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WORKING PAPER 43

Fundamentals or Financialisation of Commodity Markets - What Determines Recent Wheat Prices?

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Abbreviations

BIS	Bank for International Settlement
BRICs	Brazil, Russia, India, China
CBOT	Chicago Board of Trade
CFTC	Commodity Futures Trading Commission
CIT	Commodity Index Traders
COT	Commitment of Traders
CPOs	Commodity Pool Operators
CTAs	Commodity Trading Advisors
CV	Coefficient of Variation
DCOT	Disaggregated Commitments of Traders
EMH	Efficient Market Hypothesis
EU	European Union
FAO	Food and Agriculture Organization
FTT	Financial Transaction Tax
GDP	Gross Domestic Product
HRS	Hard Red Spring Wheat
HRW	Hard Red Winter Wheat
ICAs	International Commodity Agreements
IID	Index Investment Data
KCBT	Kansas City Board of Trade
MENA	Middle East and North Africa
MGEX	Minneapolis Grain Exchange
NFIDC	Net Food Importing Developing Countries
ODA	Official Development Aid
OECD	Organisation for Economic Co-operation and Development
OTC	Over the Counter
QB	Quantities for Biofuel
QE	Quantities for Edibles
QF	Quantities for Feed
QO	Quantities for Utilization
SRW	Soft Red Winter Wheat
SSA	Sub-Sahara Africa
SSD	Standard Deviation of the Logarithm of Prices in Differences
UNCTAD	United Nations Conference on Trade and Development
VAR	Vector Autoregression Framework

Abstract

Food price developments have various impacts at the country and household level, in particular in developing countries with severe implications on food security, poverty and economic stability. The focus of this paper is on wheat as it is, together with rice, the most important food crop. The analysis focuses on the determinants of recent wheat price developments, in particular on the role of fundamental supply and demand factors and the financialisation of commodity markets, i.e. the increasing presence of financial investors. The paper gives an overview of the relevance of wheat in the global food production system, recent wheat price developments, and different determinants of wheat prices stated in the literature, in particular the controversial debate on the influence of financial investors. It adds to this debate by employing a basic supply and demand model for global wheat prices based on the main fundamental demand and supply factors stated in the literature. The model can replicate actual wheat prices up to 2006/07 but a significant divergence appears thereafter. This gap may be explained by non-fundamental factors, most importantly financialisation.

1. Introduction

The current commodity price boom in combination with high price volatility is of a magnitude not seen at least since the 1970s. After two decades of low commodity prices in the 1980s and 1990s, many commodities had registered steep price increases since 2002 with large fluctuations reaching hikes in mid 2008 and again in mid 2011 and 2012. These price movements are in particular relevant in the case of food commodities, including the four major commodities wheat, rice, maize and soy beans, given the important consequences of high and volatile food prices on food security, poverty and economic stability.

Food price developments and price volatility can have various impacts at the country and household level. Two-thirds of developing countries are net importers of basic food commodities. But even in developing countries where imports only account for a small share of the total food consumption, global commodity prices may have an important impact on local markets (Bass 2011). At the household level, prices for food crops are important for farmers and consumers as staple food accounts for a major part of household expenditures and are the most widely planted crops in developing countries. The impact of the price hikes in food commodities in 2008 has been most dramatically reflected in food crises in many developing countries in recent years. The FAO (2008, 2012) estimates that 33 countries experienced severe or moderate food crises in 2008 and that the number of undernourished people increased by 200 million from 2005/07 to 2009 due to the food price hike.

Food prices also have important macroeconomic impacts, in particular on the balance of payments, public finances and inflation, as well as on the policy space for fiscal and monetary policy. The current account of many developing countries strongly depends on agriculture commodities' price developments. The FAO (2008) reports that in the price hike from 2006/07 to 2007/08 seven countries experienced an increase in their cereal imports as a share of GDP by more than 3 % of GDP; for seven other countries the increase was between 2 % and 3 % of GDP. Deteriorating current accounts and public finances related to high commodity import prices may impose constraints on fiscal policy. In the absence of alternative financial facilities countries may be forced into pro-cyclical policies. Further, as many developing countries pursue inflation targeting, high commodity prices may force central banks to use restrictive monetary policies to counteract inflationary pressures. The high volatility of commodity prices may make macroeconomic management even more difficult and further limit possibilities for counter-cyclical fiscal and monetary interventions.

Given these far reaching implications of food price developments, an understanding of recent food prices and their determinants is of crucial importance. The focus of this paper is on wheat as it is, together with rice, the most important food crop. Hence, the main question analyzed in this paper is: What were the determinants of recent wheat price developments and in particular which role did fundamental supply and demand factors and the financialisation of commodity markets, i.e. the increasing presence of financial investors play? To analyze this question, the paper investigates, firstly, the relevance of wheat in the global food production system (section 2) as well as recent wheat price developments (section 3). It then gives an overview of different determinants of wheat prices stated in the literature and in particular of the controversial debate on the influence of financial investors, on wheat prices (section 4). We add to this debate by employing a basic supply and demand model aimed at determining global wheat prices based on the main fundamental factors stated in the literature (section 5) and by analyzing the role of financialisation for wheat prices (section 6). The last section concludes and points out some policy issues.

2. Wheat production, consumption and trade patterns

There are five main types of wheat – hard red winter wheat (HRW), hard red spring wheat (HRS), soft red winter wheat (SRW), white wheat, and durum. Spring and winter refers to the season during which the crop is grown where winter wheat requires vernalization. Hard or soft depends on grain hardness (kernel texture); colors include red, white and amber. Grades relate to protein content. Table 1 shows the different types of wheat, their properties and uses. So-called bread wheat accounts for more than 90 % of global wheat production – spring bread wheat for 70 % while the rest is winter bread wheat.

Table 1: Wheat types, properties and uses

Wheat Type	Property	Use
Hard (red winter and red spring & white)	High protein	Bread and all purpose flour
Soft (red winter and white)	Low to medium protein and gluten	Flat breads, pastries, cookies and cakes
Durum	High protein and high gluten	Semolina flour, pasta and Mediterranean breads

Source: Ahmed (2012).

Wheat is a staple food for most of the world's population. In developing countries the large majority of wheat is used for food (as staple or through products made from wheat flour such as bread, pastry, pasta and noodles) whereas in developed countries an important share is also used for animal feed in particular poorer quality wheat. Overall, around 17 % of global wheat consumption is used for animal feed (Mitchell/Mielke 2005). Worldwide, 19 % of daily calories are met by wheat – across developing countries 16 % of total dietary calories comes from wheat (26 % in developed countries), which is second only to rice. There is however great regional variation in per capita consumption (Dixon et al. 2009). Generally, wheat consumption is less important in Sub-Saharan Africa (SSA) (where it accounts for 9 % in East Africa, 5 % in West Africa and 16 % in Southern Africa[1]), but very significant in South Asia (22 %, particularly India) and East Asia (18 %, particularly China). But the share of

[1] Southern Africa includes South Africa, the main wheat producer in SSA with 1.96 million tons or a share of 32 % of total wheat production in SSA. Besides South Africa, only Ethiopia, Sudan and Kenya produce wheat on a larger scale in SSA.

imports to domestic production is much higher in SSA than in Asia. In 2009, countries in East Africa imported a quantity of wheat that was 1.7 times the domestic wheat production, Southern Africa 0.8 times and in West Africa almost all of the consumption was imported. Contrary, East and South Asian countries imported only 10 % of their domestic production (Table 2).

Table 2: Source of daily calories by regions (2009)

	World	NFIDC		East Africa		South Asia		East Asia	
Total Calories	**2,831**	**2,465**		**2,103**		**2,386**		**3,000**	
	% of daily calories	*% of daily calories*	*Import share**	*% of daily calories*	*Import share**	*% of daily calories*	*Import share**	*% of daily calories*	*Import share**
Cereals	45.6%	54.5%	29.2%	48.8%	29.6%	57.5%	6.4%	47.0%	11.3%
Wheat	**18.8%**	**16.9%**	**72.0%**	**8.9%**	**170.1%**	**22.3%**	**10.2%**	**18.6%**	**10.5%**
Rice	18.9%	20.5%	8.4%	6.8%	27.1%	29.5%	negl.	25.9%	negl.
Maize	5.0%	10.4%	37.8%	22.1%	15.8%	2.3%	18.4%	2.0%	17.2%
Starchy Roots	4.8%	7.1%	1.5%	15.5%	negl.	2.5%	negl.	4.6%	17.4%
Animals Products	17.7%	10.5%	n.a.	7.3%	n.a.	9.9%	n.a.	22.3%	n.a.

* Import as share of domestic production.

Source: FAO Stat, Food Balance Sheets.

Wheat is produced in around 120 countries, in a wide range of climatic environments and geographic regions. There is a large diversity of wheat production systems – rain-fed and irrigated, low-land or high-land, private or public production systems, conservation agriculture or traditional practices, small or large scale farming, etc. Technologies used range from fully mechanized production and harvesting on large tracts to manual planting and harvesting on small plots. Wheat is harvested somewhere in the world in every month but harvest in the temperate zones occurs between April and September in the Northern hemisphere and between October and January in the Southern hemisphere (Dixon et al. 2009). Wheat production is however highly concentrated. The top 5 producers account for 67 % of total wheat production including the EU-27 (treated as one country), China, India, the US and Russia (Table 3). Half of global wheat production comes from developing countries.

Table 3: Top 10 wheat producers (average volume 2007/08 to 2011/12)

EU-27	20.53%	**Canada**	3.72%
China	17.13%	**Pakistan**	3.50%
India	12.10%	**Australia**	3.43%
United States	8.98%	**Ukraine**	2.99%
Russia	8.19%	**Turkey**	2.60%

Note: Share of global wheat production; average global wheat production in period 2007/08 to 2011/12 accounted for 665,754 thousand tons.

Source: USDA.

Most wheat is consumed within the country where it is produced. Only roughly one fifth of the annual crop is exported; global exports accounted for 20 % of global production for the period 2007/08 to 2011/12. Wheat is primarily exported from developed countries accounting for three quarters of total exports and imported by developing countries accounting for two thirds of all wheat imports. Top exporters are even more concentrated than top producers and dominated by OECD countries – the top 5 exporters have a market share of 72 % and include the US, the EU-27 (where France has a share of 66 %), Canada, Australia and Russia (Table 4).

Table 4: Top 10 wheat exporters (average volume 2007/08 to 2011/12)

United States	21.97%	**Argentina**	6.44%
EU-27	14.54%	**Kazakhstan**	5.54%
Canada	13.00%	**Ukraine**	4.88%
Australia	11.18%	**Turkey**	2.22%
Russia	11.02%	**Pakistan**	1.01%

Note: Share of global wheat exports; average global wheat exports in period 2007/08 to 2011/12 accounted for 136,245 thousand tons.

Source: USDA.

On the import side there is much less concentration – the top 5 importers account for 26 % and the top 10 for 41 % of total imports, including with the exceptions of the EU-27, Japan and South Korea only developing and transition countries (Table 5).

Table 5: Top 10 wheat importers (average volume 2007/08 to 2011/12)

Egypt	7.55%	**Japan**	4.29%
Brazil	5.16%	**South Korea**	3.14%
EU-27	4.82%	**Iraq**	2.78%
Algeria	4.52%	**Mexico**	2.74%
Indonesia	4.36%	**Nigeria**	2.73%

Note: Share of global wheat imports; average global wheat imports in period 2007/08 to 2011/12 accounted for 133,215 thousand tons.

Source: USDA.

The unbalanced situation between exporters and importers becomes even clearer when analyzing production, consumption and trade data by regions. We compare Asia (including East Asia, South-East Asia and South Asia) with the Middle East and North Africa (MENA) and SSA. Although the share of total wheat imports to SSA is small (12 %) compared to the other two regions, the gap between production and consumption is large in SSA leading to high import dependency. Looking at data on ending stocks (quantity of wheat held in stock at the end of the year) compared to annual domestic consumption, SSA holds only 9 % of annual consumption in stock, compared to 30 % in Asia, including the large producer countries China and India, and 25 % in MENA, and a global average of 29 % (Table 6). The mismatch of wheat production and consumption might become even more severe in the upcoming decades in SSA. According to a report of the US Wheat Association (FAO 2009), SSA will have the highest growth rates with 0.5 % per year in per capita cereal consumption of all regions throughout the year 2050. Although the growth in production capacities will also be high, production in SSA will only equal 20 % of consumption. Regarding wheat imports to SSA, around 75 % come from the main four wheat exporters the US (32 %), EU (26 %), Canada (7 %) and Australia (8 %) for the market year 2010/11.

Table 6: Wheat data by region as share of global quantities*

	Production	Consumption	Import	Ending Stocks
Asia	34.63%	39.10%	27.59%	45.04%
MENA	8.46%	14.27%	31.83%	12.33%
SSA	0.87%	3.17%	11.97%	1.02%

Note: *Average 2009/10-2012/13e

Source: USDA, Grains: World Markets and Trade, Report 08/2012.

Given the important role of wheat and other food crops for food security and economic and social stability, governments generally regulate the production and trade of wheat through agriculture and trade policies. Such policies often follow multiple objectives – food security, income transfer, expansion of domestic value added, etc. The agricultural and trade policies of important wheat producers and exporters influence global wheat production and trade and hence price developments. Policies of major exporters (with the exception of Argentina that has rather taxed than supported wheat producers) have largely aimed at supporting prices, expanding exports, and restricting production. The EU and the US provide the largest absolute support for wheat production but support is relatively higher in Japan, Norway and Switzerland. Through these price support policies, many produces are shield from developments in international markets.[2] However, since the 1980s main exporters have reduced support – Australia and Canada significantly while the EU and the US more moderately (Dixon et al. 2009).

Export support and in particular export subsidies often have negative impacts on other wheat exporting countries and domestic wheat production in importing countries. The largest providers of wheat export subsidies have been the EU and the US. Although they largely eliminated direct export subsidies, they still subsidize nearly one quarter of global wheat exports. Export credits are still used in Australia, Canada, the EU and US (Dixon et al. 2009). Export restrictions or taxes are more common in developing countries that produce and import wheat to protect domestic consumers in particular in times of high prices. Such policies however also increase global wheat price volatility and make it difficult for countries to rely on wheat imports. After decades focusing on trade-based food security in particular in developing countries, governments have tried to reduce import dependency and to focus on policies aimed at larger food self-sufficiency and food sovereignty (Mitchell/Mielke 2005), in particular in the context of the recent price hikes.

3. Development of wheat spot and futures prices

Wheat prices (as well as other commodity prices) can be differentiated in spot and futures prices as wheat is traded on spot and derivative markets. Spot or physical markets refer to the markets in which physical commodities are traded by producers and consumers, including farmers, processors and wholesalers for immediate delivery at a cash price. Commodity derivates are contracts that give holders the right (“option”) or the obligation (“future”) to trade a physical commodity in the future at a given price. Commodity derivatives are standardized contracts in which the quantity, quality and maturity dates are spelled out and can be traded on exchanges, called futures markets. Trading goes through a clearing house which demands certain transparency and security requirements (e.g. margin or capital

[2] For example, farm gate prices in 2005 varied from around 110 per ton in Kazakhstan to 150 in Australia to 301 in Saudi Arabia; in the EU and Switzerland domestic wheat prices are also substantially above world prices (Dixon et al. 2009).

requirements[3]). The majority of commodity derivatives are however traded over the counter (OTC) which means that they are traded bilaterally between two parties outside of exchanges. This provides flexibility but also risks as transactions are not regulated and there is no instance that guarantees payment (TheCityUK 2011).

Commodity futures markets provide two important functions for producers and consumers of physical commodities (Masters/White 2008). First, it provides price discovery. Trading on futures markets enables the open-market discovery of prices of commodities that are used as a benchmark for spot transactions. Spot markets of commodities are often geographically dispersed because commodities are bulky and costly to transport and the prices in these markets can vary substantially. Centralized futures markets are accepted as the best indicator for overall supply and demand conditions across spot markets and became important in the 1980s as a pricing mechanism for particularly agriculture and energy commodities. Second, the insurance function enable spot market participants to hedge against the risk of price fluctuations they are facing in spot markets. Hedging means that a physical trader of a commodity takes the opposite position to its physical position on futures markets. For example, a farmer would sell future contracts (go short) in contrast to its spot market position where he/she is holding the commodity (going long). If the price of the commodity should develop in an unfavorable direction, the loss at the spot market can be captured by the gain in the futures market. The majority of future contracts are settled in cash as the hedging of price risks in spot markets can be fulfilled without physical delivery. Only 2 % of futures contracts in wheat, maize and soybeans traded on the Chicago Board of Trade (CBOT) and the Kansas City Board of Trade (KCBT) from March 2006 to December 2011 resulted in the delivery of physical commodities (IFPRI 2012).

For wheat, UNCTAD reports two spot prices[4] – "Wheat, United States, n°2 Hard Red Winter" and „Wheat, Argentina, Trigo Pan Upriver". Both nominal prices have increased strongly since 2002 and reached a peak in mid 2008. Between 2002 and March 2008, prices increased by 249 % and 242 % respectively. Prices decreased by 48 % and 55 % from March to September 2008 and remained highly volatile thereafter reaching new hikes in mid 2011 and 2012 (Figure 1). The major futures markets for wheat are still located in the US including the CBOT, KCBT and the Minneapolis Grain Exchange (MGEX). Typically, one type of US wheat is mainly traded in one of these exchanges – SRW is known as Chicago wheat (symbol W), HRW as Kansas City wheat (symbol KW), and HRS as Minneapolis wheat (symbol MW). As the price of wheat increases with the protein content, the highest price is paid for HRS, followed by HRW and SRW (Figure 2). The most important futures market for wheat is CBOT where substantially more futures are traded than at KCBT and MGEX (Figure 3).

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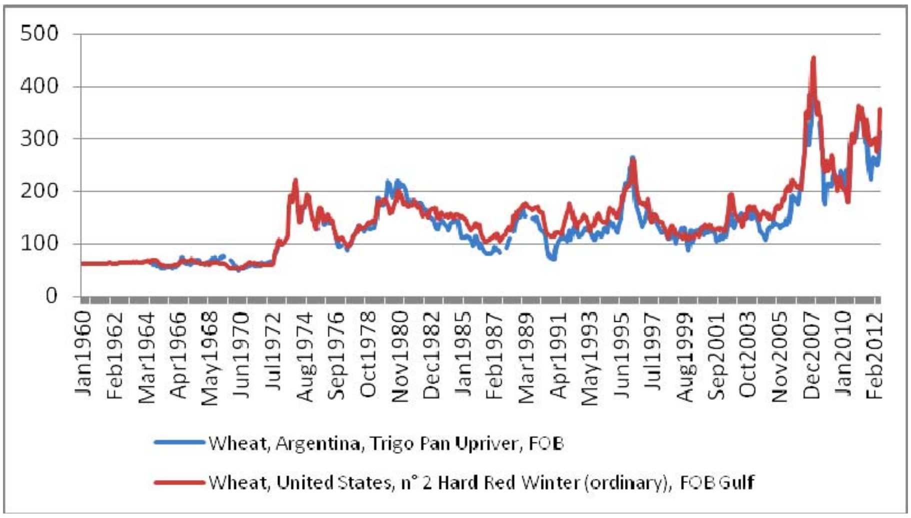
3 A deposit has to be paid by every trader to the clearing house in advance. Every day after closing, the net positions of each trader are calculated, i.e. "marking to market". If the balance falls below a certain level extra funds are demanded, called "margin calls" (Peirson 2008).

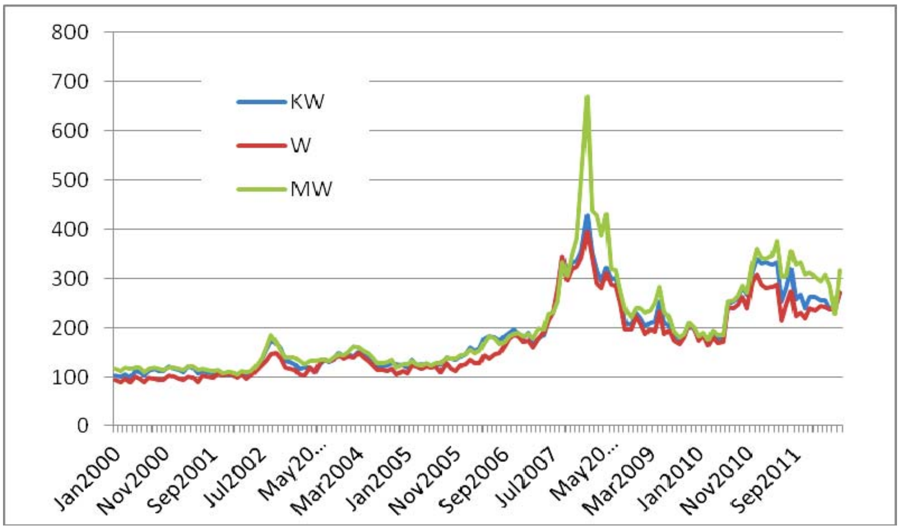
4 As spot prices are not always consistently available, missing spot price data is complemented with future price data which makes a distinction in spot and future price data not straight forward.

Figure 1: Monthly nominal wheat spot prices (1960-2012)



Source: UNCTAD Stat.

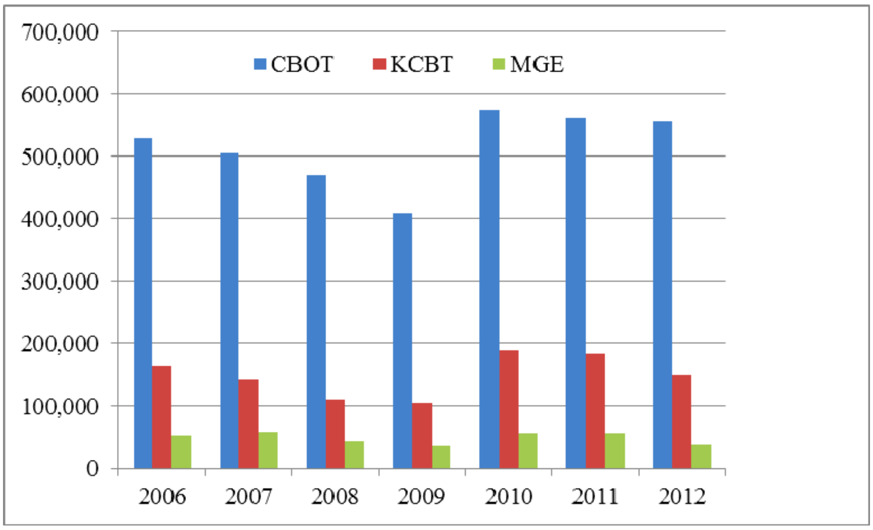
Figure 2: Monthly end-of-month settlement prices of nearby futures (Jan2000-Jun2012)



Source: MGEX.

Note: The US future exchanges have the same five expiration months, namely March, May July September and December. The last trading day is the business day prior to the 15th calendar day of the contract month. Hence, the prices shown are the settlement prices of the future contract that is the next to mature on the last trading day of a month (for example in February the settlement price of the March contract is recorded) which is usually also the most liquid contract.

Figure 3: Open Interest, number of futures and option contracts (average per year)



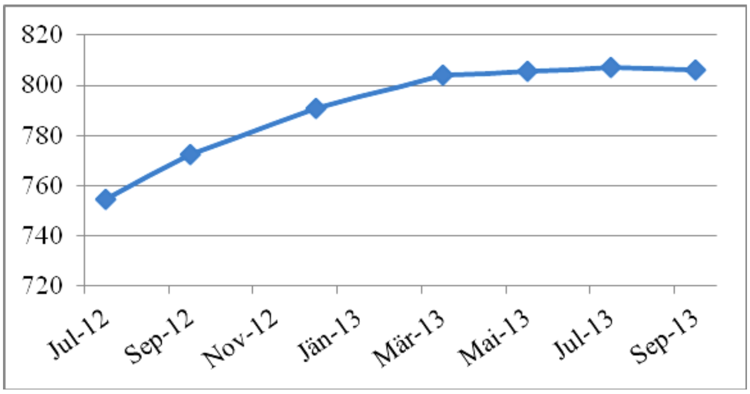
Source: CFTC, disaggregated COT futures and options.

The degree to which these global prices are transmitted to domestic prices is a critical issue. Importantly in this regard are the transmission mechanisms of global food prices to domestic prices and markets that depend on factors such as the extent of integration into global markets, import dependency, trade and agriculture policies, exchange rates or transportation costs. FAO (2011) reports that domestic food prices increased substantially in most countries in 2007/08, although often to a lesser extent than global prices and with country-specific differences. The exceptions were some large countries that were able to insulate themselves from world markets through for example restrictive trade policies. Also, after the collapse of international food prices in the second half of 2008, domestic prices eventually began to decline in most countries and, by the second quarter of 2010, domestic prices had largely returned to January 2007 levels for wheat and maize along with global prices (FAO 2011). Hence, despite variations the link between global and domestic food prices has increased, in particular given the importance of trade-based food security and as futures markets have been increasingly used as price benchmarks and for hedging in developing countries.

It is reasonable to consider a close relationship between spot and futures prices as both prices are driven by similar underlying factors. Theoretically, the differential between the current spot price and futures prices, called “basis”, can be derived from the spot-future parity or non-arbitrary theory (Hernandez/Torero 2010). This approach determines the futures prices as the spot market price plus the “cost of carry” which is the costs of purchasing and holding a physical commodity, including expenses for financing, storage, insurance or shipping. However, physical holding of commodities can also create benefits. This “convenience yield” implies that the owner might use them in production processes or gain from temporary local shortages (Hull 2003). Therefore, the theory of storage explains the value of a futures contract as: Futures price = Spot price + Cost-of-Carry – Convenience Yield.

The differences between the spot and futures prices can be positive, negative or zero and might vary substantially over time. Two relationships between spot and futures prices are in the focus of markets participants: Firstly, the term structure on the futures market also known as “contango” and “backwardation”. Contango describes a market where distant futures prices are higher than near-month futures prices or the current spot price. Backwardation describes the contrary where distant futures prices are lower than nearby futures and the current spot price.[5] Term structures in commodity futures are usually in backwardation, implying that longer dated contracts are priced lower than shorter dated contracts due to physical storage, interest costs and other factors arising from the deferred sale of the commodity. However, the term structure of several commodities has changed in recent years being on average more often in contango (Kemp 2010; Chada 2010).[6] Market participants assess the term structure to form beliefs about future price developments. Backwardation is not necessarily interpreted as a signal that prices will decrease whereas contango is generally interpreted as a signal for increasing prices (Frenk/Turbeville 2011). Comparing wheat spot prices and front-month futures prices Hernandez and Torero (2010) report strong backwardation in the period from 1994 to mid-2009 (using the SRW spot price notation at St. Louis at the US Gulf Coast). In the case of CBOT wheat futures, the futures prices were in contango on July 2, 2012 (Figure 4).

Figure 4: Term structure CBOT wheat futures (July 2, 2012)



Note: CBOT wheat futures have delivery months March, May, July, September and December.

Source: CME Group

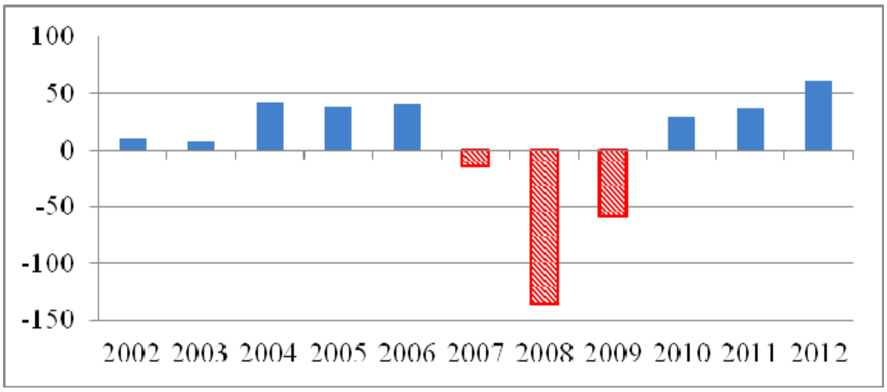
A second important relationship between spot and futures prices is the convergence of both prices at expiry of the future. In practice, there is no perfect convergence mainly because of costs associated with the delivery process (Irwin et al. 2009). But especially the CBOT wheat futures prices experienced severe problems when convergence was poor at expiry between March 2008 and December 2009. This can be illustrated by the comparison of spreads between wheat spot prices and July futures prices at expiry. While spot prices typically exceed futures prices at expiry before 2006 by up to 43 cents per bushel, the futures prices especially in 2008 and 2009 overshot spot prices significantly before returning to normal levels (Figure 5). There are several reasons for this development like the unexpected increase in the production of SRW, limited possibilities for arbitrage due to a limited delivery system (CME Group 2010) or excessive speculation (US Senate 2009). The problems in convergence distorted the possibilities for hedging significantly in 2008 and 2009 as hedging

[5] The concept applied here compares current spot prices to futures prices and explains differentials by the theory of storage. The alternative approach, known as normal backwardation was developed by Keynes (1930) and Hicks (1939) and refers to expected spot prices at expiry and is based on the insurance function of futures markets. If a commodity market is characterized by producers who sell future contracts, the speculators will engage in long positions only if they can gain on average which is only the case if futures prices are above the expected futures prices. The producers would lose money overtime which can be regarded as an insurance fee for the reduced risk (Hull 2003). This second approach can also explain fluctuations in the basis.

[6] For the S&P GSCI, until 1991 the whole range of commodities traded mostly in backwardation. During the rest of the 1990s and the first year of the 2000s, market structure was balanced between backwardation and contango. Since the late 2004 contango has become large on average (Parsons 2010; Kemp 2010; Chada 2010).

requires that futures and spot prices converge once futures expire to a reasonable level. Also price signals from futures markets are distorted if there is no reasonable convergence.

Figure 5: Spreads between spot and July futures at expiry (2002-2012)



Note: SRW spot prices at US Gulf Coast from FAO, available at: http://www.fao.org/economic/est/prices

Source: FAO and CME Group

Besides the price level of agricultural commodities, price volatility is an on-going concern (OECD 2011). Although the particular reasons for commodity price volatility differ by commodity, one important common factor is low short-run elasticities of supply and demand which means that any shock in production or consumption (that are frequent for many physical commodities) translates into significant price fluctuations as demand and supply cannot adjust quickly (UNCTAD 2010). Several studies come to the conclusion that price volatility has increased in recent years, at least when single food commodities are examined (Sumner 2009; UNCTAD 2010; OECD 2011).[7] Different volatility measures[8] of nominal wheat spot prices show that wheat price volatility was low in the 1960s, increased massively in the first half of the 1970s before coming back to a range of 5 to 15 % (coefficient of variation measurement) during the 1980s and 1990s. In the last decade, price volatility was low in some years in the first half of the decade but increased in particular from 2006 onwards (Figure 6). Also, UNCTAD's price instability index, which relates the observed magnitude of a variable to the magnitude estimated by fitting an exponential trend[9], shows that the variability of wheat is substantially higher in the period 2007-11 than in previous periods (Figure 7). Mean tests on the volatility and tests on the equality of variance for price differences for the period "Jan2007-Jul2012" compared to the whole data period (Jan1961-Jul2012), the 1970s and the first half of the 1970s (Jan1970-Dec1975) confirm the relatively higher volatility of wheat prices in the years after 2006 (Table 7).[10] Overall, the average volatility in the 5 ½

[7] In contrast, studies by Balcombe (2010) and Gilbert and Morgan (2010) fail to provide evidence of a general increase in volatility when recent volatility data of several food commodities are compared to price volatilities in the 1970s and 1980s.

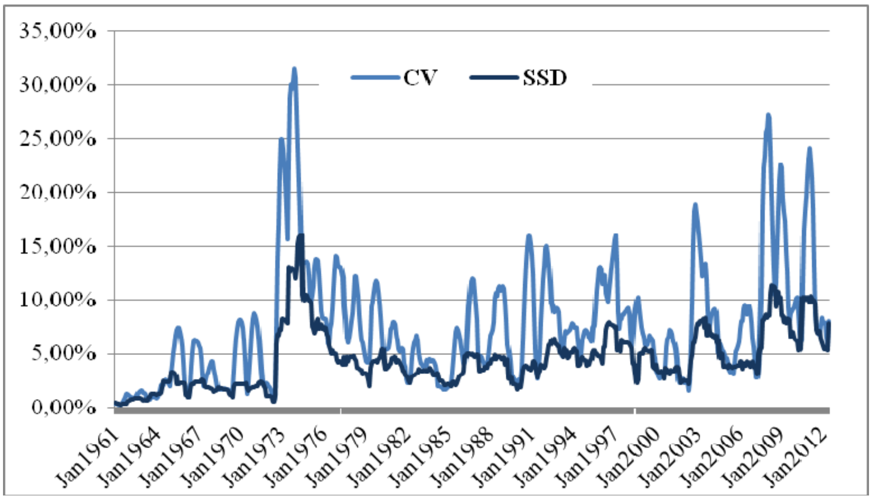
[8] The simplest way is the coefficient of variation (CV) which is the standard deviation during a specific period of time divided by the mean during that period. Hence, the standard deviation is expresses as percentage of the mean and therefore unit-free which make it easy to compare. However, the sample mean often exhibits price trends that influence the measurement of price volatility. Alternatively, one can use the standard deviation of the logarithm of prices in differences (SSD) to avoid distortions due to the mean (Gilbert/Morgan 2010; OECD 2011). Both measurements are calculated with 12 month moving average, for instance the volatility of December 2011 includes price variations from January 2011 to December 2011.

[9] See for more details http://unctadstat.unctad.org/TableViewer/summary.aspx - accessed September 2012

[10] For the test of differences in means, we assume the following null hypotheses: H_0: $\overline{vol_1} = \overline{vol_2}$ with $\overline{vol_1}$ as mean of the volatility of wheat spot prices in period 1 compared to the mean volatility in period 2 $\overline{vol_2}$. If the resulting t-statistics ($t = \frac{\overline{vol_1} - \overline{vol_2}}{\sqrt{\frac{sd_1^2}{n_1} + \frac{sd_2^2}{n_1}}}$ with sd as standard deviation and n as number of observations) are significant, indicated by a small p-value, the null hypothesis can be rejected and the means of the two periods are statistically different. In Table 7 the resulting t-

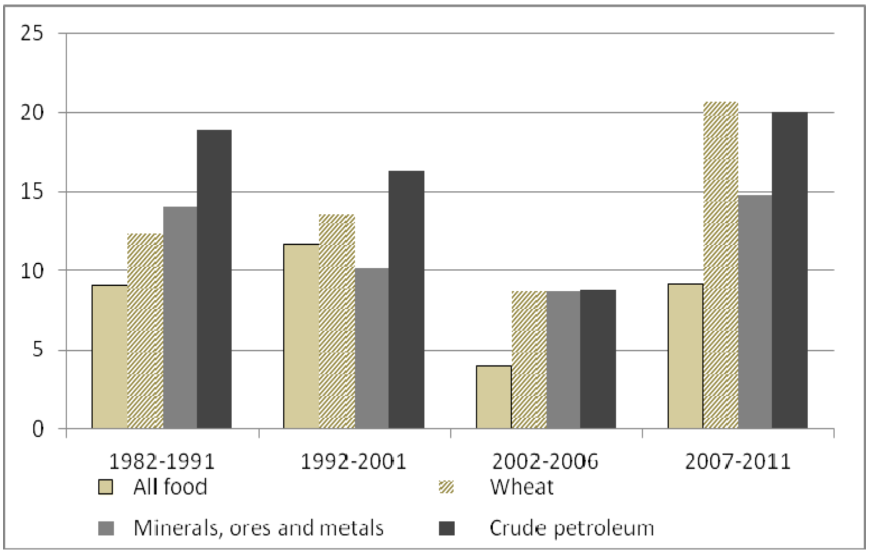
years from 2007 onwards was clearly higher than in the whole data period from 1961 onwards; it was also higher compared to the 1970s. However, the mean volatility is not significantly different to the high volatile period from 1970 to 1975.[11]

Figure 6: Coefficient of variation (CV) and standard deviation of the logarithm of prices in differences (SSD) of monthly wheat prices



Source: UNCTAD, Wheat, United States, n° 2 Hard Red Winter (ordinary), FOB Gulf, own calculation.

Figure 7: UNCTAD price instability index (absolute values)



Source: UNCTADstat.

statistics and the p-values are reported based on monthly UNCTAD data. We use CV to calculate volatilities; the results with SSD are very similar.

[11] Also the test of equality of variance for price differences underlines that the variance in the period 2007 to 2012 (30.5 % annual rate) was significantly higher than in the 1970s (24.1 %, F-stat: 1.59, p-value 0.01) but not significantly different from the variance in the first half of the 1970s (28.4 %, F-stat: 1.15, p-value 0.28).

Table 7: Test of equality of means in volatility of wheat spot prices (t-stats and p-value in brackets)

Average volatility Jan2007 to Jul2012 relative to:		
Whole period	Jan1970 to Dec1979	Jan1970 to Dec1975
6.48*** (0.00)	2.46** (0.01)	1.02 (0.31)

Note: *, **, *** for 10,5 and 1 % significance level.

Source: UNCTAD for monthly wheat prices, United States, n° 2 Hard Red Winter (ordinary), own calculation.

However, the comparison of recent commodity price volatility to historical data has to be interpreted carefully. Even if the recent volatility in wheat and other food commodity prices would have been lower than in the first half of the 1970s, the international and national context and the transmission of price volatility between global and domestic prices and between different commodity prices has changed significantly. Most important in this regard is the abolishment of international commodity agreements (ICAs) or other international price regulations as well as the liberalization of national commodity boards or similar frameworks that had the objective, although often only inefficiently met, to stabilize prices or mitigate the impact on producers and consumers. Hence, price volatility today may have stronger impacts on producers and consumers than in earlier periods.

From the discussion above, three important developments concerning wheat prices can be identified in the last decade. First, nominal wheat prices have increased in the last decade, experienced three price hikes in mid 2008, mid 2011 and 2012, and remain well above their historical levels. The transmission channel to domestic wheat prices is country-specific but generally global price hikes affected domestic prices (with the exception of some large countries that insulated themselves from world markets). Second, wheat spot and futures prices generally move together as expected from the non-arbitrage condition. There has however been a shift in term structure, being on average more often in contango in recent years. Concerning convergence, especially for CBOT wheat futures prices exceeded spot market prices significantly from March 2008 to September 2009 which made hedging by producers and consumers complicate or even impossible. Third, wheat prices, as other agriculture commodity prices, have always been volatile but volatility in particular for wheat prices has increased in recent years, although not to historically unprecedented levels as in particular in the 1970s volatility levels were similar.

4. Determinants of wheat prices

Despite the extent and the important implications of current wheat price dynamics, there is no consensus about the determinants of these developments. Theoretically, there are diverging explanations if in addition to fundamental supply and demand factors, the increasing role of financial investors on commodity markets has had an impact on commodity price developments. The different views can be broadly categorized in the efficient market hypothesis (EMH) (Friedman 1953; Fama 1970) and the noise trader or bull-and-bear hypothesis (Schulmeister 2009, 2012). In both hypotheses the role of information flows is crucial and both assume that fundamental factors that influence the demand and supply of physical commodities influence commodity prices. The difference between the two hypotheses is based on the additional impact of financial investors and their trading strategies on accelerating price movements and volatility. The EMH assumes that commodity prices are determined almost exclusively by fundamental factors while the noise traders/bull-and-bear hypothesis assumes that also non-fundamental factors exert a substantial influence on commodity prices as price dynamics are driven by the behavior and interactions of heterogeneous traders, including noise and uninformed traders, where herd behavior can increase short-term price volatility and lead to an overshooting of prices.

It is not straightforward to assess the role of fundamental factors versus financial investors in determining commodity prices empirically due to the difficulty to disentangle fundamental from non-fundamental factors as commodity prices are determined on the basis of expectation formation by heterogeneous market participants (UNCTAD 2011). Methodologically, studies on the determinants of commodity prices use generally descriptive data or regression-based analysis and tend to focus either on fundamental supply and demand factors or variables that reflect the financialisation of commodity markets in explaining price dynamics; few also include both fundamental and financial variables (for an overview see Ederer et al. 2013). Econometric estimations that assess the role of financial investors use broadly Granger (non-)causality tests to estimate the impact of open positions by different types of traders on prices, or focus on the increased link between commodity and financial markets. These studies come to different conclusions stating that financial investors have either no impact on future prices (most prominently Irwin/Sanders 2010, 2012; Sanders/Irwin 2010) or that they have moderate up to considerable impact on futures prices (for example Gilbert 2010a, 2010b; Mayer 2012; Gilbert/Pfuderer 2012; Henderson et al. 2012; Cooke/Robles 2009; Tang/Xiong 2010).

In this section, an overview of the main determinants of wheat prices that are broadly named in the literature is given. These determinants can be classified in fundamental supply and demand factors, policy factors and financial speculation.

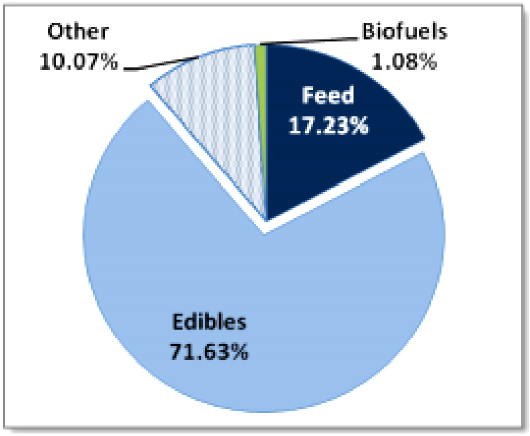
4.1. Demand- and supply-side factors

Population Growth*:* According to FAO data, the global population increased by 1.2 % p.a. on average between 2000 and 2010, equal to an expansion of more than 873 million people. This population growth translates into a constantly increasing demand for food commodities, including wheat. However, population growth is a long term trend and there was no exceptional increase in the past decade which makes it impossible to explain the recent large price hikes.

Income growth and dietary changes*:* The rapid growth of China and other emerging and developing countries particularly the BRICs (Brazil, Russia, India, China) and their increasing demand for food (as well as minerals and energy commodities) has been broadly named as drivers of food and other commodity prices in the last decade. This rising demand has been driven by increasing incomes and hence food consumption but more importantly by changing food consumption habits as demand for meat and dairy products are raising as incomes increase raising demand for animal feed. For wheat however imports of China and other large emerging countries have not considerably increased in the 2000s as in particular China and India have also increased production of wheat and other grains aiming to reach self-sufficiency. This is different to soybeans where imports have increased more significantly. Looking at the wheat trade balance for China and India, they were both net exporters of wheat from 2000 to 2003. From 2004 onwards China turned into a net importer while India continued to be a net exporter of wheat except for 2006 and 2007. But China and India have a small weight in cereal trade. In 2011, the share of China's net trade in wheat accounted for 2.6 % of global wheat imports. The importance of this explanation, at least when looking at direct wheat imports to China and India, is therefore questionable. Wheat may however be used for the production of other imports, most importantly as food for animals that are imported as meat.

***Ethanol and biofuels**:* There is an important link between oil and agriculture prices through the use of agricultural commodities in energy production. In the context of concerns related to climate change and high oil prices governments, including the US, the EU and Brazil, have promoted the development of biofuel production to substitute non-renewable fuels (oil) via renewable energy sources. Over the last ten years, world biofuel production has more than doubled which has led to a significant shift in acreage to the cultivation of crops that can produce biofuels and diversion of output of certain agricultural commodities to fuel production. For instance, in 2007, the US diverted more than 30 % of its maize production, Brazil used half of its sugarcane production, and the EU used the greater part of its vegetable oil seeds production (i.e. rapeseed and sunflowers) as well as imported vegetable oils for biofuel (Gosh 2010). The US, Brazil and the EU are the main producers, with the EU focusing on biodiesel and the US on ethanol. Rapid expansion also occurred in several other countries, particularly in Southeast Asia, Latin America and Southeast Europe (UNEP 2009). Wheat is not directly used to any great deal for biofuel production accounting only for 1,08 % of total uses in 2010/11 (Figure 8) but the strong demand for maize, especially in the US, has led to the substitution of maize for wheat leading to reduced supply of wheat that may have partly contributed to recent wheat price increases (Dixon/Li 2007).

Figure 8: Global use of wheat (2010/11)



Source: USDA data, c.f. Troester 2012: 29.

***Lack of investment**:* In the agriculture sector, production and productivity have stagnated in many developing countries since the 1980s as can be seen in slow or even stagnating growth of yields per hectare. This is related to the lack of public and private investment in agriculture technology and R&D, supporting infrastructure and rural development in the last two decades (World Bank 2007; OECD/FAO 2009). This can be also seen in the decline by half of official development aid (ODA) in the area of agriculture promotion between the 1980s and 2008 (World Bank 2008). Further, the displacement of food crops by other more profitable commodities (e.g. cash crops) impacts supply patterns. In many developing countries policies prioritized export-orientation and cash crops in the context of export-led development strategies to the detriment of national food security issues (Gosh 2010).

***Adverse weather conditions and climate change**:* In 2006 and 2007, for example, droughts in Australia and poor harvests in the EU and the Ukraine limited the supply of some crops. In tight market conditions with low stocks, such shortfalls can create pressure on prices given an inelastic demand. Weather-related supply shocks have always had crucial impacts on food prices. However, it is broadly argued that in the context of climate change weather-related shocks have become more extreme and unpredictable, including extreme heat and droughts. Further, climate change may lead to important shifts in geographical production areas (Coumou/Rahmstorf 2012; Hirabayashi et al. 2013; Meehl/Tebaldi 2004).

Increasing input costs*:* There are also important links between oil prices and agriculture commodity prices through associated higher production costs (in particular for energy-intensive production processes) and transport costs. Also increased prices of other crucial inputs into agricultural production such as fertilizers influence costs and hence prices. However, the extent of the supply response is not clear. The FAO (2011) states that the cost of fertilizers is only a minor fraction of a crop's gross values. According to Baffes/Haniotis (2010) and Mitchell (2008), the pass-though from oil prices into agriculture commodity prices ranges from 10 % to 15 %. Higher input costs may also limit production. Additionally, higher oil prices trigger an increase of biofuel production, which again diverts resources away from food production. Despite strong fluctuations, oil and fertilizer prices had historically high levels throughout the 2000s.

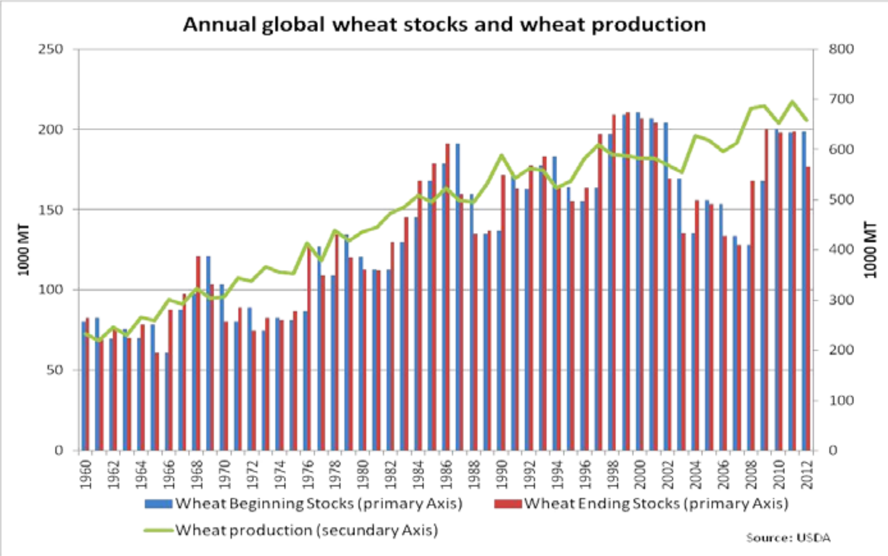
4.2. Policy factors

US dollar depreciation*:* Another factor that contributed to the commodity price increases is the US Dollar depreciation since 2002. This is related to an easy monetary policy in the US until 2007 which has also translated into inflationary pressures. As most commodities are traded in US Dollars and as the US is a major exporter of crops, the depreciation has triggered price increases to secure the value of commodities in other currencies (Schulmeister 2009). Mitchell (2008) ascribes 15 % of the price hikes to the US Dollar weakness. Other studies, however, doubt the importance of that factor.

Trade restrictions*:* As a response to high food prices some countries have imposed export restrictions or taxes to secure domestic supply. For instance, by July 2008 eleven Asian countries had export controls implemented (Piesse/Thirtle 2009) in addition to restrictions by countries such as Argentina and Russia. This led to a further tightening of global supply and accelerated price increases. On the import side, some important food importing countries abolished import tariffs and encouraged stock building due to concerns about food security. This is, however, especially relevant for the thin world market in rice with only five to six important exporting nations (Thailand, Viet Nam, Pakistan, India, US, China) and only 5 % of global production traded between nations (FAO 2009).

Low inventory levels*:* Inventories have an important role in balancing demand and supply and they may buffer unexpected supply shocks or jumps in demand. Demand is more regular over the whole year compared to supply which is seasonal and requires storage. Inventories are also essential when analyzing the relationship between futures and spot markets. Low stock levels may be a driver of prices. The drop of the stocks-to-use ratios, defined as year ending stocks as a percentage of a whole year's use, in all food commodities is an evident development since 2000. With these ratios close or below the historical lows in the 1970s, stock-rebuilding can be an additional demand factor. The low ratio also adds to tighter market conditions and creates additional stress situations in food security and might affect price elasticities. Piesse and Thirtle (2009) even argue that low inventories were the single most important factor in agricultural price increases in 2007/08. Global wheat stocks held by the five major exporters which account for three quarters of net exports declined from 80 % in 1960 to 20 % in the early 2000s, related to policy shifts that reduced government-held stock (Mitchell/Mielke 2005). Figure 9 shows the recent decline in inventory stocks in particular in the period 2002 to 2007. In the context of food price boom 2007/08 and related food crisis, inventory levels have increased again.

Figure 9: Global wheat stocks



Source: USDA.

4.3. Financial speculation

Trading activities on commodity derivative markets have undergone structural changes related to the increasing presence of financial investors since the early 2000s. Traditional actors on commodity derivative markets are commercial traders – actual producers and consumers of commodities that buy or sell on spot markets and try to reduce the related price risks through hedging on futures markets – and non-commercial traders that do not have an underlying physical commodity position to hedge but take over the price exposure from hedgers in exchange for a risk premium and are hoping to profit from changes in futures prices. These speculators provide an essential function as they accept price risks in exchange for providing liquidity by actively trading in futures. Until recently, speculators on commodity future markets were dominated by experts of physical markets whose activities were closely linked to the fundamental supply and demand dynamics (Masters/White 2008). Over the last two decades and in particular since the early 2000s another type of speculators has however become important – financial investors, in particular banks, institutional investors and hedge funds that invest in commodities as an asset class similar to stocks, bonds and real estate assets (Gilbert 2008; UNCTAD 2009; Nissanke 2011).

Financial investors can be divided into two main groups (Mayer 2009; Farooki/Kaplinsky 2011; UNCTAD 2011): First, index investors (also called swap dealers) are largely institutional investors such as pension funds, sovereign wealth funds, university endowments, public and private foundations and life insurance companies that use commodity indexes as a vehicle to become involved in commodities, gaining exposure to rising prices. They follow longer-term passive trading strategies speculating on long-term increasing prices and hence only hold long positions on a range of commodities without taking into account the fundamentals of individual commodities (Masters/White 2008). Second, money managers are financial intermediaries with much shorter time horizons, including most importantly hedge funds, floor traders (i.e. individuals on the trading floor of investment firms), commodity pool operators (CPOs), commodity trading advisors (CTAs), proprietary trading firms but also institutional investors. Their investments are generally smaller in size compared to index investors and they follow more active trading strategies and take positions on both sides of the market (long and short) which enables them to earn positive returns in rising and declining markets. Many of these investors are trend following or momentum traders and rely on computerized technical trading systems based on price trend identification and extrapolation (Gilbert 2008; Schulmeister 2009, 2012).

A number of proxies for the participation of financial investors in wheat futures markets and speculative activity can be used that all show that the presence of financial investors has increased importantly.

- Volume in futures contracts captures the total number of trading. Volumes of wheat contracts traded on the CBOT and the KFTC have increased significantly in the last decade. On the CBOT the average monthly volume in futures for wheat grew by more than 60 % in 2006 compared to the previous year. In 2007 and the first half of 2008 wheat contract volumes continued to increase. From mid 2008 however to the first quarter of 2009 the average monthly volume decreased significantly in the context of the financial crisis. Afterwards volumes increased again strongly (Figure 10).[12] Several reasons explain the increase in volume – one is the higher presence of speculators and in particular financial investors in general and another one is their more active trading strategy and shorter term perspective leading to the opening and closing of positions in a relatively short time period which increases the volume traded.
- Open interest in futures contracts describes the number of futures contracts long, i.e. purchased contracts outstanding, or short, i.e. sold contracts outstanding, for a given commodity in a delivery month or market that has been entered into but has not yet been liquidated by an offsetting transaction or fulfilled by delivery at expiration date. Figure 11 show the total long open interest positions for CBOT and KFTC since 1998. The figure clearly shows the increase in open positions in the 2000s, in particular for CBOT wheat. Positions had a first peak in mid 2008. In the second half of 2008 total open positions fell in the context of the financial crisis. However, trading on commodity exchanges has picked up again strongly since early 2009.
- The US Commodity Futures Trading Commission (CFTC) publishes open interest positions disaggregated by types of traders for US futures markets. Masters and White (2008) calculate the share of commercial traders for 1998 and 2008. For wheat, they show that in 1998 commercial traders accounted for 68 % and 86 % of long open interest positions in CBOT and KCBT respectively which declined to 16 % and 38 % whereas the share of non-commercial traders increased to 84 % and 62 % respectively. Working (1953, 1960) developed an index to measure excessive speculation that measures the adequacy of speculative positions in relation to hedging positions by commercial traders, reflecting the extent by which the level of speculation exceeds the minimum necessary to absorb long and short hedging positions.[13] The index reveals

[12] Growth has been even more impressive in OTC trade. The Bank of International Settlement (BIS) publishes semi-annual data on the notional amount of outstanding OTC commodity derivatives. In the period from June 2002 to June 2008 the value to the commodities underlying the OTC contracts increased from US$ 0.77 to US$ 13.23 trillion but collapsed due to the financial crisis and the resulting counterparty risk in 2008 reaching US$ 3.09 trillion in December 2011. This is however still significantly larger than trade on futures markets.

[13] Working's speculative "T" index is typically calculated as (Working 1960, 1953):

$$= \left[1 + \frac{NC\ OI\ Short}{c\ OI\ Short + C\ OI\ Long}\right] \cdot 100 \quad if\ COI\ Short \geq C\ OI\ Long$$

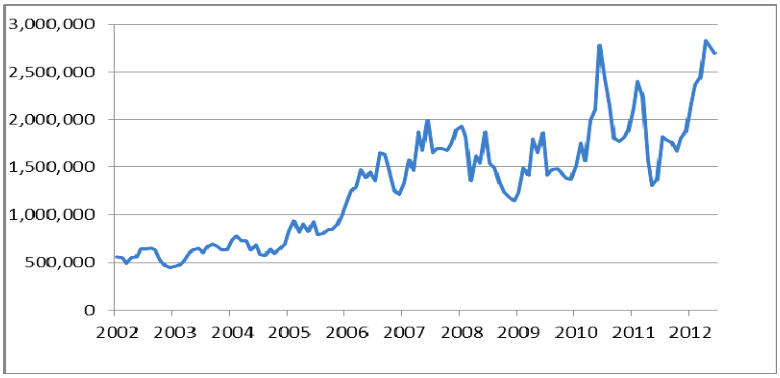
or

$$T = \left[1 + \frac{NC\ OI\ Long}{c\ OI\ Short + C\ OI\ Long}\right] \cdot 100 \quad if\ COI\ Short < C\ OI\ Long$$

Where *OI Long* refers to open interest in long futures contracts, *OI Short* refers to open interest in short futures contracts, *NC* means non-commercial traders – i.e. the sum of open interest of index investors and money managers, *C* refers to commercial traders. The minium value of the "T" index is 100, suggesting that speculation by non-commercial traders is not in excess to commercial hedging needs. Values above 100 suggest that there are % more speculation in the market than the minimum needed to offset hedging needs. The T index as calculated here, does not take into account the impact of other reportable and non-reportable traders, as their classification in commercial/non-commercial category is not clear.

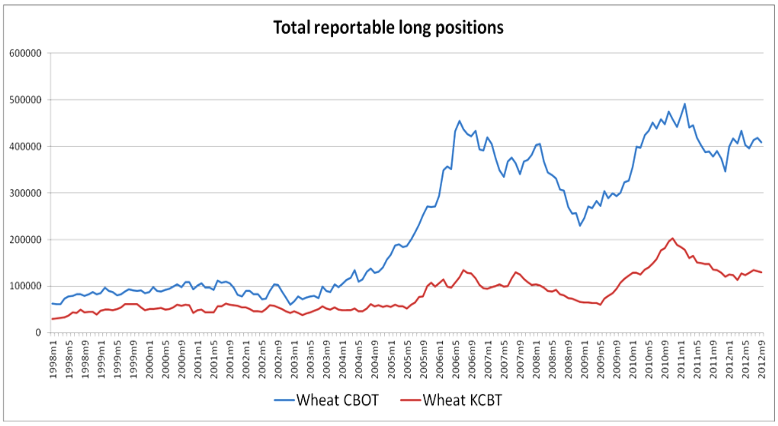
high fluctuations with peaks in certain months. In particular CBOT wheat has experienced high level of excessive speculation with peaks around 90 and 100 % in late 2009 and mid 2012 respectively whereas KFTC wheat has reached peaks of around 35 % in mid 2012 (Figure 12).

Figure 10: Volume traded in future contracts (CBOT)



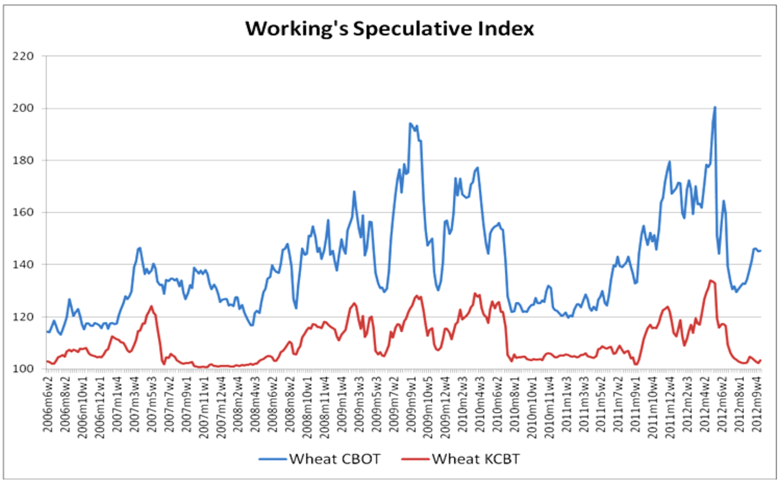
Source: CME Group, available at http://www.foodsecurityportal.org/policy-analysis-tools/annotated-wheat-price-timeline

Figure 11: Open interest in future contracts (CBOT and KCBT)



Source: CFTC.

Figure 12: Workings' specuative index (CBOT and KFTC)



Source: CFTC.

5. Basic supply and demand model for wheat prices

In this section, a basic supply and demand model for commodity prices is applied for wheat based on Troester (2012). This approach assumes that price changes are determined by the main fundamental demand and supply related factors stated in the literature, in particular three major demand drivers, i.e. population growth, meat consumption and production of biofuels, in relation to the supply of a particular food commodity. Hence, the model addresses the question of how much of the price variations in wheat prices can be explained by these fundamental factors. The difference between actual prices and prices estimated by the model is an indicator for the influence of other factors, including the oil price increase, the U.S. Dollar depreciation, trade restrictions, inventory levels and financial speculation.

The mathematical model of Collins (2008) for the US corn market provides the basis for the global supply and demand model. Also Timmer (2009) introduces a model with short- and long-run elasticities which is applied by Headey (2010) to explain the price hikes in 2007/08 for rice, wheat and corn. The basic idea in these models is to assess how a shift in demand and supply translates into price changes. The model in this section considers the impact of basic demand side factors weighted by the consumption pattern of wheat represented by the consumed quantities for edibles (QE), feed (QF), biofuel (QB) and other utilization (QO) in a given base year (indicated with subscript 0). The parameters *KE, KF, KB* and *KO* are used to account for shifts on the demand side from the base year to the next year. The parameter KS represents the shift in supply. Assuming that the market clears and total use/demand and supply are equalized, the following equation is derived:[14]

$$\%\Delta\, p = \frac{(\frac{dKE}{KE} * QE_0 + \frac{dKF}{KF} * QF_0 + \frac{dKB}{KB} * QB_0 + \frac{dKO}{KO} * QO_0 - \frac{dKS}{KS} * QS_0\,)}{(\,QS_0 * \varepsilon_S - QE_0 * \varepsilon_E - QF_0 * \varepsilon_F - QB_0\varepsilon_B - QO_0\varepsilon_O)}$$

The percentage change in the price of wheat from the base year to the following year can be expressed as a function of the percentage change in the shift parameters weighted by the value of each demand component in the base year, divided by the sum of weighted supply and demand elasticities. Hence, if the shift of the selected demand factors exceeds the shift of supply, prices will increase given the price elasticities. The mathematical presentation of the model is shown in appendix 1.

The shift parameters are set as approximations for the demand of edibles, feed, biofuels and others. For the change of the shift parameter KE we use population growth, the change in KF is represented by change in meat production, and the change in KB by the growth rate of US or EU ethanol capacities (where for wheat the latter is used); the share of other utilizations to supply is held constant (Table 8). The change in the shift on the supply side is not estimated but is calculated as the percentage change of production plus the change in beginning stocks. A build-up of stocks is therefore assumed to reduce supply.

Table 8: Change in demand shift parameters for wheat

Parameter	*Quantification*		*Comment*	*Source*
	1990-1999	**2000-2012**		
Edibles	1.48%	1.18%	Only population growth as per capita use is stagnating	FAO stat
Feed	2.9%	2.3%	Growth rate in meat production	FAO stat
Biofuels	5% / 1%	10% / 1% from 2005 on	Growth rate of US ethanol capacities	Renewable Fuels Association*
Others	0%	0%	Stable share assumed	

*Data available at http://www.ethanolrfa.org

[14] See Troester (2012) for a detailed description of the model.

This kind of analysis requires data on price elasticities of supply and demand given that elasticities determine the extent of price changes. The elasticities applied are derived from the FAPRI elasticity database[15] which is according to Baier et al (2009) the best available source for crop price elasticities. The elasticity data include two types of price elasticities for food and feed on the demand side and a single type of supply elasticity related to area expansion. As an approximation for the global supply and demand elasticity we calculate the mean for the basic model in a first step while varying elasticities are included in a second step to account for different inventory levels. Additionally, the maximum and the minimum values from the samples for wheat are derived to provide a sensitivity analysis. To reduce the influence of outliers, the maximum (minimum) value is set as the mean of the 10 (5) maximum (minimum) data points (Table 9).

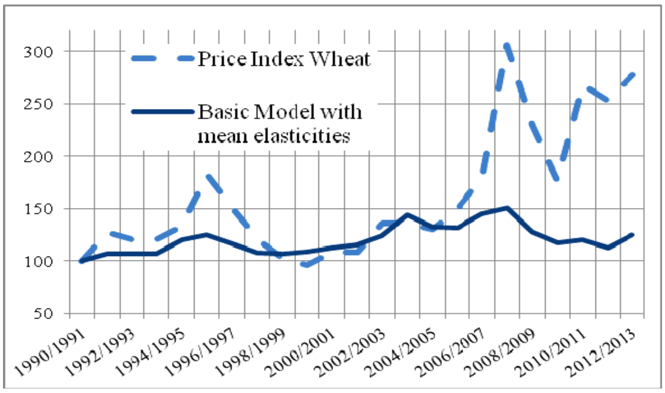
Table 9: Data on supply and demand elasticities for wheat

	Wheat	
	Demand	**Supply**
No. of countries	36	18
Mean	-0,25	0,225
Max	-0,375 (10 countries)	0,37 (5 countries)
Min	-0,13 (10 countries)	0,11 (5 countries)
Max	*Ukraine -0,43*	*Brazil 0,43*
Min	*Japan -0,06*	*Iran 0,08*

Source: FAPRI database.

With the actual data on changes in supply (production plus beginning stocks), utilization[16], the estimated changes in demand shifts and mean elasticities the model results can be compared with the actual spot price data (Figure 13). The price is based on the monthly price data of U.S. No. 2 HRW wheat (available at UNCTADstat), with the average price in the wheat market year July 1990 to June 1991 as the first base year.[17] The base year data are rolled over annually.

Figure 13: Wheat model with mean elasticities



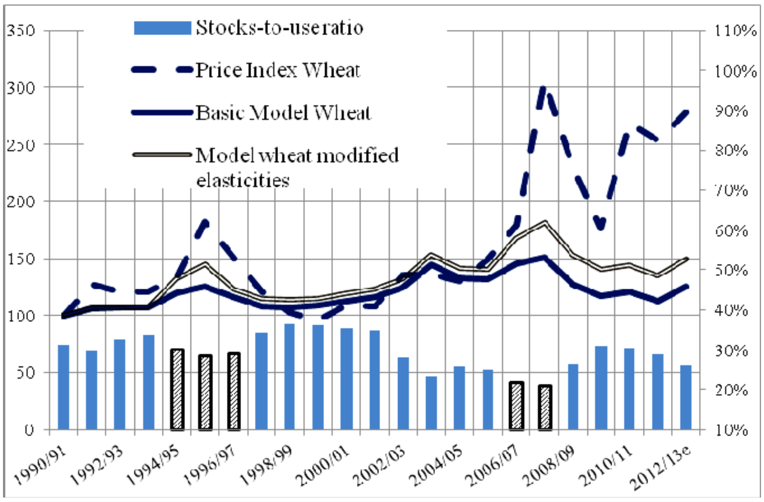
Source: UNCTADstat; own calculation.

[15] Available at http://www.fapri.iastate.edu/tools/elasticity.aspx
[16] Supply, edibles and feed utilization data from USDA, biofuel data from FAPRI (both accessed September 2012).
[17] In order to control the sensitivity of the model, we control for the effect of the initial year. The initial year for the price index and the model results can be chosen randomly. The basic results regarding the increasing divergence of actual wheat prices and model results after 2006/07 is still valid when the starting year is shifted to 1980/81 or 2000/01. The results with 1970/71 as starting point are not convincing as the model cannot explain the extreme commodity price variations in the 1970s.

The results from the model indicate that the fundamental variables in the model have some explanatory power up to 2005/06. Certainly, the prices vary substantially around the model results due to the limited demand factors in the model. Especially from 1994/95 to 1997/98 and from 2006/07 onwards, the magnitude of price movements in reality has been higher. During these periods, as described by Wright (2011), the stocks-to-use ratios were low relative to the stock ratios in the preceding years. Abbott et al. (2011) see low stocks related to tighter market conditions leading to reduced price elasticity in agricultural markets as one of the main reason for extreme price hikes. The authors name also limited land supply, higher livestock prices, biofuels and trade policies like export bans as sources for high inelasticity.

In order to account for the assumption of lower price elasticity in periods with relative low stocks we reduce the demand elasticity from -0.25 (mean from FAPRI data) to the minimum value of -0.13 and the supply elasticity from 0.225 to 0.11 in periods with reductions in stocks-to-use ratios. For wheat markets the two periods of 1994/95 to 1996/97 and 2005/06 to 2007/08 are considered. The reduction in the inventory ratio from 2000/01 to 2004/05 is not associated with lower elasticities because it is mainly explained by deceasing stocks in China. Figure 14 shows the results with varying elasticities.

Figure 14: Wheat model with modified elasticities and stocks-to-use ratios (in % on right axis)

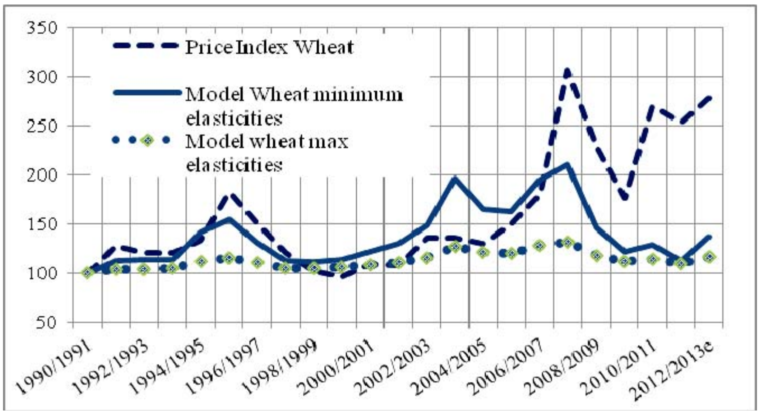


Source: UNCTADstat; stocks-to-use ratio own calculation with USDA data.

As expected, the scenario with modified elasticities shows higher price movements, however the gap between the model results and the actual price data still widens especially from 2006/07 onwards. While the model indicates a substantial price increase by 29.1 % from 2005/06 to 2007/08 as the supply fell short during that period, the price index more than doubled in these two years. The increasing divergence from 2005/06 onwards can be an indicator that other, non-fundamental factors had a significant influence on wheat prices. By using Mitchell's (2008) ad-hoc approach, the influence of the US Dollar depreciation and the oil price hikes can be estimated in a simple way. Mitchell (2008) concludes that these two factors account for up to 25 % of the price increase from 2002 to 2008. By adding these 25 % (plus 42.5 index points) on top of the model results for wheat with modified elasticities in 2007/08, the estimated price rises to 221.5 index points. The actual wheat price index with the base year 1990/91 is at 306.5 index points in 2007/08 leaving still more than one quarter of the price index unexplained by the model. Assuming lower elasticities in times of relatively low stocks and including increasing oil prices and the US Dollar depreciation increases the explanatory power of the model but the model is still not able to show the extent of price variations from 2006/07 onwards. This gap might be explained by other non-fundamental factors, including financialisation that may have also driven recent food price hikes.

For sensitivity analysis, we apply in addition to the mean also extreme elasticities (with maximum/minimum demand and supply simultaneously) for the global wheat market from 1990/91 onwards (Figure 15). The influence of elasticities on the model is critical as demand and supply elasticity data are derived from a limited database and the relation between low stocks-to-use ratios and low elasticities is criticized by some authors (Headey/Fan 2008; Dawe 2009). As expected, the scenario with minimum elasticities shows the highest price swings. However, even with these elasticities the price hikes in recent years cannot be explained with the model, particularly for the years 2006/07 to 2007/08. The results are similar when the elasticities are divided into separate food and feed demand elasticities. Clearly, in such a simple model not all factors relevant for wheat prices and the complexities of wheat markets can be taken into account. Also, the assumptions about supply and demand elasticities and the connection to stocks-to-use ratios may need further qualifications. Despite these limitations imposed by the simple structure of the model, the results are largely valid for different sensitivity analysis.

Figure 15: Sensitivity analysis with min and max elasticities for wheat



Source: UNCTADstat; own calculation.

6. The impact of financial speculation on wheat prices

The analysis in section 5 concludes that in particular in recent years a part of the wheat price increase cannot be explained by the fundamental factors captured in the basic supply and demand model. Section 4 showed some basic data on the increasing role of financial investors in wheat futures markets. This section extends this by analyzing CFTC data in more detail. The CFTC publishes data on open interest for US futures markets in the Commitment of Traders (COT), the Supplemental Commodity Index Traders (CIT) and the Disaggregated Commitments of Traders (DCOT) reports. While aggregated COT data on commercial and non-commercial traders has existed from 1986 onwards, the disaggregated CIT and the DCOT data has existed only since January 2006 and June 2006, respectively. A problem with DOT data is that index investors/swap dealers are reported as commercial trades as they hedge a financial (and not as commercial traders a physical) position. CIT reports the positions of index investors separately for twelve agricultural futures markets[18] whereas DCOT reports open positions for producers, merchants, processors and users

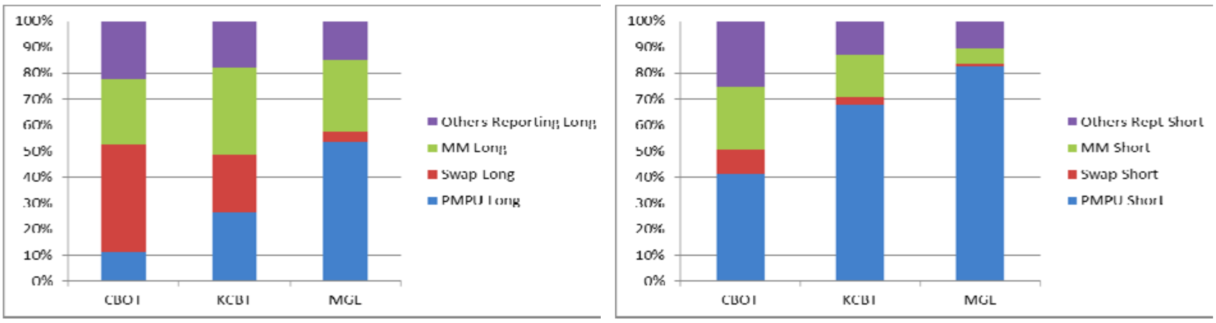
[18] The twelve commodities included are: feeder cattle, live cattle, cocoa, coffee, cotton, lean hogs, maize, soybeans, soybean oil, sugar, Chicago wheat and Kansas wheat.

(PMPU, i.e. commercial traders), swap dealers[19], money managers, and other reporting traders for twelve agricultural commodity markets and a number of energy and metals futures markets.[20] A crucial problem with these classifications is that the first classification of a trader is continued in the statistics. Hence, if a commodity trading house first hedges physical wheat transactions but later also engages in speculation without hedging interest, the second trade is still accounted as a commercial trade (for other problem of this data, see Ederer et al. 2013).

There are differences in the shares of different trader categories in the three US wheat futures markets. Concerning long positions, money manager have an equal share of between 25 to 33 % in all three exchanges. CBOT has the highest ratio of swap dealers with 41 % on average in the reporting period from June 2006 to September 2012. At MGEX the main share of long positions is hold by PMPU (Figure 16a). Concerning short positions, PMPU dominate in all three exchanges with money managers being more important in CBOT and KCBT (Figure 16b). Both figures show that especially CBOT and to a lesser extent KCBT are dominated by non-commercial traders which is related to the share of CBOT wheat in major commodity indices being higher than KCBT and MGE wheat. For commercial traders, the figures show that producers (on the selling side looking to hedge their future incomes) are larger than consumers (e.g. industrial food processors looking to hedge their costs) as is generally the case as producers often use hedging more broadly than consumers. If these volumes do not relate, non-commercial traders play an important role in closing that gap and providing liquidity to the market. However, when participation of non-commercial traders increases significantly on both sides of the market, speculators may have a more active role in influencing prices.

Figure 16: Open interest positions by different trader groups (in %, average June 2006 to September 2012)

a. LONG Positions *b. SHORT Positions*



Source: CFTC, DCOT futures and options, own calculation.

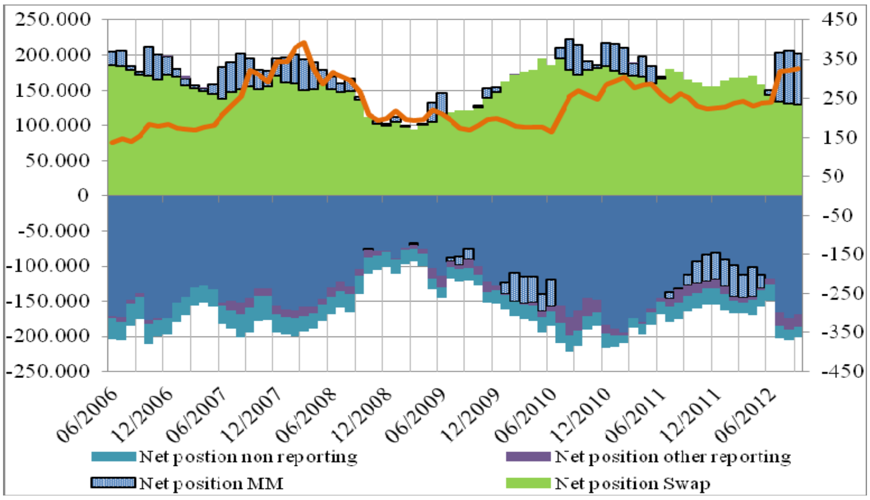
As in any other market, commodity futures prices are determined by the trading activities of different types of traders that sell or buy futures contracts. Most basically, the demand and supply for futures determines prices. If traders are attempting to buy more futures contracts than are currently offered for sale at the market price, then the market price will rise; if they demand less, the price will decline. Demand for and supply of futures, i.e. long and short

19 The index trader category of the CIT reports does not directly coincide with the swap dealer category in the DCOT reports because the swap dealer category includes also swap dealer that do not have index-related positions and the index trade category includes also pension and other investment funds that place index investments directly (and not through swap dealers) into future markets (UNCTAD 2011). Hence, a direct comparison between these two data sets is not possible.

20 Since recently, CFTC issues also a quarterly Index Investment Data (IID) report, which provides a more precise measure of actual commodity index investment than CIT and DCOT. It measures positions before internal netting by swap dealers and covers twelve agricultural markets plus seven energy and metals markets.

positions is always equal. Hence, each trader that sells futures (short positions) needs another trader that buys futures (long positions). Hence, most relevant for price pressures are net positions of different classes of traders, i.e. traders' long positions minus traders' short positions (omitting spread positions), as they represent the pressure a group of traders exerts on increasing or decreasing prices. Clearly, the extent of this pressure also depends on the price-sensitiveness of the respective trading strategies. At the CBOT, physical hedgers (PMPU) hold on average net short positions whereas swap dealers are net long in line with their trading strategy. Other reporting and non-reporting traders mainly hold relatively small net short positions. The only net position that varies in magnitude and direction is the net position of money managers (Figure 17).

Figure 17: Open net positions and nearby futures price for CBOT wheat



Note: CBOT wheat (left hand axis net position in contracts); nearby futures price (right hand axis futures price in USD per metric ton).

Source: CFTC, COT reports.

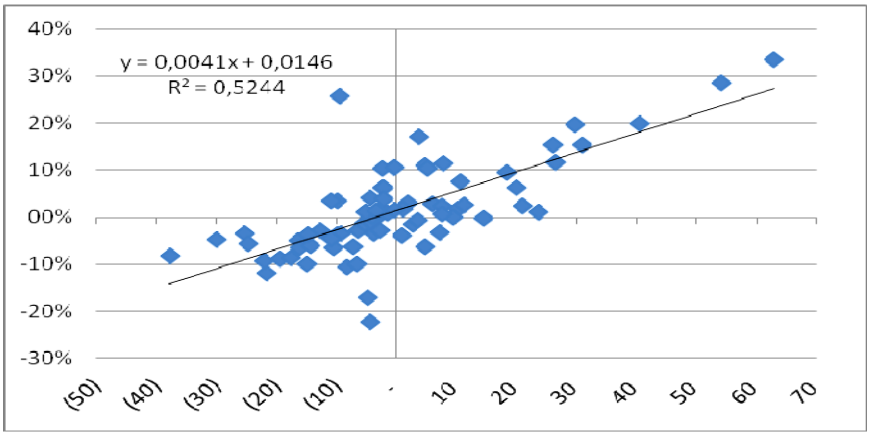
Many analyses on the impact of financialisation on commodity prices have focused on index investors/swap dealers, neglecting the effect of other types of financial investors captured in the diverse group of money managers even though the importance of money managers and more active trading strategies in general have increased in importance in recent years (for a detailed discussion see Ederer et al. 2013 and Heumesser/Staritz 2013). Relating the net positions of money managers to prices seems to show some relation – increasing prices especially in recent months go along with positive money managers' net positions while declining prices are associated with negative money managers' net positions. Obviously, an analysis based on graphs is not sufficient to draw conclusions on the impact of money managers' positions on futures prices. Indeed, the graphical analysis may be acceptable from 2009 onwards but the massive price increase in 2007 and 2008 goes along with decreasing net long positions of swap dealers and few episodes of net long positions of money managers. Nevertheless the correlation for CBOT wheat of changes in money managers' net long positions and futures prices shows a strong positive ratio, especially after July 2009 contrary to the correlation coefficient for index investors/swap dealers (Table 9, Figure 18). This is supported by an UNCTAD report (2011) that shows that from July 2009 to February 2011 the correlation between money manager position changes and commodity prices is considerably higher than the correlation between index investors position changes and prices (for CBOT wheat correlation coefficients account for 0.56 and 0.09 respectively).

Table 9: Correlation coefficient between net positions and futures prices (CBOT wheat)

	June 2006-Sep2012	July 2009-Sep2012
Money managers net positions	0.724	0.886
Index investors net position	-0.109	-0.373

Source: CFTC, DCOT reports.

Figure 18: Correlation coefficient money mangers' net positions and futures prices (CBOT wheat)



Source: CFTC, DCOT reports.

However, correlation cannot solve the question of causality. Money managers' net positions may cause wheat prices to change or, vice versa, price changes may cause changes in money managers' trading strategies with impacts on their net positions. As the majority of money managers pursue trend following or momentum trading strategies, it is reasonable to assume that money managers shift positions to long contracts when prices increase and vice versa. Granger (non-)causality tests can be used to estimate causalities. For CBOT and KFTC wheat, Ederer et al. (2013) show that weekly changes in net long positions of money managers (and also swap dealers) seem not to cause changes in futures prices but, the other way around, that changes in futures prices tend to be a good predictor of changes in money mangers' net positions (for results and a more detailed discussion see Ederer et al. 2013). These bivariate tests between net positions and price changes have however methodological problems, most importantly they may be subject to omitted variables that influence commodity prices in addition to traders' positions. Clearly, money managers' and more generally financial investors' effects on commodity prices should be perceived as occurring in addition to fundamental supply and demand factors and not in opposition to them (Gilbert/Pfunderer 2012). An adequate framework would therefore be a multivariate estimation that tests the partial effect of traders' positions on prices controlling for the effect of fundamental variables. Ederer et al. (2013) show that monthly money managers' net positions have a significant and large effect on price changes of CBOT and KFTC wheat in such a multivariate vector autoregression (VAR) framework. Such an estimation also takes into account the results of the basic supply and demand model in section 5 that show that fundamental factors have a role in explaining wheat prices but that their explanatory power decreased in particular in recent years stressing the impact of additional factors such as trading activities of money managers and financialisation more generally.

7. Conclusions

There have been important structural changes in fundamental supply and demand conditions for wheat and other food crops. However, these factors alone seem not to be sufficient to explain recent wheat price developments, in particular the large fluctuations between 2006/07 and 2012. The basic supply and demand model based on the main fundamental factors stated in the literature employed in this paper finds relatively satisfactory results from 1990/91 to 2006/07, in particular when demand and supply elasticities are assumed to be lower in times with relatively low stocks-to-use ratios. However, from 2006/07 to 2011/12, the actual price of wheat diverges quite strongly from the model results. This gap might be explained by other non-fundamental factors, including financialisation. Simultaneously to fundamental changes, trading on commodity derivative markets has undergone a major shift related to the increasing presence of financial investors since the early 2000s. The trading strategies of financial investors, for recent years in particular of money managers, tend to influence wheat prices in addition to fundamental factors.

These conclusions call for policy measures to regulate commodity derivative markets and ensure their efficient functioning for commercial traders, i.e. physical producers and consumers that use these markets for price discovery and hedging. Regulations of commodity derivative markets have been discussed at the global (G20), US and EU level. At the EU level there is still no agreement but trilogue negotiations between the European Commission, the European Parliament and the Council of Economic and Finance Ministers based on proposals by these parties are taking place. Important regulatory steps are included in these proposals, most importantly increased transparency through reporting of disaggregated positions by classes of traders that up to know was only available for US exchanges, the reduction of OTC trade, and the introduction of more stringent position limits. However, the proposals also have important limitations concerning in particular position limits that should not apply to OTC markets and the lack of broader proposals to reduce short-term volatility and stabilize commodity prices such as in the form of a multi-tier financial transaction tax (FTT). It is further difficult to assess these proposals as implementation standards and exemptions have not yet been decided which may importantly impact on how measures work in practice (for a detailed discussion on these regulations and their limitations see Staritz et al. 2013).

Besides regulations on commodity derivative markets, also broader regulations will be required to stabilize wheat and other food commodity prices. In particular mechanisms to create strategic stocks of and effectively manage physical inventories at the national and international level are crucial to avoid and protect from price volatility. Global and national counter-cyclical financing facilities would be required to mitigate incomeshocks from commodity price movements. Further, the creation of insurance instruments beyond derivative markets would be required as they have not provided effective insurance particularly for small producer and consumers in developing countries due to the high costs and complexity involved in hedging activities. Broader agricultural development strategies are also crucial with the objective to reduce commodity import and export dependency, secure food sovereignty, and diversify economies.

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Appendix 1: Mathematical presentation of the model

The model is based on Troester (2012) and is applied for the world market. Thus, exports and imports are excluded. The basic equations are:

Demand $QD(p) = KD * D(p)$

with the sub-equations:

Edibles: $QE(p) = KE * E(p)$

Feed: $QF(p) = KF * F(p)$

Biofuels: $QB(p) = KB * B(p)$

Others: $QO(p) = KO * O(p)$

and

Supply: $QS(p) = KS * S(p)$)

For the condition of market equilibrium (use = supply) the following equation is valid:

$$QS(p) = QD(p) = QE(p) + QF(p) + QB(p) + QO(p)$$

Total differentiation of the equations results in:

$$dQD = D'(p)dp + \frac{dKD}{KD} * QD_0$$

…

$$dQS = S'(p)dp + \frac{dKS}{KS} * QS_0$$

with QD_0 and QS_0 as quantities in the base year.

Hence, equating the changes in supply and demand, we get:

$$dQS = dQD = dQE + dQF + dQB + dQO$$

This equation can be rewritten:

$$S'(p)dp + \frac{dKS}{KS} * QS_0 = D'(p)dp + \frac{dKD}{KD} * QD_0$$

$$(S'(p) - D'(p))\, dp = \frac{dKD}{KD} * QD_0 - \frac{dKS}{KS} * QS_0$$

If both sides are divided by QS, we get:

$$\left(\frac{S'(p)}{QS} - \frac{D'(p)}{QS}\right) dp = \frac{\left(\frac{dKD}{KD} * QD_0 - \frac{dKS}{KS} * QS_0\right)}{QS}$$

With the supply quantity QS equal to the demanded quantity QD, S'(p) is substituted by $\frac{\delta QS}{\delta p}$ and D'(p) by $\frac{\delta QD}{\delta p}$. In order to derive the supply and demand elasticities ε_S and ε_D, the left hand side of the equation is multiplied and divided by *p:*

$$\left(\frac{\delta QS}{\delta p}\frac{p}{QS} - \frac{\delta QD}{\delta p}\frac{p}{QD}\right)\frac{dp}{p} = \frac{\left(\frac{dKD}{KD} * QD_0 - \frac{dKS}{KS} * QS_0\right)}{QS}$$

Both sides are multiplied by QS, and we get:

$$(\varepsilon_S - \varepsilon_D) * QS * \frac{dp}{p} = \frac{dKD}{KD} * QD_0 - \frac{dKS}{KS} * QS_0$$

or

$$\%\Delta p = \frac{\left(\frac{dKD}{KD} * QD_0 - \frac{dKS}{KS} * QS_0\right)}{(\varepsilon_S - \varepsilon_D) * QS}$$

with $QD = QE + QF + QB + QO$, the equation can be adjusted to:

$$\%\Delta p = \frac{\left(\frac{dKE}{KE} * QE_0 + \frac{dKF}{KF} * QF_0 + \frac{dKB}{KB} * QB_0 + \frac{dKO}{KO} * QO_0 - \frac{dKS}{KS} * QS_0\right)}{(QS_0 * \varepsilon_S - QE_0 * \varepsilon_E - QF_0 * \varepsilon_F - QB_0\varepsilon_B - QO_0\varepsilon_O)}$$