Agricultural commodities and financial markets

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Abstract

The sharp raise of the price of agricultural commodities between 2006 and 2008 seems to have a rationalization that goes beyond the mere supply and demand interaction. Data evidence suggests that financial factors, rather than real determinants, played an important role in determining the dynamics of agricultural commodity prices. In particular, there seems to be a common source underlying food price changes and the financial markets dynamics. Evidence based on principal components supports the view that large fluctuations of food commodity prices can be related to portfolios adjustments of financial agents. We find robust evidence of a strong inverse correlation between financial markets' returns and the movements of food commodity prices. Moreover, such an inverse relationship has clearly emerged during the recent financial crisis.

Keywords: Financial Markets, Portfolio Diversification, Commodity Prices
JEL codes: C10, E31, G11, G15.

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1. Introduction

The peak of the price of agricultural commodities in 2008 seems to be explained by reasons that go beyond the mere interaction between supply and demand. In this work we thus challenge the conventional view that large fluctuations of agricultural commodity prices are simply determined by the conditions related to the relative force of supply and demand. In particular, three aspects encourage exploring the dynamics of commodity prices from an unconventional perspective. First, the sharp raise of food prices in 2007-2008 occurs during a period of economic crisis, thus the argument that a strong demand may have affected the price dynamics appears definitely weak. Second, if we believe that the 2007-2009 recession has not affected the world demand for food, because the decreasing demand from industrialized countries has been offset by the soaring one from the fast-growing emerging economies, it is difficult to find a reason underlying the plummet of food prices in late 2008. Finally, if supply shortage has temporarily boosted prices, again we cannot easily explain why such a shortage has allowed the subsequent sharp drop of commodity prices occurred in the second half of 2008. As a matter of fact some real factors[1] have modified the relative weight of supply and demand before the food price peak in 2008; but, for instance, the overall effect is not enough to justify an increase in the price of wheat by about 215% between 2006 and 2008, or a rise by 240% the price of corn and barley over the same span. Moreover, real determinants cannot certainly explain the quick, and sudden, 60% price reduction in the aforementioned food commodities between 2008 and 2009. One could also argue that, rather than being driven by the current market conditions, food prices are mainly influenced by expectations regarding the future level of supply and demand; however, it is easier to believe that the actual effect on prices exerted by the expected future level of supply and demand passes through the financial market channel.

Although, as mentioned earlier, we are aware that the joint effect of a number of factors may have contributed to the unusual movements of food commodity prices, we believe that financial factors may significantly lie beneath such a phenomenon. In spite of previous evidence that has not been able to establish a clear relationship between the financial sector and the atypical evolution of food commodity prices (Fama and French, 1987; Bryant *et al*. 2006; Gorton *et al*., 2007; Irwin *et al*. 2009; Sanders and Irwin, 2010), our view is that such a relationship exists. Cheung and Miu (2010) find significant evidence regarding the diversification benefit of adding commodities to equity portfolios; however, they point out that the phenomenon is complex and it deserves further examination. Edwards and Park (1996) show that actively managed commodity futures offer a great opportunity to portfolio diversification and increase the rate of returns of conventional bond/stock portfolios. Jensen *et al*. (2000) investigate the role of commodity futures in diversified portfolios. They observe that in periods characterized by tight monetary policy, commodity futures play an important role in efficient portfolios allowing significant superior returns at any risk level. Within dynamically optimized frameworks Jensen *et al*. (2002) confirm previous results and conclude that "*metals and agricultural futures contracts offer the most diversification benefits for investors*". Gilbert (2010) finds that index-

[1] Droughts in Australia due to severe weather conditions, growing demand for food from China, expanding rice imports from Philippines, bio-fuel productions are among the factors that have altered the standard conditions of supply and demand.

based investment in agricultural futures markets is an important channel through which macroeconomic and monetary factors have generated the food price rises.

In this work we thus follow the view that changes in supply and demand fundamentals cannot fully explain the recent drastic increase in food prices (Von Braun and Torero, 2009). First, we extract the principal components from different groups of commodities (Food 1, Food 2, Metals, and Chemical & Energy) and look at the dynamic correlation coefficients; then, we examine whether the first principal component of food commodities is significantly related to financial markets movements. Empirical evidence seems to suggest that portfolio diversification may underlie the dynamics of food commodity prices. The inverse correlation between financial markets returns and food prices is, in fact, significantly increasing over time. In this respect it seems that asset managers' find it convenient to shift resources from stock markets to food commodities when their expectations regarding the future evolution of stock indexes worsen; such a strategy clearly aims at limiting capital loss in bear markets. Hence, strategic portfolio diversification allows asset managers to minimize the negative impact of stock markets dynamics on portfolio's returns in periods of financial distress. According to our analysis the Financial Markets component significantly explains the price dynamics of Food commodities; but, we do not claim that it is the only determinant; we recall that the issue is far more complex and that a great variety of different reasons have generated the abnormal dynamics of food commodity prices. In line with our results, Von Braun and Torero (2009) claim that the injection of significant financial resources into futures markets, including food commodity markets, contributed to a price spike in the first part of 2008.

It has also been argued that financial speculators were only reacting to the unusual set of supply and demand circumstances; their actions were thus simply fuelling what was already an unusual volatile situation (Von Braun and Torero, 2009; World Bank, 2008a). In this regard we would like to clarify that the aim of this paper is not to understand the reason behind speculators' actions, but whether or not investors and asset managers have contributed to inflating and busting the commodity price bubble. Pyndick (2004) has examined the impact of price volatility on the price of some commodities. He concludes that, to some extent, price variability may be linked to speculative noise trading and herding behaviour.

A visual inspection of Figure 1 makes clear why we are interested in explaining the Food price dynamics with the Financial Markets argument. The negative dynamic correlation[2] between the first principal component (henceforth PC) of the Food (1) group and the first PC of the Financial Markets group has become more and more important over time. Before year 2000 the correlation coefficient between these two components is almost zero, indicating that food prices and stock markets dynamics were actually independent. In the last decade the value of the correlation coefficient has decreased at a constant pace achieving level -0.6 with an overall reduction of approximately 0.55 points. The change of the correlation coefficient between the Food (1) principal component and the other groups' PCs has not been so large. In particular, the correlation between the components of Food (1) and Chemicals & Energy has passed from 0.4 to 0.7. While the correlation between the Food (1) component and the components of the

[2] Dynamic correlation is intended as the recursive correlation coefficient computed backward from the last available observation (August 2011). The first correlation coefficient is obtained with the lowest number of observations (36). The first correlation coefficient thus captures the relationship between the principal components from August 2008 to August 2011. The other correlation coefficients are computed extending the sample backward.

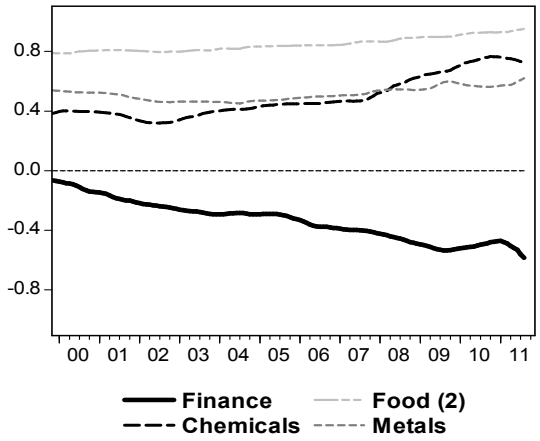

Fig. 1. Dynamic Correlation

remaining group (Metals, Food 2) has roughly levelled off. Hence, a preliminary conjecture may concern the increasingly important role of agricultural commodities in the asset managers' portfolios. While metals and energetic commodities have always been considered as a form of investment, the idea that food commodities may be viewed as a potential instrument of portfolio diversification has emerged only in recent times. In this paper we find robust evidence that the dynamics of food prices is related to the performance of financial markets. Our results are in line with the conclusion by Mittal (2009) as he claims that "*the role of speculation also immediately attracted considerable attention in part because the focus on the 'fundamentals' did not seem to explain the severity of the volatility*".

The rest of the paper is organized as follows. Section 2 presents the dataset and contains a preliminary discussion. Empirical evidence is reported in Section 3. In Section 4 we perform further robustness checks. Finally, Section 5 concludes.

2. Description of Data

We have clustered commodities into 4 groups: Food (1), Food (2), Metals, and Chemicals & Energy. Barley, corn, rice[3], and wheat are the commodities belonging to the Food (1) group. Food commodities in group (2) are the following: coffee (Brazil), robusta coffee, cocoa (Ecuador), orange, orange juice, soybeans, sugar, sunflower seeds oil, tea[4] (Calcutta), tea, and wool. Food (1) commodities represent consumption goods both in rich and in poor countries, while commodities in the Food (2) group are mainly consumed in developed countries. Aluminium, copper[5], gold, lead, nickel, silver, zinc, and tin represent the Metals group. The pool

[3] In Section 4 we rule out rice since the price of rice has rocketed in 2007 due to some structural changes affecting the supply side. In particular, in 2007 India has imposed export restrictions (except for *Basmati* rice), while in 2008 Vietnam has tightened export quotas.

[4] In Section 4 we rule out the sunflower seeds oil and the tea (Calcutta) series since the price of these commodities are expressed in UK Pounds, and Indian rupee respectively. As a matter of fact the different currency issue affects our analysis only marginally so long as we work with time series expressed in annual percentage changes.

[5] In Section 4 we rule out the copper series since it is expressed in UK Pound.

of Chemicals & Energy is composed by ammonia, natural gas, gasoline, gum, oil[6], propane. In addition, we have considered the group of Financial Markets which includes some representative stock market indexes of the industrialized economies: FTSE 100, FTSE all, MIB, NIKKEY 500, S&P 500, DJIA, DAX 30, CAC 40, Russell 2000, Wilshire 5000. A first reason to explore the relationship between financial market, i.e. eventual speculation, and food prices comes from the obvious consideration that explosive dynamics affecting the price of Food (1) commodities would generate a famine problem in poor countries and developing economies. In addition, sudden drops of food prices would have a negative impact on farmers' income both in emerging and in advanced economies. On the one hand, price volatility is acknowledged to be a financial risk indicator and excessive price volatility is a typical feature of stock markets; on the other hand, in the last few years it seems that price variability has equally interested the price of food commodities. The aim of this work is thus to examine the evolution of Food (1) and Food (2) prices over time in order to understand whether it has been dominated by financial determinants.

TABLE 1

Principal Component Analysis

Group	PC (1)	PC (2)	SUM
FOOD (1):	66%	24%	90%
FOOD (2):	27%	18%	45%
FINANCIAL MARKETS	82%	6%	88%
CHEMICALS & NRG	60%	16%	76%
METALS	60%	13%	73%

From each of the aforementioned groups we have extracted the first two principal components of the annual price changes. Table 1 shows the portion of the price variability of the groups captured by the two PCs. As expected, the PCs of the financial markets explain a high percentage of stock indexes variation over time. This is due to the strong correlation between stock market indexes. Conversely, the PCs of the Food (2) group can explain only a small portion of price variability; this outcome is consistent with the relatively high heterogeneity characterizing such a commodity group. The first PC of Food (1), Metals, and Chemicals accounts for about 60% of the price variability of the respective group. The analysis carried out in the next Section aims at finding the relation, if any, between the first PC of both the Food (1) and the Food (2) groups and the first principal component of the other groups.

Before continuing the analysis it seems interesting to look at Figure 2 and Figure 3. In Figure 2 we report the volatilities computed on the monthly changes of the Corn price (left diagram), the Wheat price (mid panel), and the S&P 500 index (right diagram). Volatility is obtained as the squared monthly returns of the price series. A visual inspection suggests that the corn price (left panel) has been quite volatile in the last decade, while the wheat price exhibits a peak in volatility only during the 2007-2009 crisis. Surprisingly, the S&P 500 is not as volatile

[6] In Section 4 we rule out the oil price series which will enter the regressions as a control variable.

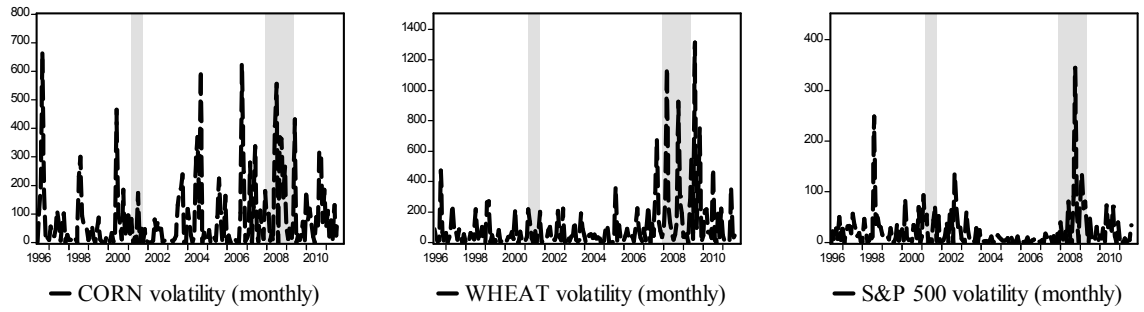

Fig. 2. Corn, Wheat, and S&P 500.

NOTES: from the left diagram to the right one the black lines represent the Corn squared monthly price change, the Wheat squared monthly price change, and the squared monthly rate of return computed on the S&P 500 index respectively.

as the food prices. The S&P 500 volatility is mainly concentrated around specific dates and it displays a peak during the financial crash in autumn 2008. However, we believe that the volatility computed on monthly price changes is not enough informative about the trading strategies of asset managers; in particular, the high volatility which is not related to the financial crisis can be attributed either to specific factors affecting commodities markets or to idiosyncratic noise[7].

As evident from Figure 3, the volatility of food prices computed on the annual span has dramatically increased in recent times. In addition, the volatility of returns computed on a yearly basis is much more significant to the extent that it can be related to portfolios strategies. Ruling out high-frequency traders whose targets may be expressed in daily, weekly, and/or monthly figures, asset managers' ability is usually assessed over a 12-month horizon. As a matter of fact, volatility measures computed on annual returns may well be regarded as a core variable entering the portfolio management process.

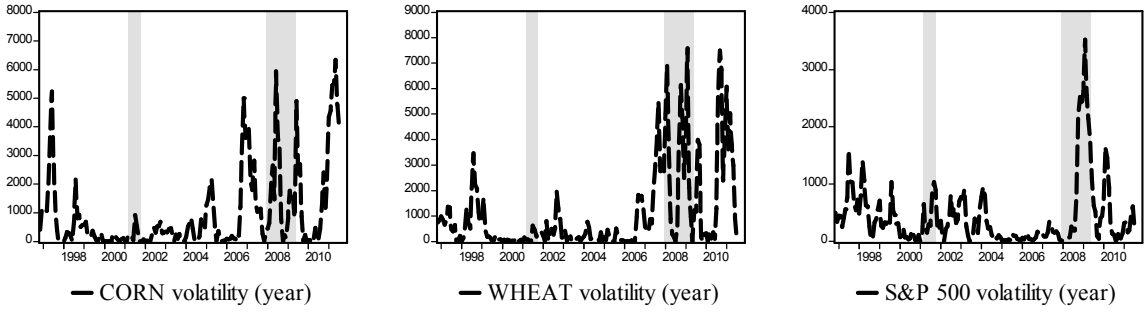

Fig. 3. Corn, Wheat, and S&P 500.

NOTES: from the left diagram to the right one the black lines represent the Corn squared annual price change, the Wheat squared annual price change, and the squared annual returns generated by the S&P 500 index respectively.

[7] For instance, the price of rice rocketed in 2007 due to specific supply conditions.

3. Empirical Evidence

In this Section we present the empirical results supporting our conjecture that the dynamics of food commodity prices could have been driven by financial factors. We estimate the following equations allowing for the first principal component of the aforementioned groups, other than Food (1) and Food (2), to be the explanatory variable of these models:

$$Food(1)_t^{PC,1} = \alpha_0 + \alpha_1 x_t^{PC,1} + \varepsilon_t \quad (1)$$

$$Food(2)_t^{PC,1} = \alpha_0 + \alpha_1 x_t^{PC,1} + \varepsilon_t \quad (2)$$

where $Food(1)_t^{PC,1}$ is the first principal component extracted from the Food (1) group, $Food(2)_t^{PC,1}$ is the first PC extracted from the Food (2) group, and $x_t^{PC,1}$ is the first PC obtained from one of the other groups (Financial Markets, Metals, and Chemicals & Energy). Equations (1) and (2) are OLS estimated; however, since the regressors are generated variables such estimations have to be confirmed by the Instrumental Variables (IV) technique. The left panel of Table 2 shows the results of equation (1); while, the estimation results of equation (2) are reported in right panel of Table 2. The empirical analysis is performed in two different samples: the first sample (Sample 1) goes from November 1996 to August 2011; while, the second sample (Sample 2) ranges between January 2005 and August 2011[8]. The choice of splitting the sample in January 2005, rather than in February 2006 when Bernanke took office at the Federal Reserve Bank and the upward trend of food prices started, allows having a sufficient number of observations in Sample 2. The volatility of food prices in the second sample has been particularly high.

First, evidence suggests that there is not any statistically significant relationship between financial markets and food prices over the entire sample (1996-2011); however, food commodity prices are significantly inversely correlated with the financial market component in Sample 2 (2005-2011). The financial market effect seems to concern both the commodities of the Food (1) group and those included into the Food (2) group. The IV[9] analysis confirms the results obtained with generated variables in the OLS regressions. The magnitude of the coefficients suggests that financial markets dynamics has a higher impact on the price of the Food (2) commodities; in addition, the higher goodness of fit implies that a larger portion of the Food (2) price fluctuations can be explained by the financial markets dynamics. The first impression is that asset managers can exploit the inverse correlation between financial market returns and food price dynamics to achieve an effective diversification of their portfolios. If financial agents expect stock prices to drop, they will find it convenient to sell stocks and buy commodities, or commodity futures, in such a way to minimize the negative impact of stock markets collapse on the returns of the managed portfolios. Second, although the Chemicals &

[8] The entire sample is split according to the results of the Chow breakpoint test.

[9] The instruments employed in the IV regressions are the following. The lagged annual return of the S&P 500 index is the instrument for the principal component of Financial Markets (FM). The lagged annual change of the oil price backs the PC (1) of Chemicals and Energy (C&E); while, the annual change of the gold price is the instrument of the Metals' first PC.

TABLE 2

Equations (1) and (2)

Dependent Variable:	FOOD (1)					FOOD (2)				
Sample	Const.	**PC (1) FM**	PC (1) C&E	PC (1) Met	adj-R^2	Const.	**PC (1) FM**	PC (1) C&E	PC (1) Met	adj-R^2
1	-0.009	-0.032			0.004	0.154	-0.031			0.001
	(0.942)	(0.392)				(0.218)	(0.424)			
IV	-0.015	-0.551			0.002	0.152	-0.046			0.001
	(0.952)	(0.551)				(0.523)	(0.637)			
2	-0.677	-0.254			0.168	-0.867	-0.330			0.346
	(0.002)	(0.000)				(0.002)	(0.000)			
IV	-0.728	-0.351			0.141	-0.923	-0.433			0.311
	(0.085)	(0.001)				(0.008)	(0.000)			
1	0.036		0.277		0.143	0.191		0.237		0.090
	(0.752)		(0.000)			(0.109)		(0.000)		
IV	0.037		0.285		0.143	0.192		0.247		0.089
	(0.875)		(0.005)			(0.441)		(0.040)		
2	-0.468		0.457		0.264	-0.601		0.567		0.488
	(0.022)		(0.000)			(0.000)		(0.000)		
IV	-0.472		0.437		0.264	-0.604		0.551		0.487
	(0.205)		(0.002)			(0.033)		(0.000)		
1	0.104			0.364	0.287	0.239			0.368	0.260
	(0.319)			(0.000)		(0.027)			(0.000)	
IV	0.176			0.616	0.146	0.293			0.618	0.137
	(0.412)			(0.000)		(0.204)			(0.000)	
2	-0.116			0.386	0.282	-0.255			0.397	0.353
	(0.584)			(0.000)		(0.173)			(0.000)	
IV	0.141			0.620	0.174	-0.148			0.493	0.332
	(0.713)			(0.001)		(0.626)			(0.004)	

Notes: **Sample 1**: Nov 1996 - Aug 2011; **Sample 2**: Jan 2005 - Aug 2011. PC(1) is the first principal component. FM: Financial Market group; C&E: Chemicals & Energy group; Met: Metals group.

Energy component is significantly related to Food prices over the entire sample, there is clear evidence that the impact of such a component on food price variability has increased in Sample 2. As shown in the mid panel of Table 2, the magnitude of the coefficients has more than doubled passing from 0.2 to 0.4 for Food (1), and from 0.2 to 0.5 for Food (2). In recent years there has been a growing importance of energy management specialists and energy traders not only within asset management companies but also within firms operating in the energy industry at both production and delivery levels. We may interpret this outcome consistently with our previous way of reasoning. Hedge funds managers have recently increased the size of their portfolios invested in energetic commodities to smooth the influence of financial market cycles; as a result, we can expect an increasing correlation between the movements of energetic and food commodity prices as long as they accomplish the same objective. Third, the bottom panel of Table 2 shows that there is no difference regarding the estimated coefficient before and after 2005. For instance, such a finding is due to the fact that gold has always been strategically considered by investors as a countercyclical buffer.

We can summarize as follows. On the one hand, our findings highlight a different behaviour of the estimated relationships in Sample 1 and Sample 2. There is, in fact, a structural change in 2005 regarding both the relationship between food price fluctuations and the financial market component and the relationship between food price movements and the Chemical & Energy factor. In both situations the magnitude of the estimated coefficients tends to increase in absolute value in Sample 2. However, in the former case the negative sign of the coefficient highlights an important inverse correlation; while, in the latter case, the positive coefficient signals that food and energy commodities have been affected by common trends. In contrast, the relationship between the food prices and metal commodity prices seems stable across samples. On the other hand, the reaction of food prices to both the financial markets and the Chemicals & Energy components depends on the Food group, the intensity being greater for Food (2). Whereas, the Metal principal component affects both Food groups with roughly the same force.

Now we focus on the ability of the financial market component to predict the volatility peaks exhibited by the food price series. We construct one dummy variable for each Food group. The dummy variable (UP) assumes value "*1*" if the incoming (*h = 12*) level of the Food first principal component is greater than "*2*", and zero otherwise; such a dummy thus captures states of the world in which the price dynamics of the Food group is exceptionally upward biased. It essentially happens at during years 2007 and 2008. The independent variable of the following probit regression is the actual Financial Markets principal component ($FM(1)_t^{PC,1}$):

$$\Pr\left(Food_{t,t+h}^{PC,1}(UP)=1\right)=\Psi\left(\lambda_0+\lambda_1 FM_t^{PC,1}\right) \tag{3}$$

The above model is estimated in both samples for Food (1) and for Food (2). The empirical results are reported in Table 3. When the dependent dummy variable indicates an incoming upward movement of the food prices, the sign of the Financial Markets component is negative; such an inverse correlation suggests that rocketing food prices can be significantly predicted by plummeting stock market indexes. Hence, it seems that in periods of financial distress the food price dynamics can be anticipated by looking at stock markets movements. Moreover, as discussed before, there is evidence that such a phenomenon has become more important in the second sample. In Sample 2 both the magnitude of the estimated λ_1 coefficient and the goodness of fit are substantially larger. The probit analysis reinforces our IV-based conclusion that exists a significant probability for stock markets dynamics to predict food price movements.

TABLE 3

Equations (3) - Probit Models

Dependent Variable:	FOOD (1) - UP			FOOD (2) - UP		
Sample	Const.	PC (1) FM	McF-R^2	Const.	PC (1) FM	McF-R^2
1	-1.511 (0.000)	-0.116 (0.003)	0.088	-1.402 (0.000)	-0.134 (0.000)	0.111
2	-1.377 (0.000)	-0.183 (0.000)	0.215	-2.007 (0.000)	-0.293 (0.000)	0.476

Notes: PC(1) is the first principal component of the Financial Markets (FM) group. McF-R^2 stands for the McFadden goodness of fit.

We conclude this Section by showing that the empirical results obtained so far are robust to the inclusion of some control variables in the above regressions[10]. First we include some leading indicators of the economy such as the U.S. monetary policy instruments, or variables related to it. Second, we include the exchange rate dynamics in order to account both for the international trade effects and for the fact that some commodity price series are not expressed in U.S. Dollar (sunflower seeds oil, Calcutta tea, and copper). In Table 4 we report the IV estimations of the augmented version of equations (1) and (2) after including as controlling variables the federal funds rate (panel a) and its first differenced series (panel b). To be concise, from Table 4 onward we omit reporting the OLS estimations; the results will thus refer to the instrumental variable analysis only. The inclusion of the policy rate does not affect the empirical results obtained above; evidence, in fact, highlights a clear negative relationship between the Financial Market and the Food principal components. In the second sample, the significance of the coefficients multiplying the Financial Markets does not vanish after the inclusion of the policy variable. Also the positive correlation between Food and both Chemicals and Metals is confirmed. In Table 4 (a) the level of the federal funds rate enters the augmented version of the regressions (1) and (2).

TABLE 4 (a)

Equations (1) and (2) - Regressions Augmented with Control Variables

Dependent Variable:	FOOD (1)						FOOD (2)					
Sample	Const.	**PC (1) FM**	PC (1) C&E	PC (1) Met	ffr	adj-R^2	Const.	**PC (1) FM**	PC (1) C&E	PC (1) Met	ffr	adj-R^2
1 (IV)	-0.361	-0.084			0.107	0.007	-0.899	-0.139			0.319	0.125
	(0.487)	(0.373)			(0.394)		(0.115)	(0.181)			(0.014)	
2 (IV)	-0.242	-0.315			-0.200	0.171	-1.132	-0.449			0.086	0.307
	(0.740)	(0.007)			(0.297)		(0.101)	(0.000)			(0.622)	
1 (IV)	-0.199		0.292		0.076	0.152	-0.629		0.273		0.254	0.195
	(0.650)		(0.005)		(0.504)		(0.222)		(0.030)		(0.038)	
2 (IV)	0.139		0.385		-0.266	0.309	-0.589		0.549		-0.006	0.481
	(0.814)		(0.002)		(0.127)		(0.278)		(0.000)		(0.964)	
1 (IV)	0.337			0.649	-0.048	0.100	-0.191			0.518	0.142	0.253
	(0.517)			(0.000)	(0.682)		(0.716)			(0.000)	(0.221)	
2 (IV)	0.376			0.606	-0.107	0.179	-0.319			0.504	0.078	0.330
	(0.559)			(0.004)	(0.579)		(0.593)			(0.004)	(0.665)	

Notes: **Sample 1**: Nov 1996 - Aug 2011; **Sample 2**: Jan 2005 - Aug 2011. PC(1) is the first principal component. FM: Financial Market group; C&E: Chemicals & Energy group; Met: Metals group. ffr is the federal funds rate.

While, in Table 4 (b) the first difference of the federal funds rate enters the augmented specification of equations (1) and (2). In the second sample the coefficient multiplying the Financial Markets component remains significantly negative.

[10] The robustness analysis through the inclusion of control variables is not extended to the probit analysis where additional variables are generally included with the only aim of increasing the goodness of fit of the model.

TABLE 4 (b)

Equations (1) and (2) - Regressions Augmented with Control Variables

Dependent Variable:	FOOD (1)						FOOD (2)					
Sample	Const.	**PC (1) FM**	PC (1) C&E	PC (1) Met	d(ffr)	adj-R^2	Const.	**PC (1) FM**	PC (1) C&E	PC (1) Met	d(ffr)	adj-R^2
1 (IV)	0.052	-0.121			2.974	0.002	0.189	-0.077			1.453	0.001
	(0.829)	(0.256)			(0.107)		(0.478)	(0.521)			(0.427)	
2 (IV)	-0.591	-0.482			8.012	0.208	-0.814	-0.537			6.335	0.361
	(0.085)	(0.000)			(0.000)		(0.007)	(0.000)			(0.000)	
1 (IV)	0.140		0.335		3.360	0.168	0.257		0.278		2.075	0.093
	(0.532)		(0.000)		(0.008)		(0.310)		(0.013)		(0.063)	
2 (IV)	-0.384		0.420		3.492	0.279	-0.567		0.544		1.484	0.485
	(0.287)		(0.002)		(0.046)		(0.048)		(0.000)		(0.096)	
1 (IV)	0.332			0.618	5.384	0.270	0.422			0.618	4.423	0.201
	(0.045)			(0.000)	(0.000)		(0.048)			(0.000)	(0.000)	
2 (IV)	0.231			0.559	6.147	0.332	-0.102			0.461	3.194	0.385
	(0.487)			(0.000)	(0.000)		(0.751)			(0.002)	(0.006)	

Notes: **Sample 1**: Nov 1996 - Aug 2011; **Sample 2**: Jan 2005 - Aug 2011. PC(1) is the first principal component. FM: Financial Market group; C&E: Chemicals & Energy group; Met: Metals group. ffr is the federal funds rate. d represents the first difference operator.

In Table 5 we report the estimations of equations (1) and (2) after including the 10-year Treasury bond rate, rather the federal funds rate, as the control variable. To tackle the financial crisis and the economic recession, in fact, chairman Bernanke has substantially increased the supply of money with the effect of bounding the short-term rate to the zero level; further money supply has been accompanied by massive purchases of long-duration bonds with the aim of

TABLE 5 (a)

Equations (1) and (2) - Regressions Augmented with Control Variables

Dependent Variable:	FOOD (1)						FOOD (2)					
Sample	Const.	**PC (1) FM**	PC (1) C&E	PC (1) Met	tb10y	adj-R^2	Const.	**PC (1) FM**	PC (1) C&E	PC (1) Met	tb10y	adj-R^2
1 (IV)	-2.744	-0.136			0.588	0.094	-3.965	-0.184			0.871	0.238
	(0.023)	(0.176)			(0.012)		(0.000)	(0.000)			(0.091)	
2 (IV)	-1.338	-0.363			0.155	0.130	-3.905	-0.492			0.758	0.358
	(0.536)	(0.007)			(0.761)		(0.027)	(0.000)			(0.056)	
1 (IV)	-2.064		0.311		0.457	0.225	-3.005		0.288		0.681	0.284
	(0.048)		(0.005)		(0.023)		(0.008)		(0.026)		(0.002)	
2 (IV)	0.399		0.417		-0.225	0.253	-1.579		0.574		0.251	0.497
	(0.852)		(0.007)		(0.680)		(0.365)		(0.000)		(0.549)	
1 (IV)	-0.793			0.534	0.206	0.241	-1.886			0.428	0.455	0.347
	(0.404)			(0.000)	(0.248)		(0.061)			(0.000)	(0.018)	
2 (IV)	-1.732			0.637	0.486	0.184	-2.588			0.516	0.633	0.385
	(0.419)			(0.001)	(0.383)		(0.148)			(0.002)	(0.156)	

Notes: **Sample 1**: Nov 1996 - Aug 2011; **Sample 2**: Jan 2005 - Aug 2011. PC(1) is the first principal component. FM: Financial Market group; C&E: Chemicals & Energy group; Met: Metals group. tb10y is the 10-year T-bond.

lowering long-term interest rates. Such a monetary strategy followed by the Fed is known as the *quantitative easing*. Hence, the long-term rate can be considered as the intended policy rate after 2008. The main conclusion that exists a significant inverse correlation between the Food and the Financial Markets principal components is confirmed once again. The statistical results reported in Table 5 (a) regard the estimations of the augmented specification of equations (1) and (2) when the control variable is the level of the long-term rate. While, results reported in Table 5 (b) refer to estimations when the control variable is the first difference of the long-term interest rate.

TABLE 5 (b)

Equations (1) and (2) - Regressions Augmented with Control Variables

Dependent Variable:	FOOD (1)						FOOD (2)					
Sample	Const.	**PC (1) FM**	PC (1) C&E	PC (1) Met	d(tb10y)	adj-R^2	Const.	**PC (1) FM**	PC (1) C&E	PC (1) Met	d(tb10y)	adj-R^2
1 (IV)	0.029	-0.065			2.014	0.001	0.226	-0.076			4.366	0.001
	(0.912)	(0.491)			(0.582)		(0.405)	(0.413)			(0.226)	
2 (IV)	-0.595	-0.350			5.500	0.001	-0.747	-0.432			7.256	0.001
	(0.204)	(0.002)			(0.259)		(0.071)	(0.000)			(0.118)	
1 (IV)	0.093		0.281		2.397	0.069	0.271		0.236		4.398	0.001
	(0.711)		(0.005)		(0.417)		(0.297)		(0.041)		(0.164)	
2 (IV)	-0.390		0.411		3.571	0.149	-0.491		0.516		4.891	0.259
	(0.342)		(0.005)		(0.422)		(0.158)		(0.000)		(0.241)	
1 (IV)	0.305			0.616	5.407	0.001	0.415			0.613	6.797	0.001
	(0.182)			(0.000)	(0.039)		(0.075)			(0.000)	(0.008)	
2 (IV)	0.227			0.561	6.256	0.001	-0.059			0.432	6.548	0.001
	(0.595)			(0.003)	(0.166)		(0.870)			(0.008)	(0.126)	

Notes: **Sample 1**: Nov 1996 - Aug 2011; **Sample 2**: Jan 2005 - Aug 2011. PC(1) is the first principal component. FM: Financial Market group; C&E: Chemicals & Energy group; Met: Metals group. tb10y is the 10-year T-bond. d represents the first difference operator.

Finally, we correct equations (1) and (2) for the exchange rate effect. We consider the natural *logarithm* of the trade weighted exchange rate between U.S. and some developed countries. The exchange rate series is available from the FREDatabase. Although not reported in Table 6, the augmented regressions have also been estimated with the first difference of the effective exchange rate, and the annual change. The inverse relationship between the Financial Markets and the Food price dynamics remains robust to the different measures related to the control variable.

TABLE 6

Equations (1) and (2) - Regressions Augmented with Control Variables

Dependent Variable:	FOOD (1)						FOOD (2)					
Sample	Const.	**PC (1) FM**	PC (1) C&E	PC (1) Met	*ln*(ex)	adj-R^2	Const.	**PC (1) FM**	PC (1) C&E	PC (1) Met	*ln*(ex)	adj-R^2
1 (IV)	-16.944	-0.039			3.782	0.100	-21.805	-0.025			4.905	0.143
	(0.065)	(0.718)			(0.062)		(0.027)	(0.831)			(0.026)	
2 (IV)	-59.813	-0.299			13.581	0.347	-58.144	-0.383			13.153	0.512
	(0.002)	(0.007)			(0.002)		(0.000)	(0.000)			(0.000)	
1 (IV)	-13.799		0.247		3.089	0.210	-19.283		0.193		4.348	0.201
	(0.111)		(0.036)		(0.106)		(0.060)		(0.176)		(0.057)	
2 (IV)	-40.046		0.372		9.089	0.358	-31.463		0.500		7.088	0.550
	(0.049)		(0.019)		(0.045)		(0.091)		(0.000)		(0.094)	
1 (IV)	7.001			0.698	-1.518	0.049	-1.349			0.599	0.366	0.151
	(0.533)			(0.000)	(0.540)		(0.914)			(0.004)	(0.896)	
2 (IV)	-46.471			0.457	10.668	0.380	-49.594			0.321	11.316	0.468
	(0.018)			(0.003)	(0.167)		(0.009)			(0.036)	(0.009)	

Notes: **Sample 1**: Nov 1996 - Aug 2011; **Sample 2**: Jan 2005 - Aug 2011. PC(1) is the first principal component. FM: Financial Market group; C&E: Chemicals & Energy group; Met: Metals group. ex is the trade-weighted exchange rate. *ln* is the natural logarithm.

4. Robustness Analysis

We show robustness after ruling out the noisiest elements from each group as mentioned in *footnote*s 3, 4, 5, and 6. In particular, we remove rice from the Food (1) group, gold from the Metals group, and oil from the Chemicals & Energy group. In addition we exclude from the principal component analysis all the price series which are not expressed in U.S. dollar (copper, sunflower seeds oil, and Calcutta tea) from the correspondent group. We motivate our choice as follows. In 2007 the price of rice was affected by the shift in the supply curve due to the Indian decision of restricting exports. Similarly in 2008 the Vietnam Government imposed tight quotas on the quantity exported. Oil is the core input of a great variety of production processes; the price of oil depends on a cartel determined by the oil companies, and at a higher level by the producing countries, i.e. OPEC. Gold is a typical investment opportunity exploited by traders in bear markets, so that removing the effect of gold from the Metals group allows us to avoid redundancy. As a matter of fact gold is an investment buffer that asset managers have always held in their portfolios, hedge funds managers' interest in gold has definitely increased in the last few years though.

The empirical results reported in the following part of the paper are in line with the argument of a portfolio substitution effect starting from 2005. When the financial markets do not offer satisfactory returns, traders seem to exploit the Food price dynamics in order to compensate financial adversity. This behaviour seems to have consolidated during the initial stage of the financial crisis. The instrumental variable estimations of equations (1) and (2) after removing noise elements from the commodity groups are reported in Table 7.

TABLE 7

Equations (1) and (2) - After ruling out noisy elements from commodity groups

Dependent Variable:	FOOD (1)					FOOD (2)				
Sample	Const.	**PC (1) FM**	PC (1) C&E	PC (1) Met	adj-R^2	Const.	**PC (1) FM**	PC (1) C&E	PC (1) Met	adj-R^2
1 (IV)	-0.018	-0.065			0.001	0.185	-0.017			0.001
	(0.942)	(0.462)				(0.361)	(0.795)			
2 (IV)	-0.676	-0.365			0.184	-0.738	-0.239			0.301
	(0.101)	(0.000)				(0.000)	(0.000)			
1 (IV)	0.001		0.344		0.126	0.188		0.262		0.119
	(0.996)		(0.006)			(0.322)		(0.009)		
2 (IV)	-0.481		0.508		0.223	-0.610		0.451		0.524
	(0.205)		(0.006)			(0.000)		(0.000)		
1 (IV)	0.168			0.778	0.049	0.311			0.709	0.001
	(0.462)			(0.000)		(0.141)			(0.000)	
2 (IV)	0.047			0.733	0.224	-0.351			0.358	0.274
	(0.896)			(0.001)		(0.080)			(0.003)	

Notes: **Sample 1**: Nov 1996 - Aug 2011; **Sample 2**: Jan 2005 - Aug 2011. PC(1) is the first principal component. FM: Financial Market group; C&E: Chemicals & Energy group; Met: Metals group.

Also the probit analysis confirms previous results. We have estimated equation (3) after ruling out commodities from the respective groups as described above. In particular, results reported in Table 8 emphasize the fact that negative movements of the financial market component can anticipate upward pressures (UP) on Food prices. This outcome is definitely more important in the second sample thus reinforcing the conclusion that financial speculation may underlie the impressive spike shown by food prices in 2008.

TABLE 8

Equations (3) - Probit Models after ruling out noisy elements from commodity groups

Dependent Variable:	FOOD (1) - UP			FOOD (2) - UP		
Sample	Const.	**PC (1) FM**	McF-R^2	Const.	**PC (1) FM**	McF-R^2
1	-1.746	-0.205	0.263	-1.341	-0.079	0.039
	(0.000)	(0.000)		(0.000)	(0.032)	
2	-2.304	-0.434	0.678	-2.444	-0.207	0.313
	(0.000)	(0.000)		(0.000)	(0.018)	

Notes: PC(1) is the first principal component of the Financial Markets (FM) group. McF-R^2 stands for the McFadden goodness of fit.

In Table 9, we show that the negative relationship between the Food and Financial Markets principal components is robust also to the inclusion of the oil price dynamics as a control variable. Regressions (1) and (2) are augmented with the (*log*) oil price (panel a), the annual change of the oil price (panel a), and the first differenced price series (panel b), respectively.

TABLE 9 (a)

Equations (1) and (2) - Regressions Augmented with Oil price measures as the Control Variable

Dependent Variable:	FOOD (1)					FOOD (2)				
Sample	Const.	**PC (1) FM**	*ln*(oil)	d(oil)	adj-R^2	Const.	**PC (1) FM**	*ln*(oil)	d(oil)	adj-R^2
1 (IV)	4.531	-0.098	-1.235		0.216	5.292	-0.066	-1.398		0.392
	(0.000)	(0.300)	(0.000)			(0.000)	(0.343)	(0.000)		
2 (IV)	15.879	-0.261	-3.853		0.430	8.144	-0.184	-2.067		0.492
	(0.000)	(0.008)	(0.000)			(0.000)	(0.002)	(0.000)		
1 (IV)	0.044	-0.036		-0.156	0.001	0.215	-0.003		-0.076	0.001
	(0.856)	(0.736)		(0.062)		(0.274)	(0.966)		(0.241)	
2 (IV)	-0.646	-0.351		-0.043	0.167	-0.744	-0.242		0.007	0.292
	(0.112)	(0.004)		(0.592)		(0.000)	(0.002)		(0.893)	

Notes: **Sample 1**: Nov 1996 - Aug 2011; **Sample 2**: Jan 2005 - Aug 2011. PC(1) is the first principal component. FM: Financial Market group; *ln* stands for the natural logarithm; d represents the first difference operator.

The first lag of the respective oil-based variable is chosen as the instrument of the instrumental variable estimations; while, the first lag of the S&P 500 annual rate of return backs the Financial Markets first principal component. Results seem also to highlight a negative relationship between the dynamics of the oil price and the trend of agricultural commodities. However, this effect is weak and needs further investigation which goes beyond the aim of this paper.

TABLE 9 (b)

Equations (1) and (2) - Regressions Augmented with Oil price measures as the Control Variable

Dependent Variable:	FOOD (1)					FOOD (2)				
Sample	Const.	**PC (1) FM**	*ln*(oil)	d(oil, 12)	adj-R^2	Const.	**PC (1) FM**	*ln*(oil)	d(oil, 12)	adj-R^2
1 (IV)	0.165	0.005		-0.016	0.127	0.334	0.039		-0.014	0.087
	(0.511)	(0.923)		(0.005)		(0.081)	(0.454)		(0.010)	
2 (IV)	-0.547	-0.297		-0.008	0.212	-0.489	-0.109		-0.015	0.450
	(0.213)	(0.031)		(0.550)		(0.021)	(0.035)		(0.002)	

Notes: **Sample 1**: Nov 1996 - Aug 2011; **Sample 2**: Jan 2005 - Aug 2011. PC(1) is the first principal component. FM: Financial Market group; *ln* stands for the natural logarithm; d(x, 12) represents the annual change of the x variable.

In Table 10, exactly the same exercise as before has been carried out when the price of gold is taken as the control variable. Investments in gold are generally viewed as an alternative to the investments in financial securities; financial market participants are used to trading gold either in bear markets when stocks do not offer satisfactory returns, or when the level of uncertainty is quite high. Although the price dynamics of both oil and gold are relevant indicators for financial markets participants, our interest in Table 9 and in Table 10 focuses on the statistical significance of the negative coefficient that multiplies the Financial Market component. Hence, rather than investigating the nature of the relationship between the price of agricultural commodities and the movements of the control variables, we simply aim at confirming that our key hypothesis holds in spite of corrections for different effects.

TABLE 10 (a)

Equations (1) and (2) - Regressions Augmented with Gold price measures as the Control Variable

Dependent Variable:	FOOD (1)					FOOD (2)				
Sample	Const.	PC (1) FM	*ln*(gold)	d(gold)	adj-R^2	Const.	PC (1) FM	*ln*(gold)	d(gold)	adj-R^2
1 (IV)	6.221	-0.080	-1.009		0.117	8.068	-0.039	-1.277		0.266
	(0.029)	(0.442)	(0.035)			(0.000)	(0.627)	(0.000)		
2 (IV)	10.994	-0.358	-1.738		0.280	1.944	-0.238	-0.399		0.310
	(0.032)	(0.001)	(0.027)			(0.520)	(0.000)	(0.398)		
1 (IV)	-260.5	-1.357		32.004	-	19.066	-0.224		-2.470	-
	(0.998)	(0.998)		(0.998)		(0.983)	(0.983)		(0.983)	
2 (IV)	-1.672	-0.441		0.054	-	-0.988	-0.259		0.014	0.001
	(0.625)	(0.155)		(0.756)		(0.454)	(0.043)		(0.843)	

Notes: **Sample 1**: Nov 1996 - Aug 2011; **Sample 2**: Jan 2005 - Aug 2011. PC(1) is the first principal component. FM: Financial Market group; *ln* stands for the natural logarithm; d represents the first difference operator.

TABLE 10 (b)

Equations (1) and (2) - Regressions Augmented with Gold price measures as the Control Variable

Dependent Variable:	FOOD (1)					FOOD (2)				
Sample	Const.	PC (1) FM	*ln*(gold)	d(gold, 12)	adj-R^2	Const.	PC (1) FM	*ln*(gold)	d(gold, 12)	adj-R^2
1 (IV)	0.553	-0.101		-0.065	0.308	0.685	-0.054		-0.059	0.375
	(0.005)	(0.150)		(0.000)		(0.000)	(0.272)		(0.000)	
2 (IV)	0.912	-0.232		-0.079	0.305	-0.159	-0.191		-0.029	0.365
	(0.290)	(0.048)		(0.034)		(0.671)	(0.006)		(0.125)	

Notes: **Sample 1**: Nov 1996 - Aug 2011; **Sample 2**: Jan 2005 - Aug 2011. PC(1) is the first principal component. FM: Financial Market group; *ln* stands for the natural logarithm; d(x, 12) represents the annual change of the x variable.

5. Concluding Remarks

In this paper we have examined whether the atypical pinnacle exhibited by food commodity prices between 2007 and 2008 could have a financial rationalization. It seems, in fact, that the mere interaction between supply and demand cannot fully account for the aforementioned unusual peak. Three different arguments support this view. First, the sharp raise of food prices in 2007-2008 occurs during a period of economic crisis, it is actually difficult to justify the price rise with the strong demand argument. Second, if the weak demand from industrialized countries has been compensated by the soaring one from the fast-growing emerging economies, how can we explain the sudden drop of food prices in late 2008? Finally, if a supply shortage has contributed to the temporary price boost, again the brisk fall of commodity prices in late 2008 does not have a robust explanation. Although the conditions related to the relative force of supply and demand may have induced financial agents, we find

evidence of a significant portfolio substitution effect. In particular, when stock market indexes follow a downward trend, fund managers find it convenient to shift resources from financial securities to commodities in order to limit negative returns of their equity portfolios. Although some commodities, such as oil and gold, have always been traded as an investment buffer, food commodities seem to have attracted financial agents' attention only recently. Empirical evidence based on principal component factors suggests that, from 2006, there is a significant inverse correlation between stock markets movements and the dynamics of food commodity prices. Moreover, data evidence highlights that such an inverse correlation has progressively increased over time.

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