00)	0.0048 (0.01)
2005	0.0042 (0.00)	0.0001 (0.95)
2006	0.0020 (0.09)	-0.0011 (0.54)
2007	0.0027 (0.02)	-0.0010 (0.58)
2008	0.0070 (0.00)	0.0073 (0.00)
2009	0.0055 (0.00)	0.0032 (0.08)
20010	0.0023 (0.06)	0.0000 (0.97)
2011	0.0057 (0.00)	0.0010 (0.61)
2012	0.0039 (0.00)	0.0000 (0.98)
2013	0.0024 (0.05)	-0.0015 (0.44)
Dummies for seasons		
spring	0.0011 (0.09)	0.0022 (0.03)
summer	0.0034 (0.00)	0.0044 (0.00)
fall	0.0023 (0.00)	0.0026 (0.01)
R^2	0.133	0.099
F-statistic	6.178	4.402
Observations	702	702

(a) p-values in parentheses.

CONCLUSION

The objective of this research is to investigate how new information about drought conditions affects price expectations in commodity markets. In particular, this study tests whether information provided by the U.S. Drought Monitor impacted futures prices for commodities between 2000 and 2012.

Results based on the November futures prices for soybeans indicate that there is a statistically significant difference in mean and variance of absolute percentage price changes between days when the Drought Monitor is released and other days for close-to-open price changes (but not for close-to-close price changes). It is possible to reject the null hypotheses that means and variances of close-to-open absolute percentage price changes are the same for report and non-report days.

However, further analysis suggests that the effect of the Drought Monitor information varies during the year. Regression analysis shows that absolute percentage price changes (both close-to-open and close-to-close) are generally smaller on report days than on non-report days during the winter and spring, but are larger on report days than on non-report days during the summer.

Finally, it was also investigated whether the magnitude of drought conditions had an impact on prices. Focusing on the percentage of the U.S. areas under drought categories D3 and D4, it was found that larger areas under extreme drought conditions lead to larger absolute price changes, both close-to-open and close-to-close.

Results presented here represent preliminary findings of this project. Many dimensions of the research question still need to be explored. First, only futures prices from open outcry were used at this point. Since the Drought Monitor is released approximately one hour before the beginning of the open outcry trading session, it is possible that market participants have enough time to absorb the new information, which could potentially reduce its impact. Adopting futures prices from the electronic trading session could help investigating price changes closer to the release time of the Drought Monitor. Second, there can be other reports that are relevant for futures markets around the time the Drought Monitor is released. This will require a closer examination of other information released on those days and how to separate their impact from the Drought Monitor news. Third, the effect of the proportion of area under certain drought categories can be refined to consider other categories and also specific states that may be more relevant for certain commodities. Fourth, other commodities need to be included in the analysis, such as corn, wheat and cattle. Fifth, it needs to be discussed if and how the Drought Monitor can be related to other weather variables available on higher frequencies, and whether the information in the Drought Monitor can be somehow anticipated by these other variables.

REFERENCES

Baffes, J. and T. Haniotis (2010). Placing the 2006/08 Commodity Price Boom into Perspective. The World Bank, Development Prospects Group, Policy Research Working Paper 5371.

Colling, P.L. and S.H. Irwin (1990). The Reaction of Live Hog Futures Prices to USDA Hogs and Pigs Reports. American Journal of Agricultural Economics 72, 84-94.

Fortenberry, T.R. and D.A. Sumner (1993). The Effects of USDA Reports in Futures and Options Markets. The Journal of Futures Markets 13, 157-173.

Garcia, P., S.H. Irwin, R.M. Leuthold and L. Yang (1997). The Value of Public Information in Commodity Futures Markets. Journal of Economic Behavior & Organization 32, 559-570.

Hao, N., B. Seong, C. Park, G. Colson, B. Karali and M. Wetzstein (2013). Drought, Biofuel, and Livestock. Proceedings of the AAEA & CAES Joint Annual Meeting, Washington, DC.

Isengildina, S.H. Irwin and D.L. Good (2006). The Value of USDA Situation and Outlook Information in Hog and Cattle Markets. Journal of Agricultural and Resource Economics 31, 262-282.

Isengildina-Massa, O., S.H. Irwin, D.L. Good and J.K. Gomez (2008). The Impact of Situation and Outlook Information in Corn and Soybean Futures Markets: Evidence from WASDE Reports. Journal of Agricultural and Applied Economics 40, 89-103.

Lehecka, G.V. (2013). The Reaction of Corn and Soybean Futures Markets to USDA Crop Progress and Condition Information. Proceedings of the AAEA & CAES Joint Annual Meeting, Washington, DC.

McNew, K.P. and J.A. Espinosa (1994). The Informational Content of USDA Crop Reports: Impacts on Uncertainty and Expectations in Grain Futures Markets. The Journal of Futures Markets 14, 475-492.

Piesse, J. and C. Thirtle (2009). Three Bubbles and a Panic: An Explanatory Review of Recent Food Commodity Price Events. Food Policy 34, 119-129.