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WORKING PAPER 42

The role of fundamentals and financialisation in recent commodity price developments – an empirical analysis for wheat, coffee, cotton, and oil

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Contents

List of Abbreviations.......... 2
Index of figures and tables.......... 3
Abstract.......... 4
1. Introduction 4
2. Fundamental and macroeconomic determinants of commodity prices.......... 8
3. "Financialisation" effects on commodity prices 9
3.1. Co-movement between commodities and other markets 10
3.2. Effect on commodity price levels 11
3.3. Effect on commodity price volatility.......... 13
3.4. Critical remarks.......... 14
4. Empirical methods, models and data description 15
4.1. Vector Autoregressive Models (VAR) 15
4.2. Model description 17
4.3. Data description.......... 18
5. Results.......... 26
5.1. Bivariate VAR: weekly traders' net long positions and returns 26
5.2. Multivariate VAR: monthly fundamental, macro and financialisation variables and returns 28
6. Conclusions 37
References.......... 39
Authors.......... 46
Appendix A: Variable sources, scale, units and computation 47
Appendix B: Summary statistics 50
Appendix C: Effect of changes in traders' net long positions on changes in other traders' net long positions 53

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List of Abbreviations

AIC	Akaike Information Criterion
ADF	Augmented Dickey–Fuller
ADL	Autoregressive Distributed Lag
CBOT	Chicago Board of Trade
COT	Commitment of Traders
CFTC	Commodity Futures Trading Commission
CPO	Commodity Pool Operator
CTA	Commodity Trading advisor
CLN	Commodity-Linked Notes
DCOT	Disaggregated Commitment of Traders
DJ-UBSCI	Dow Jones-Union Bank of Switzerland Commodity Index
EMH	Efficient Market Hypothesis
EU	European Union
ETF	Exchange Traded Funds
ETN	Exchange Traded Notes
FPE	Final Prediction Error Criterion
FAO	Food and Agriculture Organization of the United Nations
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
HQ	Hannan-Quinn Criterion
HRW wheat	Hard Red Winter Wheat
IID	Index Investment Data
ICE	Intercontinental Exchange
ICO	International Coffee Organisation
ICAC	International Cotton Advisory Committee
KCBT	Kansas City Board of Trade
LIC	Low-Income Country
MIFID	Markets in Financial Instruments Directive
NCNC	Neither Carded Nor Combed
NYMEX	New York Mercantile Exchange
OLS	Ordinary Least Squares
OECD	Organisation for Economic Co-operation and Development
OTC	Over-the-Counter
REER	Real Effective Exchange Rate
SIC	Schwarz Information criterion
SRW wheat	Soft Red Winter Wheat
S&P GSCI	Standard & Poor’s Goldman Sachs Commodity Index
S&P 500	Standard & Poor's 500
SSA	Sub-Saharan Africa
UNCTAD	United Nations Conference on Trade and Development
US	United States
USD	United States Dollar
VAR	Vector Autoregressive Model
WTI	West Texas Intermediate

Index of figures and tables

Figure 1: Monthly commodity prices 19
Figure 2: US interest rate 20
Figure 3: US REER 20
Figure 4: Stock market indices 20
Figure 5: Global industrial production index 20
Figure 6: Monthly commodity exports of the largest exporting countries 21
Figure 7: Net long positions and commodity prices 25
Figure 8: Impulse responses: Coffee 30
Figure 9: Impulse responses: Cotton 31
Figure 10: Impulse responses: SRW wheat 32
Figure 11: Impulse responses: HRW wheat 33
Figure 12: Impulse responses: Brent crude oil 34
Figure 13: Impulse responses: WTI crude oil 35
Figure 14: Historical decomposition 36

Table 1: Annual average positions of trader groups in long futures contracts (measured as the proportion of annual average total open interest in that market) 23
Table 2: Annual average positions of trader groups in short futures contracts (measured as the proportion of annual average total open interest in that market) 24
Table 3: Granger causality test results for the null hypothesis that changes in traders' net long positions do not lead commodity returns 27
Table 4: Granger causality test results for the null hypothesis that commodity returns do not lead traders' net long positions 27

Abstract

In the context of recent commodity price hikes, the financialisation of commodity derivative markets, reflected in the increased presence of financial investors and new financial products such as commodity index and exchange traded funds has been controversially discussed. Many studies focus on the effect of passive index investors on rising commodity prices, but hardly look at the effect of the diverse group of money managers where an important share engages in technical and trend following trading strategies and thus has the potential to push prices up and down. This is problematic given the increased importance of money managers and more generally of active trading strategies in recent years. We analyze for the commodities coffee, cotton, soft red winter and hard red winter wheat and WTI and Brent crude oil the effect of both types of financial investors within a Vector Autoregressive (VAR) model framework, conducting Granger (non-)causality tests and impulse response analyses for the period June 2006 to October 2012. We complement the bivariate model approach, which looks at the lead-lag relationship between financial investors' positions and commodity returns, with a multivariate approach. We thus assess financial investors' positions in addition to a range of fundamental and macroeconomic variables which may influence commodity prices. In both models, index investors' net long positions are not found to have a significant effect on commodity returns in recent years. In the multivariate model money managers' net long positions have a statistically significant and large effect on returns for all commodities; in the bivariate model they only have an effect for coffee. In the bivariate model, we also find that commodity returns drive money managers' positions, which may indicate the presence of trend following trading strategies. Overall, our results support the hypothesis of financialisation of commodity derivative markets.

1. Introduction

After nearly three decades of low commodity prices, commodities have experienced an unprecedented price boom since the early-2000s. From 2002 onwards, most commodities have registered steep price increases, with a first peak in mid-2008. UNCTAD's All Price Commodity Index increased by 211 % in nominal terms for the period 2002 to mid-2008. The price of crude petroleum experienced the sharpest increase of 585 %, and the food price and agricultural raw materials price index increased by 175 % and 158 %, respectively (UNCTADStat 2012). In the second half of 2008 prices fell sharply across commodities in the wake of the financial and economic crisis. They began to rise again in the first half of 2009 and non-fuel prices reached an all time high during summer 2011. After declines at the beginning of 2012, commodity prices increased again in the second half of 2012. Despite large fluctuations in recent years commodity prices are projected to remain above their historical levels (OECD/FAO 2012).

The consequences of these developments were dramatic. Many developing countries are net importers of basic commodities such as fuel and food. Consumers in low-income countries (LICs) use a high proportion of their income for such basic commodities (FAO 2011). Commodity price dynamics consequently have direct effects on food and energy security, poverty and economic growth and stability (von Braun/Tadesse 2012; FAO 2011). Many developing countries, in particular in Sub-Saharan Africa (SSA), are also characterized by a persisting dependency on exporting specific commodities. These countries may have benefitted from rising revenues from commodity exports, but increased price volatility has also highlighted their vulnerability and difficulties in managing their economies (FAO 2011; Nissanke 2012). High price volatility complicates financial and economic planning, investment decisions and resource management for producers, consumers and governments, as well as negatively influences economic development and exacerbates commodity dependence (Brown et al. 2008; Nissanke 2012; UNCTAD 2012).

The questions which factors drive commodity prices and caused the commodity price hikes in 2007/08 and 2011/12 and which measures can be taken to prevent similar price surges and volatilities in the future have become central in international and domestic policy debates (e.g. G-20 summits). Particular attention has been devoted to the increased presence of new financial actors in commodity markets, their potential to impact commodity price levels and volatility, and necessary regulations of commodity derivative markets (see for the United States (US) the Dodd Frank Act signed in 2010 and for the European Union (EU) ongoing discussions on the Markets in Financial Instruments Directive (MiFID); for a detailed discussion see Staritz et al. 2013).

Commodity prices are determined by fundamental supply and demand conditions in physical commodity markets as well as macroeconomic factors. Similar to past commodity booms in the 1970s, the current commodity boom peaking in 2007/08 and again in 2011/12 was set in an expansionary fiscal and monetary environment and a period of high economic growth (Baffes/Haniotis 2010; Radetzki 2006). In particular, the rapid economic growth and increased commodity demand of emerging countries, e.g. China or India, and the increased demand for agricultural crops for the production of biofuels to substitute non-renewable fuels are discussed to have caused the price hike. On the supply side there are also common factors that may have adversely affected commodity supply: rising oil prices that increase production and transport costs; adverse weather effects that have increased in the context of climate change; supply constraints for some energy and mineral commodities; a lack of investment in agricultural sectors in developing countries in the last two decades; and export bans on commodities in particular since 2008. On the macroeconomic side, low interest rates and the depreciating US Dollar are broadly stated as factors behind the price hikes (Cooke/Robles 2009; IMF 2012).

But are these factors sufficient to explain recent commodity price developments? At the same time of these fundamental and macroeconomic developments, trading activities on commodity derivative markets have undergone major changes. Traditional traders on these markets are commercial traders, i.e. producers, consumers and traders of physical commodities that use these markets for price discovery and hedging against the risk of price fluctuations, and non-commercial traders that do not have an underlying physical commodity position but take over the price exposure from hedgers and hope to profit from changes in futures prices. Since the early 2000s, financial investors, in particular banks, institutional investors and hedge funds have increased in importance. The trading volumes on commodity future exchanges and over-the-counter (OTC) markets, notably from financial investors have substantially increased and a range of new commodity investment products, in particular commodity index funds and exchange traded funds (ETFs), have been developed to facilitate investment in commodities. Financial investors are typically classified in index investors or swap dealers[1] and money managers. Index investors/swap dealers pursue a longer-term and passive investment strategy, using commodity indices or ETFs. They exhibit a price-insensitive behavior in investing in long futures contracts of a range of commodities, irrespective of specific commodity market conditions. Money managers, such as hedge funds, commodity trading advisors (CTA) or commodity pool operators (CPO), pursue shorter-term, more active and long and short trading strategies. Their strategies vary considerably with traditional CTAs often focusing on fundamental information but technical trading has considerably increased in importance in particular along with the increasing role of large hedge funds (for a detailed description of financial investors see Heumesser/Staritz 2013). Whether and to which extent these financial investors distort commodity prices from levels justified by fundamental factors or have changed the character and the functioning of commodity derivative markets have been subject to controversial debates (Domanski/Heath 2007; UNCTAD 2011).

To date, there exists a multitude of empirical studies, based on a variety of estimation methods (e.g. time series, cross section analyses), model specifications (variable selection regarding fundamentals or financial investors; bivariate or multivariate; number of lags), data aggregation and data sets (mostly since 2006; (un)published daily, weekly, monthly, quarterly data), and specifications of variables which represent the effect of financial speculation ("financialisation

[1] Not every swap dealer is an index investor. The correspondence is quite close in agriculture markets where the large majority of swap dealers are index investors but swap dealers in energy markets conduct a substantial amount of non-index swap transactions. The most appropriate data is however available for the swap dealer category which is used in this paper. See further discussions on this issue below.

variables") on commodity prices. The results are mixed, highlighting the complexity of price determination in commodity derivative markets and of trading dynamics. Roughly, three broad lines of empirical research can be classified:

- One line of research investigates whether financial investors contribute to an excess co-movement between returns of different types of commodities or commodity and financial asset returns such as equities, bonds or exchange rates. There is overwhelming evidence that the co-movement between commodity and financial markets has increased (Bicchetti/Maystre 2012; Büyükşahin/Robe 2012; Creti et al. 2013; Lehecka 2013a; Silvennoinen/Thorp 2013; Tang/Xiong 2010). It is suggested that financialisation in general (Creti et al. 2013) and the trading strategies of index investors (Tang/Xiong 2010) or money managers (Büyükşahin/Robe 2012) in particular played a major role in this regard. To our knowledge few studies – of the reviewed analyses only one study by Büyükşahin et al. (2010) – find a weakening relationship between commodity and equity markets.
- A second line of research investigates within time series frameworks the lead-lag dynamics of financial investors' positions, in particular index investors' positions, on commodity prices. Most of these analyses employ bivariate Granger (non-)causality tests between index funds' positions and commodity futures returns. The majority of empirical analyses find little evidence – for instance only for selected commodities or under specific model assumptions – of a significant relationship between financial investors' positions and commodity returns (Aulerich et al. 2012; Büyükşahin/Harris 2009; Irwin/Sanders 2012; Irwin/Sanders 2010; Sanders/Irwin 2011; Sanders et al. 2009; Stoll/Whaley 2009; Lehecka 2013b). There are however also studies that find an effect of index investors' positions on commodity returns (Gilbert/Pfuderer 2012; Mayer 2012; Henderson et al. 2012; Gilbert 2010a; Gilbert 2010b). Financialisation, tested by variables such as volume of traded contracts or total market open interest, is also found to have caused an increase in commodity prices in some studies (Cooke/Robles 2009; Robles et al. 2009). Within these analyses, only few explicitly consider the effect of financial investors other than index investors, i.e. money managers, on commodity prices but find that they generally have an effect (Büyükşahin/Robe 2012; Mayer 2012).[2]
- A third line of research looks at the effect of financial investors on commodity price volatility. The majority of empirical analyses does not find a significant effect (Bohl et al. 2012; Bohl/Stephan 2012; von Braun/Tadesse 2012; Brunetti/Büyükşahin 2009; Brunetti et al. 2011; Gilbert 2012; Irwin/Sanders 2012). However, some studies find a positive correlation between increased speculation, represented by Working's excessive speculative index, and volatility (Algieri 2012; McPhail et al. 2012).

Despite this wealth of empirical analyses, we find shortcomings which we will address in this paper:

- Firstly, many analyses focus on the effects of index investors on commodity prices that may distort commodity markets by pushing prices above a level justified by fundamental factors. The effects of other types of financial investors captured in the diverse group of money managers has been neglected even though their importance in terms of positions held in commodity futures markets has increased in recent years (UNCTAD 2011; Mayer 2012). As an important share of them employs technical trading strategies rather than fundamental-related information they also have the potential to distort commodity markets by amplifying prices up- and downwards (Bicchetti/Maystre 2012; Büyükşahin/Robe 2012; Mayer 2012; UNCTAD 2011). Therefore, our analysis puts weight on this category of traders.

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2 Within this line of research, also the effect of financial, and particularly index investors' positions on commodity futures spreads - the difference between futures prices at different contract maturities - is investigated. Again, the evidence is mixed. Several researchers suggest that index investment does not have an impact on spreads (Garcia et al. 2011; Hamilton/Wu 2012; Stoll/Whaley 2009) while others suggest that, in particular during the roll period, when index investors roll their expiring contracts over to new contracts, index investors temporarily expand spreads (Brunetti/Reiffen 2011; Frenk/Turbeville 2011; Irwin et al. 2011; Mou 2010; for a detailed discussion see Heumesser/Staritz 2013).

- Secondly, as a variable for financialisation we use net positions by different classes of traders, taking into account that trading strategies can push prices up and down. This is particularly important for money managers but, more recently, also some index-based investments have become more active (for a discussion on the microstructure of commodity derivative markets see Heumesser/Staritz 2013). Using alternative measures such as total long positions, volume traded, the share of non-commercial to commercial positions or Working's excessive speculative index, generally assumes a positive correlation with commodity prices, i.e. that an increase in these variables increases prices but cannot decrease commodity prices (Schulmeister 2009, 2012). Taking net positions captures the net effect of different trading classes and hence represent the buying or selling pressure a group of traders exerts that can have a positive (net long) or a negative (net short) impact on prices.
- Thirdly, many of the above cited time series analyses employ Granger (non-)causality tests within a bivariate Vector Autoregressive (VAR) framework to test whether traders' position changes influence commodity returns. The estimated (non-)causality in bivariate tests may be subject to omitted variables. Clearly, financial investors' effects on commodity prices should be perceived as occurring in addition to other, i.e. fundamental and macroeconomic, drivers and not in opposition to them (Gilbert/Pfuderer 2013; Gilbert/Pfuderer 2012). We therefore test the partial effect of traders' position changes on prices within a multivariate VAR framework which allows controlling for the effect of fundamental and macroeconomic variables on commodity prices.

Our analysis focuses on the following research questions: (1) How has the presence of financial investors – index investors and money managers – evolved over time in commodity derivative markets? (2) To which extent are commodity prices determined by fundamental and/or macroeconomic factors, such as interest rates, exchange rates, and demand- or supply-related factors? (3) What are the effects of traders' positions, in particular financial investors' positions, on commodity prices? Is there a difference between the activity of index investors, represented by swap dealers, and the speculative activity of money managers?

This set of questions is assessed using time series data and regression models. The second and third question is investigated within a multivariate VAR framework on a monthly scale as most fundamental and macroeconomic data is only available on a monthly basis. As the effect of position changes on commodity prices can be more pronounced during shorter time periods, i.e. on a weekly or daily basis, in addition to the multivariate analysis we employ Granger (non-) causality tests in a bivariate VAR framework with weekly data. The analysis is performed for six commodities traded on US exchanges: Arabica coffee and cotton, traded on the Intercontinental Exchange (ICE); soft red winter (SRW) and hard red winter (HRW) wheat traded on the Chicago Board of Trade (CBOT) and the Kansas City Board of Trade (KCBT), respectively; and WTI and Brent crude oil traded on the New York Mercantile Exchange (NYMEX).

The paper is structured as follows. In section 2 and 3 we present fundamental, macroeconomic, and financialisation determinants of commodity price developments, referring to the relevant literature. In particular in section 3, we provide a comprehensive literature review of the empirical evidence on financial investors' effects on commodity prices along the main lines of empirical research. Section 4 describes the empirical methods used in our analyses (i.e. VAR, Granger (non-)causality tests, impulse response analysis), the specified regression models, and the data used. Section 5 discusses results and the last section concludes.

2. Fundamental and macroeconomic determinants of commodity prices

Several macroeconomic and fundamental supply- and demand-related factors drive commodity prices. On the fundamental side, clearly, global production and consumption play a crucial role. Agricultural price booms are often linked to supply shocks such as weather events or pests which disrupt production. During the commodity boom in 2008, weather related supply shocks, e.g. in the form of drought in commodity producing regions such as Australia or South America, as well as floods or typhoons occurred. Commodity prices also react strongly to increased oil, energy and fertilizer prices (Gilbert 2010a) as they represent input costs (e.g. fuel, energy for irrigation, primary processing and transportation), and because energy is a major input into fertilization and other chemical products, which are essential for crop production (Mitchell 2008). Studies have estimated the elasticity of non-energy commodities with respect to energy prices at about 12-18 % (Baffes/Haniotis 2010). Mitchell (2008) suggests that high energy prices have contributed 15-20 % to higher US food commodities' production and transport cost. In addition, some energy and mineral commodities reached supply constraints (Nissanke 2012) and agricultural production and productivity have stagnated, due to low investment in agricultural sectors and R&D in developing countries in the last two decades (Baffes/Haniotis 2010; Piesse/Thirtle 2009). For instance, for important cereals the growth rates have fallen from around 3 % in time of the green revolution to around 1 % in the early 2000s (World Bank 2008). Trade barriers and export restrictions – in particular after prices have started to rise in 2008 – are also named as relevant supply side factors which have contributed to increasing commodity prices. For instance, by July 2008 eleven Asian countries had export controls implemented which may have led to an increase in prices over the following weeks (Piesse/Thirtle 2009). Piesse and Thirtle (2009) argue that low inventories were the single most important factor in recent agricultural price increases. Large inventory holdings may buffer unexpected supply shocks or jumps in demand and decrease price volatility (Carter et al. 2011; Piesse/Thirtle 2009; Symeonidis et al. 2012). The stocks-utilization ratio for grains and oilseeds fell to 15 % during the commodity price boom in the 1970s and had even a level of 14 % in 2008. However, not all grains exhibited exceptionally low inventory levels; for instance, cotton inventories were about average (Carter et al. 2011).

On the demand side, an increasing population, rising world demand, dietary changes and income growth in emerging nations, in particular China and India, are said to cause increased demand for food, feed, minerals and energy and have thus raised commodity prices (Cooke/Robles 2009). Baffes and Haniotis (2010) investigate data on growth, population and income over the past decade and point out that, despite a clear acceleration of GDP growth since 2003, stronger food demand growth in China or India or in the world as a whole cannot be confirmed (Alexandratos 2008; FAO 2009). For maize and soybeans increasing demand has been observed, which was however driven by the demand for edible oils and biofuels production (Baffes/Haniotis 2010). For instance, global consumption of wheat, rice and maize increased by 0.8 %, 1 % and 2.1 % per annum from 2000 to 2007, but increased at a higher rate – 1.4 %, 1.4 % and 2.6 % per annum – from 1995 to 2000 (Piesse/Thirtle 2009 citing FAO 2008). The effect of income growth has however more directly increased demand for metals and oil. Through an increased oil price and other macroeconomic linkages, food commodity prices might be indirectly affected (Piesse/Thirtle 2009). The growing demand for biofuels, i.e. maize based ethanol and oilseed based biodiesel, is named as a significant factor affecting agricultural commodity price developments. During the boom in 2008, the price of maize and crude oil moved closely together (Baffes/Haniotis 2010). Mitchell (2008) argues that biofuel production from grains and oilseed was the most important factor behind the food price increase between 2002 and 2008. Others (e.g. Gilbert 2010a) do not find a direct link, or argue that biofuels only account for 1.5 % of the area under grains or oilseeds, raising doubts that biofuels have accounted for a large shift in global demand (Baffes/Haniotis 2010).

There are a range of macroeconomic factors, which have an effect on commodity prices. Expansive monetary policy, low interest rates and liquidity supported by central banks in order to stabilize financial markets and stimulate output may exert inflationary pressure on commodity prices (Baffes/Haniotis 2010; Belke et al. 2013; Browne/Cronin 2010; Byrne et al. 2013; Calvo 2008; Frankel 2008; Gilbert 2010a). This also led to increased activity by financial players, which, through various new investment products, deregulation and regulatory loopholes (Staritz et al. 2013), found their way into commodity derivative markets (Baffes/Haniotis 2010; Belke et al. 2013). Increased liquidity may also lead to increased speculative demand for spot commodities that has been particularly observed for some metals (CRU 2012; for a discussion see Heumesser/Staritz 2013). Also the depreciation of the US dollar negatively affected commodity prices, as most commodities are quoted in US dollars (Baffes/Haniotis 2010).

3. "Financialisation" effects on commodity prices

Empirical studies investigating the effect of financial speculation on commodity prices typically rely on two broad lines of argumentation related to the behavioral finance literature about how financial speculators can or cannot influence commodity price dynamics (Schulmeister 2009, 2012; for a detailed discussion see Heumesser/Staritz 2013). The first hypothesis, the "efficient market hypothesis" (EMH) (Fama 1970; Friedman 1953), states that financial market prices are determined largely by fundamental factors. Markets are assumed to be generally efficient in absorbing and processing instantaneously all available information regarding market fundamentals and macroeconomic developments, and are dominated by rational market participants. Prices follow a random walk and as a consequence speculation based on past prices cannot be systematically profitable. Therefore uninformed speculation cannot distort commodity prices in a systematic and/or persistent way. This is opposed by the "noise trader hypothesis" or "bull-and-bear hypothesis" (Schulmeister 2009, 2012) which states that, apart from fundamental factors, speculation also substantially influences commodity prices, as there is imperfect knowledge and price dynamics are driven by the expectations of heterogeneous agents (see e.g. Shiller 1984; Schleifer/Summers 1990; deLong et al. 1990; Schleifer 2000; De Grauwe et al. 1993; De Grauwe/Grimaldi 2006; Hommes 2006; Frydman/Goldberg 2007). They can be roughly classified in informed traders that base their trading activities on dynamics in physical markets (i.e. fundamental factors) which may include commercial traders[3] as well as some speculators classified as non-commercial traders such as CTAs, and noise and uninformed traders, who do not rely on fundamental information. The latter group of traders may act upon beliefs or sentiments which are not justified by fundamentals or employ technical trading strategies which are not directly based on fundamental information but on past price developments. These trading strategies can lead to herding, i.e. the tendency of individual traders to mimic the actions of a large group rather than to rely on their own information. Both strategies may result in price distortion. If such traders dominate, it may be also irrational for informed traders to act against the trend, even if justified by information about fundamentals, leading to complex interrelations among different types of traders (Keynes 1936; UNCTAD 2011).[4]

3 Not all commercial traders need to be informed traders as they can be badly informed on fundamentals and/or act irrationally. A further problem refers to classification as some commercial traders, in particular large trading houses may be involved in hedging and speculative trading activities (see below; for a more detailed discussion see Heumesser/Staritz 2013).

4 Two further hypotheses can be related to the "noise trader/bull-and-bear hypothesis" (Heumesser/Staritz 2013) – the "weight of money hypothesis" and the "excess co-movement hypothesis". The "weight of money hypothesis" (Mayer 2009; UNCTAD 2011) is widely stated in the context of the increasing importance of index investors that generally take very large positions on one side of the market. It argues that individual market participants may make position changes that are so large relative to the size of commodity futures markets that they move prices temporarily or even persistently. The "excess co-movement hypothesis" (Pindyck/Rotemberg 1990), investigates whether co-movement of commodity prices can be exclusively explained in terms of a fundamental supply and demand relationship or common macroeconomic effects. If this is not the case, co-movements of different commodity prices and between commodity prices and other financial assets may be explained by speculation. The trading of many commodities and other asset classes based on similar trading strategies such as technical trading by noise or uninformed traders may explain co-movements.

3.1. Co-movement between commodities and other markets

A large number of studies investigate whether financial investors have contributed to an excess co-movement between different commodity returns and commodity and financial asset returns. Only Büyükşahin et al. (2010), who use dynamic conditional correlation and recursive co-integration techniques on daily, weekly and monthly data over 18 years on several commodities, suggest that there is little evidence of an increase in linkages between financial asset and commodity returns.

The majority of studies suggest that the integration between commodity and financial markets has increased. For instance, Lescaroux (2009) finds that price cycles of oil and metals are highly correlated supporting a co-movement but he explains this due to the tendency of fundamental factors to move together and not due to financialisation of commodity markets. Lehecka (2013a) suggests that the co-movement between the FAO food price index and the MSCI stock market index started to increase in particular around 2008. Tang and Xiong (2010) employ regression analysis and find that after 2004 the increased presence of index investors has lead to a greater increase in the return correlations of indexed commodities – part of the S&P GSCI Commodity Index and Dow Jones-UBS Commodity Index – with oil future prices whereas the return correlation between off-index commodities and oil future prices was lower. Index investors were found to act as channels for bringing volatility to commodity markets, as indexed non-energy commodities had greater price volatility than off-index commodities in 2008. Creti et al. (2013) employ a dynamic conditional correlation GARCH modeling framework for 25 commodities from 2001-11 to assess how correlation between commodity and stock returns has evolved over time. The highest correlation is observed during financial turmoil. They stress that commodities cannot be seen as a homogenous asset class with regard to their links to stock markets. For instance, correlation between S&P 500 returns and the commodities oil, coffee and cocoa grows in times of increasing stock prices and declines in time of bearish financial markets. Silvennoinen and Thorp (2013) estimate whether changes in correlation between commodity futures, equity and bond returns (S&P 500) were driven by financial variables (non-commercial long open interest and proportional difference between non-commercial net long and short open interest). They employ a bivariate double smooth transition conditional correlation GARCH modeling framework for the period 1990-2009 on weekly agricultural, metal and energy commodity returns. They find that commodity futures correlation dynamics with US stocks increased during this period and financial shocks appear to be important predictors for correlation dynamics. Bicchetti and Maystre (2012) add to the discussion by assessing the co-movement between several commodity returns and the E-mini S&P500 on an intra-day basis for the period 1997-2011. On daily frequency, the correlation between commodities and stock indices has increased since 2003/04, on intra-day level the correlation deviates from zero and takes on negative levels in early and mid-2008, and positive levels since late 2008 until the end of their sample. The increase in high frequency trading activities and algorithmic strategies may have in particular impacted these correlations. Büyükşahin and Robe (2012) employ a dynamic conditional correlation methodology on non-public, daily data on individual traders' positions for 17 US commodity futures markets for the period 2000-10 from the Commodity Futures Trading Commission's (CFTC) large trade reporting system to investigate the correlation between commodity and equity returns. They employ an Autoregressive Distributed Lag (ADL) model to estimate the long run effect of different variables on commodity-equity return correlations and conclude that increased speculative activity of hedge funds, rather than commodity index funds, leads to a higher correlation between stock and commodity market returns. This is valid in particular for hedge funds which are active in both equity and commodity futures markets. Similar to Bicchetti and Maystre (2012), they highlight the growing importance of different types of financial traders, apart from index investors.

3.2. Effect on commodity price levels

Another line of research investigates the lead-lag dynamics of non-commercial or financial investors' positions on commodity price returns within a time series framework. Usually bivariate Granger (non-)causality tests are employed and CFTC's monthly, weekly or daily data is used.

There is a range of studies which reject the hypothesis that index investors affect commodity returns. Sanders et al. (2009) employ bivariate Granger causality tests to investigate the lead-lag dynamics between commercial, non-commercial and non-reported traders' share of net long positions and commodity returns on ten agricultural futures markets in a weekly sample from 1995-2006. They find limited evidence that traders' positions lead futures returns. Commercial positions are found useful for forecasting returns in CBOT and KCBT wheat and lean hogs, and non-commercial positions for soybeans. Irwin and Sanders (2010), using weekly data on agricultural and energy futures markets, investigate the relationship between returns, implied and realized volatility and index funds' total and share of net long positions and Working's speculative index. Changes in index funds' net long positions did neither cause a bubble in commodity futures prices nor increased market volatility. Lehecka (2013b) tests the lead-lag relationship between the share of traders' net long positions and Working's speculative index and prices of 24 commodities with a lag-augmented Granger causality approach. He finds strong evidence that prices tend to lead variables on positions for the majority of commodities, but not vice versa. Also Sanders and Irwin (2011) employ bivariate Granger causality tests on an unpublished, weekly data set from 2004-09 and fail to reject almost all causal relationships between commodity index activity and grain futures prices (corn, soybean and KCBT and CBOT wheat). When implementing a long-horizons model they confirm a positive causal effect of index investors' positions on soybean prices. Similarly, Stoll and Whaley (2009) employ regression analysis and Granger causality tests on CFTC's weekly data and find no evidence that index rolls or inflows and outflows from commodity index investments have an impact on futures prices, except for cotton. Hamilton and Wu (2012), using weekly data on 12 agricultural commodities, find that changes of index notional positions have no statistically significant impact on commodity returns, except for sugar and cotton on which notional returns have a negative impact. Capelle-Blancard and Coulibaly (2011) use a systems framework and find no evidence that commodity index positions Granger-cause prices in the majority of markets they examine, except for cocoa before September 2008 and live cattle for the period 2008-10. Finally, Irwin and Sanders (2012) use CFTC quarterly data on index investors for 19 commodity futures markets from 2008-11. They estimate a cross sectional Ordinary Least Squares (OLS) regression and employ Fama-MacBeth tests and do not find evidence that index position (represented as percentage change in notional value and percentage change in net long positions) impact returns or volatility, regardless of whether lagged or contemporaneous effects are considered.

Arguing that weekly data aggregation may be too coarse to estimate lead-lag dynamics, several studies employ daily data sets. For instance, Aulerich et al. (2012) use non-publicly available daily data from CFTC's Large Trader Reporting System for the period 2000-09. They employ bivariate Ganger causality tests within a seemingly unrelated regression framework, which accounts for contemporaneous error correlation and aggregate effects across markets, to estimate lead-lag dynamics of aggregate index investment flows on commodity returns and implied volatility. They also investigate aggregate index investment flows within a roll period. They test 12 markets and can reject the null hypothesis of no impact on returns only on three markets – feeder cattle, lean hogs and KCBT wheat. Büyükşahin and Harris (2009) use daily data for the period 2000-08 to investigate the effect of traders' net positions on WTI crude oil market. Employing Granger causality tests, they fail to reject the null hypothesis of no causality from position changes to price. Irwin and Sanders (2012) also estimate time series and Granger causality tests using daily actual position data reported by energy-related exchange traded funds, but fail to reject the null hypothesis of no causal link between daily returns or volatility in crude oil and gas futures markets and the positions of ETFs. When contemporaneous effects are included a negative association between fund buying and market returns is found.

There are also studies that find that index investors' positions have an impact on commodity returns. For instance, Gilbert (2010b) uses daily data for the period 2000-09 for crude oil, aluminum, copper and nickel, CBOT wheat and soybeans to test with a Positive Augmented Dickey-Fuller (ADF) test for price bubbles. He finds evidence of bubbles in the copper market in 2004, 2006 and 2008 and in the soybean market in 2008 and suggests that these might have been caused by CTAs and other trend following traders but also by fundamental/macroeconomic factors. He further estimates a 3SLS model accounting for contemporaneous effects and finds that the self-calculated quantity index of index investment appears to explain movement in energy and metals prices in the order of 3-10 % in 2006 and 2007 and rises to 20-25 % in 2008. His findings suggest that index-based investment may not have caused price hikes in oil, metals and grain prices but appear to have amplified fundamentally-driven price movements. In a similar analysis, Gilbert (2010a) uses monthly data for the period 2006-09 and employs a 2SLS approach. He finds that index investment has a significant effect on UNCTADs food price index and on the oil price. He suggests that index futures investment was a principal channel through which monetary and financial activity have affected food prices over recent years. Gilbert and Pfuderer (2012) use the same approach as Irwin and Sanders (2011) but on a shorter sample, from 2006-09, and find evidence that a normalized change in net long index positions Granger-causes corn and soybean prices. However, the coefficients have a negative sign. They suggest that Granger causality tests may not pick up effects in liquid markets as these are relatively efficient and price impacts are likely to happen within a short period of time. They perform tests for less liquid soybean oil and livestock markets and find that index positions do impact prices (Gilbert/Pfuderer 2012).[5] Henderson et al. (2012) investigate the effect of Commodity-Linked Notes (CLN)[6] on energy and non-energy commodity prices during the period 2003-11 in a regression framework accounting for contemporaneous effects. Their results reveal that CLN issuer's hedging trades temporarily impact commodity futures prices.[7] Cooke and Robles (2009) use monthly data for the period 2002-09 to estimate a first difference OLS model with one lag and contemporaneous effects of the exogenous variables as well as rolling Granger causality tests.[8] They include monthly volume of traded contracts, open interest, volume to open interest ratio and the non-commercial long and short positions to total trade ratio are included as financialisation variables. They find for corn, wheat and soybeans significant positive effect of financialisation on prices. Using the same financialisation variables, Robles et al. (2009) employ rolling Granger causality tests for 30 months periods for 2002-08 and find significant impacts on wheat, rice and maize. Most studies look at the price impact of index investors. But Mayer (2012) using an ADL model for the period 2006-09 finds that changes in index traders' net long positions caused changes in returns for soybean, soybean oil, copper and crude oil, whereas money managers' positions had a causal impact on maize, and on copper and oil during the price spike in 2007 and 2008.

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5 Not finding a causal link in the more liquid markets may stem from a deficient in the Granger causality method rather than a lack of a price impact. Even though this conjecture is not provable, they consider contemporaneous effects and find significant positive correlation for all commodities. They conclude that it is undeniable that there is an association between CIT positions and futures returns. Causation could run either way or a third variable could be an unseen joint cause of both returns and CIT position changes. Hence, provided that markets are liquid and given the broad belief that grains are traded on efficient markets, quantifying the effect on prices needs to consider contemporaneous effects (Gilbert/Pfuderer 2012).

6 CLNs are issued by financial institutions that then execute hedge trades in commodity futures markets.

7 During a 2-day window around the pricing date of CLNs, they find increased returns to the front month futures contract between 37 and 51 basis points.

8 For the rolling Granger causality test, Cooke and Robles (2009) use the first 30 months available in their sample (January 2002-June2004) and test for Granger causality. Then they roll the sample period one month ahead and redo the Granger causality tests. Their models include past prices and a variation of exogenous variables, i.e. exchange rate, monetary aggregate real M2 as proxy for world real aggregate expenditure, grains exports, fertilizer prices, oil prices and ethanol and biodiesel production, as well as financialisation variables, i.e. monthly volume of traded contracts, open interest, volume to open interest ratio and the non-commercial long and short positions to total trade ratio.

3.3. Effect on commodity price volatility

Argumentations based on the EMH suggest that speculators, which are assumed to buy when the price is low and sell when it is high, have a stabilizing effect as they smooth prices and reduce volatility (Algieri 2012, reference to Friedman 1953). On the other hand, arguments related to the noise trader or bull-and-bear hypothesis suggest that an increased participation of speculators may have a destabilizing effect (Algieri 2012). Price volatility may particularly be exacerbated by traders employing trend-following strategies, where rising prices encourage buying and falling prices encourage selling (Baumeister/Peersman 2011).

The evidence, whether current levels of commodity price volatility are unusual compared to the past and whether volatility was affected by financial investors, is mixed. Comparing price volatility in individual decades, Gilbert and Morgan (2010) suggest that agricultural price volatility has been lower in the most recent two decades, than in the 1970s and 1980s, expect for rice. Balcombe (2009) fails to find a general increase in volatility. OECD (2011) suggests that price volatility in 2006-10 was higher than in the 1990s, but not higher than in the 1970s, except for wheat and rice (Huchet-Bourdon 2011; OECD 2011). Algieri (2012), assessing annualized volatility for 3-year periods, finds that for 2006-09 the volatility is highest compared to previous periods for all commodities.

The majority of empirical evidence finds that financialisation has not increased volatility. Brunetti et al. (2011) and Brunetti and Büyükşahin (2009) employ Granger causality test between daily realized volatility net traders' positions from the CFTC's Large Trader Reporting System . Swap dealers and money managers reduce volatility, also contemporaneous market volatility, and seem to reduce the overall risk in these futures markets. Von Braun and Tadesse (2012) conduct OLS regressions to estimate the effect of volume of futures trade on the total realized volatility (percentage of annual standard deviation from the long term average price), but find no significant effect for the analyzed agricultural commodities. Irwin and Sanders (2010) suggest that larger long positions by index traders lead to lower market volatility, which might, however, be caused by a third variable. Irwin and Sanders (2012) suggest that there is no causal link between ETF positions and volatility in crude oil and gas futures. Bastianin et al. (2012), using the Working's excessive speculative index and conditional volatility for energy and non-energy commodities for the period 1986-2010 does not find an influence of excessive speculation on volatility except for oil. Finally, also Gilbert (2012), employing a conditional volatility modeling approach, fails to find consistent impacts of financialisation, i.e. index positions and money managers' positions on grain price volatility. Similarly, Bohl et al. (2012) and Bohl and Stephan (2012) employ conditional volatility approach and a stochastic volatility model and conclude that increasing financialisation and index investors' positions have not led to more volatile commodity prices.

In contrast, Algieri (2012) and McPhail et al. (2012) employ Granger causality tests to identify a lead-lag relationship between Working's excessive speculative index and price volatility. The index is found to drive price volatility for maize, rice, soybeans and wheat for selected time periods for 1995-2012. Borin and Di Nino (2012) and Doroudian and Vercammen (2012) find that swap dealers' investment seems to amplify price volatility in some markets. Balcombe (2009) also finds that volatility is transmitted across agricultural commodities, and in particular oil price volatility has an effect on agricultural price volatility. Dwyer et al. (2011) stress the role of speculation in explaining volatility in the short run.

3.4. Critical remarks

Overall, the evidence put forward by empirical analyses is not conclusive. This can be explained by various factors:

The difference in results can be related to different measurements for financialisation (e.g. net positions, total open positions, share of (non-)commercial long positions to total long positions, volume of traded contracts, speculation indices). A statistically significant effect of financial speculators on commodity prices is found by a range of studies which employ less frequently used measures of financialisation such as volume of traded contracts, total open interest, share of (non-) commercial long positions to total long positions, and a calculated index to approximate index positions (Cooke/Robles 2009; Gilbert 2010a; Gilbert 2010b; Henderson et al. 2012; Robles et al. 2009). The majority of studies using (changes in) traders' net long positions in their analyses find no impact. It should be noted however that even those studies which generally reject the impact on prices, often confirm an impact for specific commodities in their sample (Capelle-Blancard/Coulibaly 2011; Hamilton/Wu 2012; Irwin/Sanders 2010; Sanders et al. 2009; Stoll/Whaley 2009). These differing results could lead to the follow-up question about the constitution of the microstructure of these commodity markets, and which specificities these markets exhibit that make a price-distorting impact of financial investors more likely. For instance, Gilbert and Pfuderer (2013) suggest that less liquid markets may be more prone to be distorted by traders' positions.

Further, data aggregation plays a role. Studies use largely weekly or monthly data. CFTC provides weekly data, but price impacts may happen in a shorter period of time. Within a weekly data set, but possibly also within a daily data set, financial investors' impacts on returns may show as contemporaneous correlations so that cause-effect relations cannot be disentangled by time series analysis (Granger 1980). Therefore, some studies suggest using cross-sectional regression models to test contemporaneous effects of traders' positions on commodity returns. For instance, Gilbert and Pfuderer (2012) or Mayer (2012) find strong contemporaneous positive correlation between index investors' positions and commodity returns. But clearly, causation could run either way, or could be caused by a third variable.

From a methodological viewpoint, there are several concerns related to time-series econometrics and Granger (non-)causality tests in particular (see also section 4.1.). Models may not have sufficient statistical power to reject the null hypothesis for relatively short time periods (Sanders/Irwin 2011, p. 530). In general the time interval for the analysis is rather short given that only from 2006 onwards CFTC data is disaggregated in commercial traders, swap dealers/index investors and money manager (see below). Traditional time series tests may also lack statistical power due to the large volatility of returns (Summers 1986, in Aulerich et al. 2012; Frenk 2010). Further, estimations are highly sensitive to the number of lags (Thornton/Batten 1985; Aaltonen/Östermark 1997; Singleton 2010; Frenk 2010).

Moreover, it is often suggested that Granger (non-)causality tests within a bivariate time series framework may suffer from omitted variable bias. This seems plausible as the possible effect of financial investors cannot be interpreted in opposition to fundamentally based effects on prices but in addition to them. Financialisation may have influenced some commodities beyond fundamentals although it may not have been the main driver (Dwyer et al. 2012). To consider these effects in a regression framework requires multivariate analyses, including the effects of fundamental and macroeconomic factors in addition to financialisation variables.

Finally, most of the reviewed studies focus on the question whether index investors affect commodity prices. They provide little evidence of the effect of other financial investors, most importantly money managers, that may act upon other than fundamental, commodity related information and may distort markets (Bicchetti/Maystre 2012; Büyükşahin/Robe 2012; Mayer 2012; UNCTAD 2011). Their increased presence on commodity derivative markets and more active trading strategies are hardly investigated.

4. Empirical methods, models and data description

In light of the discussion in section 3, we investigate commodity price developments applying two approaches: a bivariate VAR and Granger (non-)causality tests, using weekly data, and a multivariate VAR and impulse response analyses, using monthly data. The methods, models estimated and data used are discussed in this section.

4.1. Vector Autoregressive Models (VAR)

A VAR is an n-equation, n-variable linear model in which each variable is in turn explained by its own lagged values plus current and past values of the remaining n-1 variables. There is hence one equation for each variable. Usually, the results of VARs are reported by *Granger causality tests*, *impulse response functions* and *forecast error variance decomposition*. These statistics are generally more informative than the VAR regression coefficients. A reduced form VAR model[9] of order p, VAR(p), without exogenous variables typically takes the form:

$$y_t = \mu + \mathrm{A}_1 y_{t-1} + \cdots + \mathrm{A}_p y_{t-p} + u_t \qquad \text{(Eq. 1)}$$

where $y_t = (y_{1t}, y_{2t}, \dots, y_{kt})'$, is a (Kx1) random vector, A_i are fixed (KxK) coefficient matrices, and $\mu = (\mu_1, \dots., \mu_K)'$ is a fixed (Kx1) vector of intercept terms. $u_t = (u_{1t}, \dots, u_{kt})'$ is a K-dimensional white noise or innovation process, with $E(u_t) = 0$, $E(u_t u_t') = \Sigma_u$, and $E(u_t u_s) = 0$ for $s \neq t$. Often assumptions regarding u_t are made which determine the process y_t. An important assumption is that u_t is Gaussian white noise, in which case, y_t is a Gaussian process, i.e. subcollections $y_t, \dots\ y_{t+h}$, have multivariate normal distributions for all t and h (Lütkepohl 2005). For a bivariate VAR(2) the model equation takes the form:

$$\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \begin{pmatrix} a_{11}^1 & a_{12}^1 \\ a_{21}^1 & a_{22}^1 \end{pmatrix} \begin{pmatrix} y_{1t-1} \\ y_{2t-1} \end{pmatrix} + \begin{pmatrix} a_{11}^2 & a_{12}^2 \\ a_{21}^2 & a_{22}^2 \end{pmatrix} \begin{pmatrix} y_{1t-2} \\ y_{2t-2} \end{pmatrix} + \begin{pmatrix} u_{1t} \\ u_{2t} \end{pmatrix} \qquad \text{(Eq.2a)}$$

or:

$$\begin{aligned} y_{1t} &= \mu_1 + a_{11}^1 y_{1t-1} + a_{12}^1 y_{2t-1} + a_{11}^2 y_{1t-2} + + a_{22}^2 y_{2t-2} + u_{1t} \\ y_{2t} &= \mu_2 + a_{21}^1 y_{1t-1} + a_{22}^1 y_{1t-1} + a_{21}^2 y_{1t-1} + a_{22}^2 y_{2t-2} + u_{2t} \end{aligned} \qquad \text{(Eq. 2b)}$$

Before estimating a VAR(p) a number of assumptions have to be fulfilled. A stable VAR needs to be stationary, i.e. the first and second moments are time invariant: $\mathrm{E}(y_t) = \mu \ \ \forall\, t$, and $\mathrm{var}(y_t) = \sigma^2\ \forall t$ (Lütkepohl 2005), as otherwise implausible relationships may be identified (Lütkepohl 2005; Zapata et al. 1988; Ziemer/Collins 1984). For economic variables these conditions often do not apply. To test for stationarity, several unit root tests are available but their power is known to be low. If the variables are found to have a unit root and reflect a non-stationary process, they can be transformed by taking the first difference which however changes the interpretation of the model. Further, the time series are not allowed to be cointegrated. For cointegration several tests, for instance from Johansen (1992, 1988), are available which however often do not provide reliable estimates for relatively small samples sizes which are typical for economic time series

9 VARs are distinguished in reduced, recursive and structural VARs. A *reduced VAR* has no contemporaneous effects and does not show mutual interactions within one time period. A reduced VAR expresses each variable as a linear function of its own past values, past values of all other variables and a serially uncorrelated errors term. Equations are estimated by OLS in which the number of lags is determined using standard information criteria . However, if the variables are correlated, then error terms will also be correlated across equations. In a *recursive VAR*, the error terms are constructed to be uncorrelated with the error in the preceding equations by including contemporaneous values as regressors. Estimation by OLS produces uncorrelated residuals across equations. The estimation results will depend on the order of variables. There are n! recursive VARs representing all possible orderings. A *structural VAR* requires identification assumptions, which allow correlations to be interpreted causally. This can involve the entire VAR or just a single equation. This produces instrumental variables that permit the contemporaneous link to be estimated with instrumental variables regression (Stock/Watson 2001).

(Toda/Yamamoto 1995). If the time series are cointegrated, a Vector Error Correction model has to be used instead of a VAR.

It is crucial to choose the right lag order of the variables. If p is chosen too large, the forecast precision of the VAR(p) model will suffer. Also the estimation precision of the impulse response depends on the precision of the parameter estimates (Lütkepohl 2005). There are four information criteria which can be used to choose the right lag order: Final Prediction Error criterion (FPE), Akaike Information Criterion (AIC) (Akaike 1973), Hannan-Quinn criterion (HQ) (Hannan/Quinn 1979) and Schwarz information criterion (SIC) (Schwarz 1978).[10] When the lag order is selected, the white noise assumptions of the residuals need to be tested where a Lagrange-Multiplier test for residual correlation, often referred to as Breusch-Godfrey test, can be employed (Lütkepohl 2005). Finally, a test for structural breaks allows identifying whether changes have occurred in specific points in time, by comparing the estimated parameters before and after the possible break date (Lütkepohl 2005).

Granger (non-)causality test, typically used in a VAR model framework, are a standard analysis techniques for determining whether one time series is useful in forecasting another (Granger 1969). The main idea is that cause cannot come after the effect and hence the question, whether knowledge of the past history of a variable helps to improve forecasting an effect, i.e. another variable, is central. The term causality is used in a statistical sense. Considering equation 2a, if a variable y_1, e.g. traders' net positions, affects the variable y_2, e.g. commodity prices, then y_1 should help to improve the predictions of y_2, assuming that all relevant information available up to period t are considered in the model. If y_2 can be predicted more efficiently when information about y_1 is taken into account, then y_1 is said to Granger-cause y_2. y_2 is not Granger-caused by y_1 if and only if $a_{12}^{i} = 0$ for $i = 1, \dots, p$ (Lütkepohl 2005). The information sets can contain more variables than those for which the causal link is established. If y_{2t} is found to cause y_{1t} and vice versa, instantaneous causality is given. This describes a non-zero correlation between two sets of variables, but does not say anything about cause and effect. Finally, it has to be kept in mind that the causality is based on an estimated VAR and not on a known system. Granger causality tests can simply be seen as a statistical tool, which shows that a set of variables contains useful information for improving the prediction of another set of variables (Lütkepohl 2005).

There are several sources of sensitivity when employing Granger causality tests that are relevant for our estimations (see Grosche 2012 for a comprehensive overview). First, if the temporal aggregation is too coarse, a potentially present lead-lag relationship may remain undiscovered or could be manifested as instantaneous causality (Granger 1980). When contemporaneous effects are included in a regression framework, a lead-lag relationship between the variables remains unidentified. Second, Granger causality tests may lack the statistical power necessary to reject the null hypothesis for relatively short time periods and if variables are too volatile (Sanders/Irwin 2011; Irwin 2013). Third, time series models are highly sensitive to the selected number of appropriate lags (Aaltonen/Östermark 1997; Thornton/Batten 1985). Finally, omitted variable bias is a crucial issue, in particular in a bivariate VAR. The omission of relevant variables in the information set can lead to spurious or wrong feedback relations and results. Lütkepohl (1982) even concludes that there are serious doubts regarding the reliability of a bivariate framework for testing Granger causality of economic variables (Grosche 2012; Lütkepohl 1982).

It is often interesting to know the response of one variable to an impulse in another variable in a system which involves a number of variables. If an impulse response is given, a causal relationship between the variables in question can be established (Lütkepohl 2005). Impulse response describes the response of current and future values of each variable to a one-unit increase in the current value of one of the VAR errors based on the assumption that the error returns to zero in the subsequent periods and that all other errors are equal to zero (Stock/Watson

[10] FPE and AIC asymptotically choose the correct order almost with probability one if the underlying series has a large dimension K and are designed to minimize the forecast errors; HQ and SBC are both consistent and strongly consistent. In small samples AIC and FPE may have better properties and choose the correct order more often than HC and SIC. Large and small samples models based on AIC and FPE may produce superior forecasts even though they may not estimate the orders correctly (Lütkepohl 2005).

2001). If the variables have different scales, it is useful to consider changes in standard deviation rather than a unit increase. If the impulse response is zero, i.e. if a change in variable k has no effect on the other variables, the former variable does not Granger-cause the set of remaining variables (Lütkepohl 2005).

4.2. Model description

The multivariate VAR model includes four endogenous variables on a monthly basis which are suggested to explain each others' development: real prices of the respective commodity; production data for oil and export quantities of a range of important exporting countries for cotton, coffee and wheat to proxy global commodity supply; an index for global industrial production to proxy commodity demand; and net long positions of money managers or swap dealers/index investors of the respective commodity. Four exogenous variables, which are suggested to have an effect on the development of the endogenous variables, and in particular on commodity price returns, are included in the model: the US real interest rate, the US real effective exchange rate (REER), a stock market index, i.e. the S&P 500 index, and the real oil price (in the case of all commodities but oil) (see Appendix A for an overview of data sources). The vector of variables estimated in the VAR can be therefore summarized as

$$y' = (iprod, ex, nlp, rp),$$

where *iprod, ex, nlp* and *rp* are global industrial production, commodity production/exports, net long positions of money managers or swap dealers/index investors and real commodity prices. All variables except traders' positions are taken in logarithms to eliminate their exponential trend.

Concerning endogenous variables, commodity production or the volume of commodity exports is included into the model to control for the effect of global commodity supply on commodity prices. For oil, monthly production data is available; for cotton, coffee and wheat, we use monthly commodity exports of the largest exporters as a supply proxy as monthly production and inventory data is not publicly available. We expect the export quantities to inversely affect commodity prices. For instance, the effect of national export restrictions which were imposed on several grains exports during the food crises in 2008 is suggested to have increased commodity prices. A limitation of this proxy is however that the variable may also pick up demand pressure in international markets, suggesting that increasing exports reflect higher demand and cause therefore higher prices (Cooke/Robles 2009). As a measure for the demand side, we use a global industrial production index which measures global real production output. We expect a positive effect on commodity prices as commodity demand is assumed to increase with global economic production. Traders' and particularly financial investors' net long positions, i.e. traders' long positions minus traders' short positions, in commodity futures are included to approximate financialisation of commodity derivative markets. Traders' net long positions capture the net effect of different trading classes and represent the buying or selling pressure of a group of traders that can have a positive (net long) or a negative (net short) impact[11]. This financialisation variable takes into account that traders can push prices up and down (Schulmeister 2009, 2012). We assume, while controlling for other relevant variables, a positive effect of the size of traders' net long positions on commodity prices. Compared to analyses which assess the effect of changes in traders' net long positions, we use total net long positions in the monthly analysis, suggesting that not a monthly change in positions but the total value of net long positions affect commodity prices.

[11] The sum of demand for and supply of futures, i.e. long and short positions is always zero. Hence, each trader that sells futures (short positions) needs another trader that buys futures (long positions). Hence, a larger share of market participants or a higher trading volume has no clear effect on prices. What is more interesting is the net positions of certain types of traders. If the positions cannot be bought or sold at current prices, it can lead to increasing or declining prices to be able to find a partner for the contract. Clearly, the extent of this pressure also depends on the price-sensitiveness of the respective trading strategies.

Concerning exogenous variables, we expect oil prices to have a positive effect on commodity prices, as higher oil prices increase production and transportation cost.[12] We assume that a decline in the US interest rate has a positive effect on commodity prices. We use the US REER to analyze whether the dollar depreciation can explain price movements as many commodities are priced in US dollars. Commodity prices typically follow an inverse relationship with the value of the US dollar: when the value of the dollar declines the price of commodities usually rises (IMF 2012). In accordance with the literature on the co-movement between commodity and financial asset prices, we also include a stock market index, the S&P 500 index. The correlation could be negative when commodity investment is seen as a way to diversify investment portfolios or positive when commodity investments follow similar trading strategies than other financial investments. As discussed above, recent literature found an increasing co-movement and declining diversification benefits of commodity investments (Basu/Gavin 2011; Gorton/Rouwen-horst 2006).

Monthly data may be too coarse to capture the effect of traders' net long positions on commodity prices. Thus, we also use weekly positions and commodity prices and perform Granger (non-) causality tests within a bivariate VAR framework (as fundamental data is only available on a monthly basis). Similar to the above cited literature, we investigate the effect of changes in net long positions of financial investors on commodity price returns, as well as the effect of returns on changes in net long positions. We thus estimate the model

$$y' = (\Delta nlp, \Delta p)$$

where Δnlp are changes in traders' net long positions and Δp the nominal weekly commodity returns. Weekly commodity returns are taken in logarithm to eliminate their exponential trend.

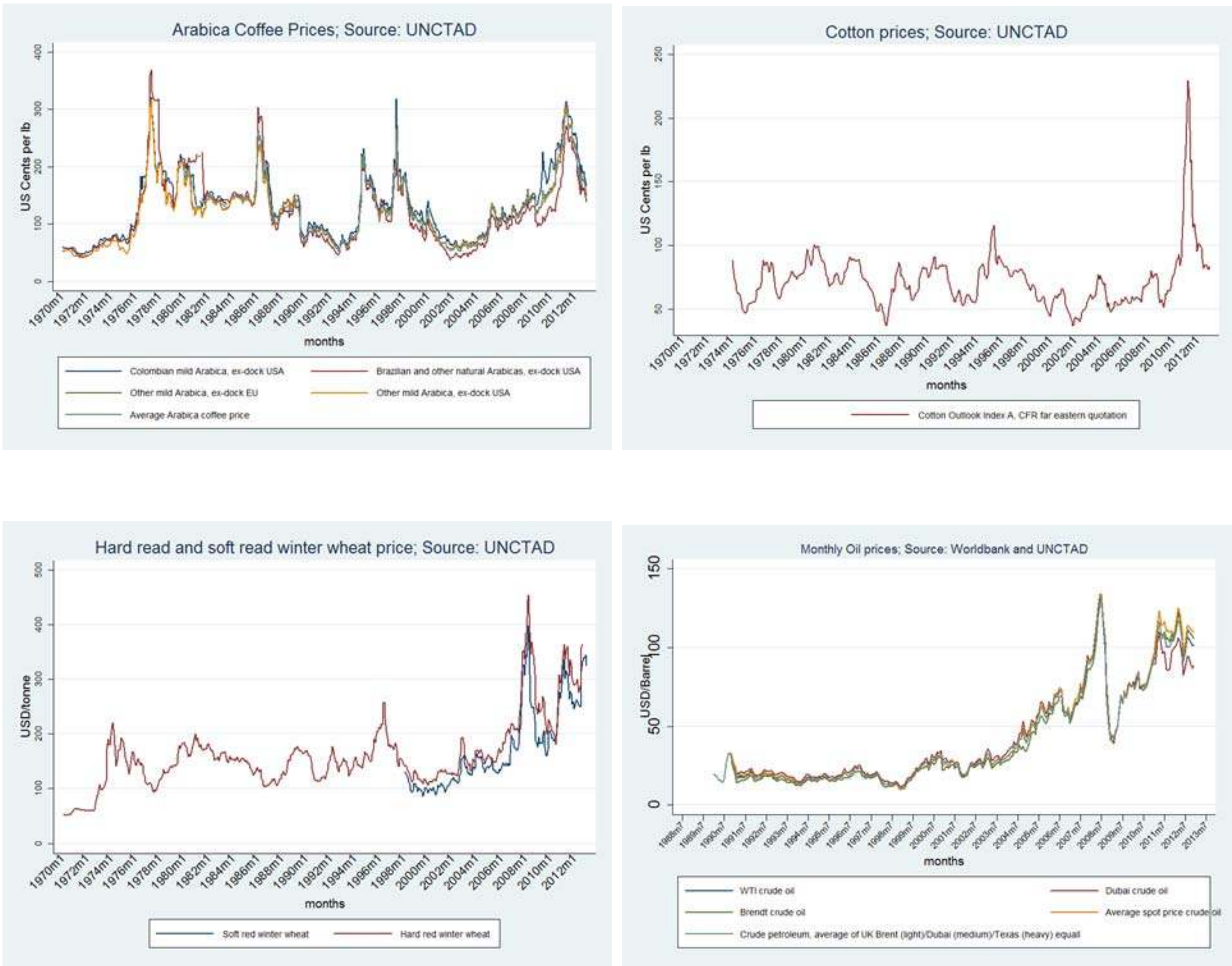
4.3. Data description

Data sources, scales, units and computation as well as a summary statistics of all relevant variables are available in Appendix A and B. Figure 1 presents price developments for our focus commodities. For Arabica coffee, we calculate the average of the price of Colombian, Brazilian and other natural and other mild Arabica coffees ex-dock US and ex-dock EU (UNCTADStat 2012). Arabica prices reflect a cyclical movement, with price peaks in the 1970s, 1980s, 1990s, and in 2010. Arabica coffee prices have increased from 2004 onwards until mid-2011, before they started to decline drastically. In contrast, the prices of HRW wheat (FAO 2012; UNCTADStat 2012) and SRW wheat (FAO 2012) experienced a gradual increase from 2000 onwards, a drastic hike in 2007/08 and a sharp decline thereafter, and started to pick up again in 2011 reaching new peaks in mid-2011 and -2012. The Cotton Outlook A Index (UNCTADStat 2012) shows low levels in the 2000s with a sharp price hike only in 2010 and a sharp decline in mid-2011. In 2008, cotton prices remained relatively low compared to other commodities.[13] The price of crude petroleum developed quite similarly to wheat prices. The decade-long close price movements of Brent, WTI and Dubai crude petroleum (IEA 2013) start to diverge in mid-2011. For the period 2007 to 2012, the average commodity price level is approximately 50 % higher for all commodities than during the period 2000 to 2006.

[12] But the oil price may also have an effect on the commodity demand side. Oil prices might reflect the effect of increasing GDP growth on commodity prices. Higher economic activity, as reflected by higher oil prices, might increase demand for commodities leading to price increases (Benes et al. 2012).

[13] However, the monthly price series does not reveal a notable increase in weekly price data of the Cotton Outlook A Index in 2008. Within the first week of March 2008, the cotton futures price increased sharply and was even locked limit-up at 84.86 cent/pound, but it declined again in the same week (CFTC 2010).

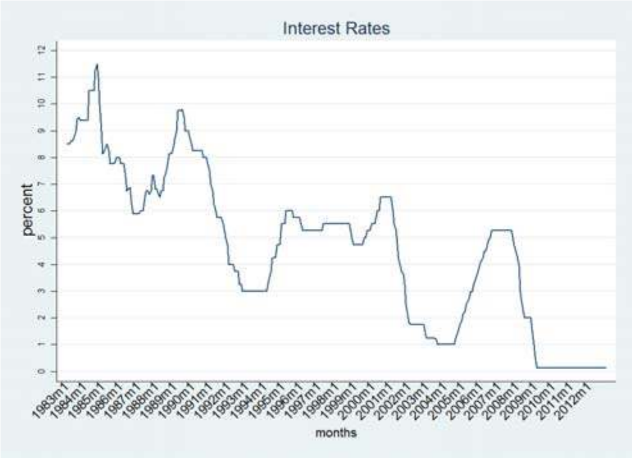
Figure 1: Monthly commodity prices



Source: UNCTADStat(2012).

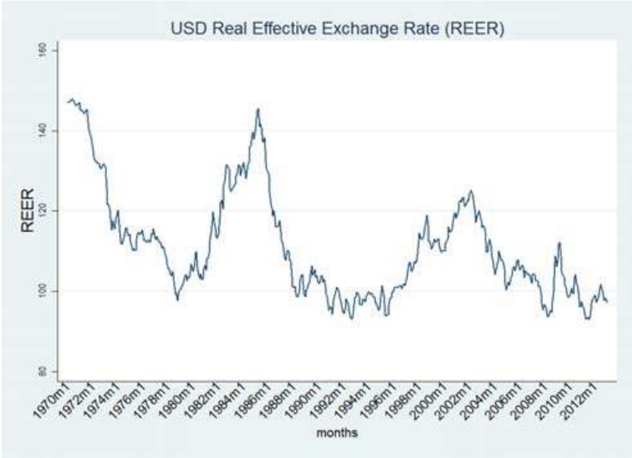
Figures 2 to 6 show the development of macroeconomic and fundamental variables. The first two figures show the declining US interest rate and US REER (which is a weighted average of the US dollar (USD) relative to a basket of (in our case 27) major currencies adjusted to inflation). The latter two show the global industrial production index and the S&P 500 stock market index. Regarding supply data, monthly global supply data is available for oil from the International Energy Agency (IEA 2013). The monthly volume of cotton exports reflects the sum of US cotton Upland and US cotton Am Pima exports, the neither carded nor combed (NCNC) cotton exports from the EU-27, Brazilian NCNC cotton exports, and cotton export volumes from India and Australia. For coffee, we obtained monthly total coffee export data (Arabica and Robusta) from the International Coffee Organization (ICO) upon request. Monthly wheat exports consist of exports from the EU-27, the US and Canada. Figure 6 shows the aggregated monthly export volumes for cotton, coffee and wheat (see Appendix B for the monthly export volumes in relation to annual export volumes and production).

Figure 2: US interest rate



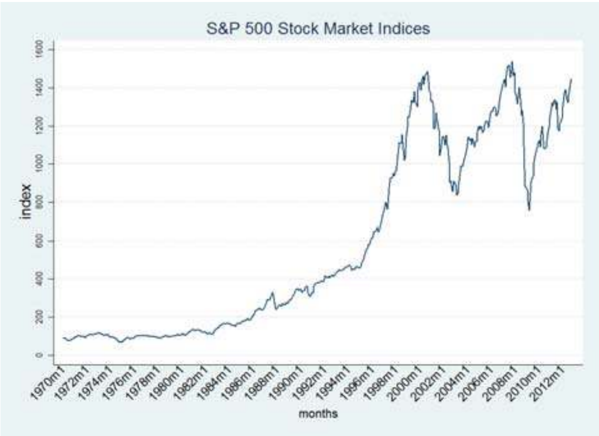
Source: FRED (2012).

Figure 3: US REER



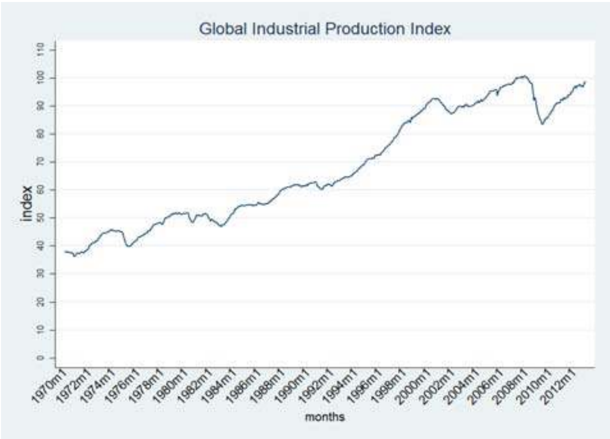
Source: BIS (2012).

Figure 4: Stock market indices



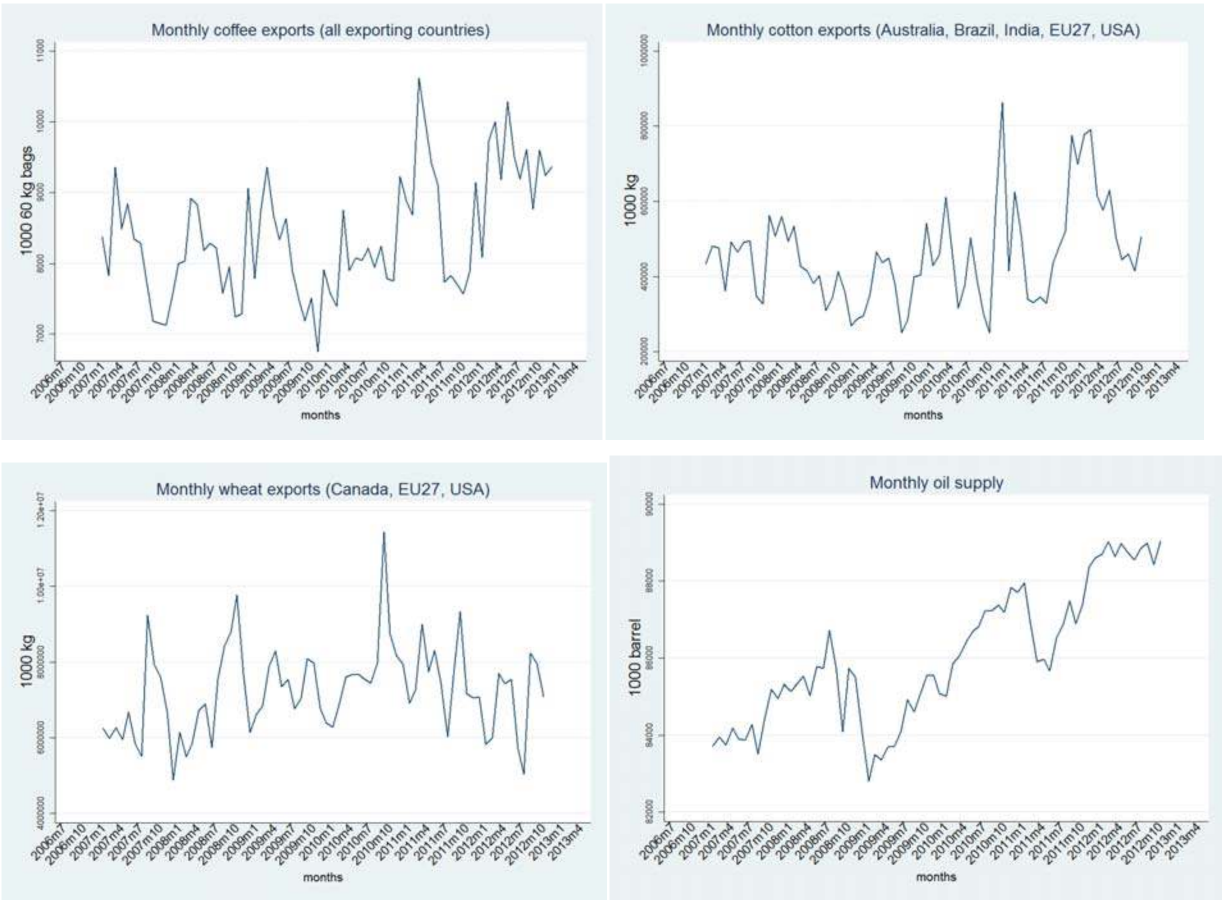
Source: Wikiposit (2012).

Figure 5: Global industrial production index



Source: FRED (2012)

Figure 6: Monthly commodity exports of the largest exporting countries



Source: Coffee: ICO; cotton: AliceWeb (2012), CANSIM (2012), Eurostat (2012), USDA (2012), ICAC; wheat: CANSIM (2012), Eurostat (2012), USDA (2012); oil: IEA (2012).

The most important source of information on trading activities in commodity futures markets is the CFTC, which publishes each Friday data on Tuesday's open interest on US futures markets. The open interest[14] for a given market is aggregated across all contract expiration months in the Commitment of Traders (COT) report. We use the Disaggregated Commitments of Traders (DCOT) report that contains data for twelve agricultural commodity markets and a number of energy and metals futures markets since June 2006. For the analysis based on weekly data, we use Tuesday's traders' net positions and the according average weekly commodity prices. In the multivariate model based on monthly data, we use the average monthly traders' net positions and the according average monthly commodity prices. We use time series from June 2006 to October 2012 for all commodities except Brent crude oil for which the time series is only available from April 2008 onwards (CFTC 2012). As the weekly data series for Brent crude oil contains however several missing values, the analysis is only conducted for monthly data.[15] The traders' categories include swap dealers, managed money, processors and merchants (commercial traders), other and non-reporting traders.[16] The CFTC reports are subject to limitations. First, traders may belong

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[14] Open interest describes the total number of futures contracts long, i.e. purchased contracts outstanding, or short, i.e. sold contracts outstanding, for a given commodity in a delivery months or market that has been entered into but has not yet been liquidated by an offsetting transaction or fulfilled by delivery. The open interest position which is reported each day represents the increase or decrease in the number of contracts on that day. Open interest will increase by one contract if one new buyer and none new seller are initiating a new position. Increasing open interest means that new money is flowing into the market.

[15] Hence, for some months the average is only based on fewer than four or five weeks. Additionally, for two months data is missing.

[16] CFTC classifies "a 'producer/merchant/processor/user' as an entity that predominantly engages in the production, processing, packing or handling of a physical commodity and uses the futures markets to manage or hedge risks associated with those activities. A 'swap dealer' is an entity that deals primarily in swaps for a commodity and uses the futures markets to manage or hedge the risk associated with those swaps transactions. The swap dealer's counterparties may be speculative traders, like hedge

to more than one category given their different business lines and trading strategies. CFTC counts however all positions of one trader in one trader class based on their main activity (Tang/Xiong 2010). Traders' categories can be reclassified by CFTC. But the problem is that CFTC classifies traders and not trading activities, meaning that they can't know with certainty that for example commercial traders are only hedging or other classes of traders only pursue trading strategies related to their classification (CFTC 2013a). Second, disaggregated data is not available prior to 2006, and thus lacks those years in which the proportion of index investment started to increase significantly. Third and more specifically, index activity is not specifically defined by the CFTC but proxied by swap dealers so that there could be some inconsistencies across reporting entities (CFTC 2013b). While in agriculture markets the swap dealer category corresponds well with index investors the swap dealers in energy markets also conduct a substantial amount of non-index swap transactions.[17]

Table 1 and 2 shows the annual average position of trader groups in long and short futures contracts, respectively. For coffee, cotton, SRW wheat and WTI and Brent crude oil, swap dealers hold the highest share of long positions. But their share seems to decline towards 2012, except for WTI and Brent crude oil. The average share held by money managers seems to increase from 2006-12 for coffee, cotton and SRW. For coffee, cotton and SRW wheat, money managers are present on the long side of the futures market with a share of 15 to 30 %. For WTI and Brent crude oil, they constitute a slightly lower proportion of 8 to 24 %. For HRW wheat, the largest share fluctuates between commercial traders and money managers. Concerning short positions, for coffee, cotton, HRW and SRW wheat, the share is highest for producers and merchants, ranging between 46 % (SRW wheat in 2012) and 76 % (coffee in 2008), and, as expected, lowest for swap dealers, ranging between 0 and 9 %. Brent oil is an exception as swap dealers also hold important shares of short contracts, ranging from 37 to 59 %; also for WTI the share is on average higher than in agricultural markets ranging from 8 to 21 %.[18] Money managers hold 5-13 % of short contracts in HRW wheat, 12-25 % in SRW wheat, 9-29 % in cotton and coffee, with the latter being a similar share as in long futures contracts, and 4-37 % in Brent oil.

funds, or traditional commercial clients that are managing risk arising from their dealings in the physical commodity. A 'money manager' is a registered commodity trading advisor (CTA); a registered commodity pool operator (CPO); or an unregistered fund identified by CFTC. These traders are engaged in managing and conducting organized futures trading on behalf of clients. Every other reportable trader that is not placed into one of the other three categories is placed into the 'other reportables' category" (CFTC 2013a).

17 Further, positions data is aggregated across all future contract maturity months so that the market impact of index investors cannot be investigated during the roll period (Aulerich et al. 2012).

18 This is the case as in agriculture markets the DCOT swap dealer category corresponds well with index investors. However, swap dealers in energy markets conduct a substantial amount of non-index swap transactions. CFTC estimates that only 41 % of long swap dealer positions in crude oil futures on three dates in 2007 and 2008 are linked to long-only index fund positions. This generally questions using DCOT swap dealers as a proxy for index investors for crude oil and demands at least caution in interpreting results.

Table 1: Annual average positions of trader groups in long futures contracts (measured as the proportion of annual average total open interest in that market)

	Prod./ Merch	Swap dealers	Money managers	Other rep.	Non-rep	Prod./ Merch	Swap dealers	Money managers	Other rep	Non-rep
	Cotton, ICE					**Coffee, ICE**				
2006	17%	48%	15%	9%	11%	26%	30%	18%	15%	11%
2007	14%	44%	21%	10%	12%	26%	29%	25%	13%	8%
2008	16%	46%	19%	9%	10%	24%	39%	24%	8%	6%
2009	9%	50%	26%	4%	11%	25%	37%	23%	8%	8%
2010	19%	36%	30%	5%	10%	18%	37%	28%	9%	7%
2011	25%	31%	23%	10%	11%	27%	32%	27%	7%	7%
2012	18%	36%	22%	14%	10%	37%	27%	21%	9%	6%
	Hard red winter wheat, KCBT					**Soft red winter wheat, CBOT**				
2006	17%	19%	26%	15%	22%	18%	51%	17%	4%	10%
2007	22%	23%	26%	11%	18%	11%	51%	22%	5%	11%
2008	30%	19%	23%	9%	19%	8%	52%	24%	5%	11%
2009	26%	21%	23%	10%	19%	10%	51%	23%	5%	11%
2010	27%	21%	25%	12%	15%	14%	53%	17%	7%	10%
2011	26%	18%	29%	9%	17%	13%	51%	18%	7%	11%
2012	24%	26%	27%	7%	15%	10%	46%	27%	7%	10%
	Brent crude oil financial futures					**WTI crude oil financial futures**				
2006						14%	26%	10%	10%	41%
2007						21%	41%	18%	4%	16%
2008	8%	56%	8%	11%	16%	13%	44%	24%	5%	14%
2009	9%	42%	20%	6%	23%	17%	48%	24%	3%	9%
2010	15%	58%	8%	2%	17%	23%	52%	17%	1%	7%
2011	6%	58%	18%	1%	16%	18%	67%	8%	0%	7%
2012	12%	56%	14%	4%	14%	9%	69%	11%	2%	8%

Source: CFTC's Disaggregated Commitments of Traders (DCOT) report (CFTC 2012)

Note: We consider time series from June 2006 to October 2012; for Brent crude oil we consider time series from April 2008 to October 2012. The proportion is calculated as a trader category's long position divided by sum of all trader categories' long positions. Spread positions are not considered.

Table 2: Annual average positions of trader groups in short futures contracts (measured as the proportion of annual average total open interest in that market)

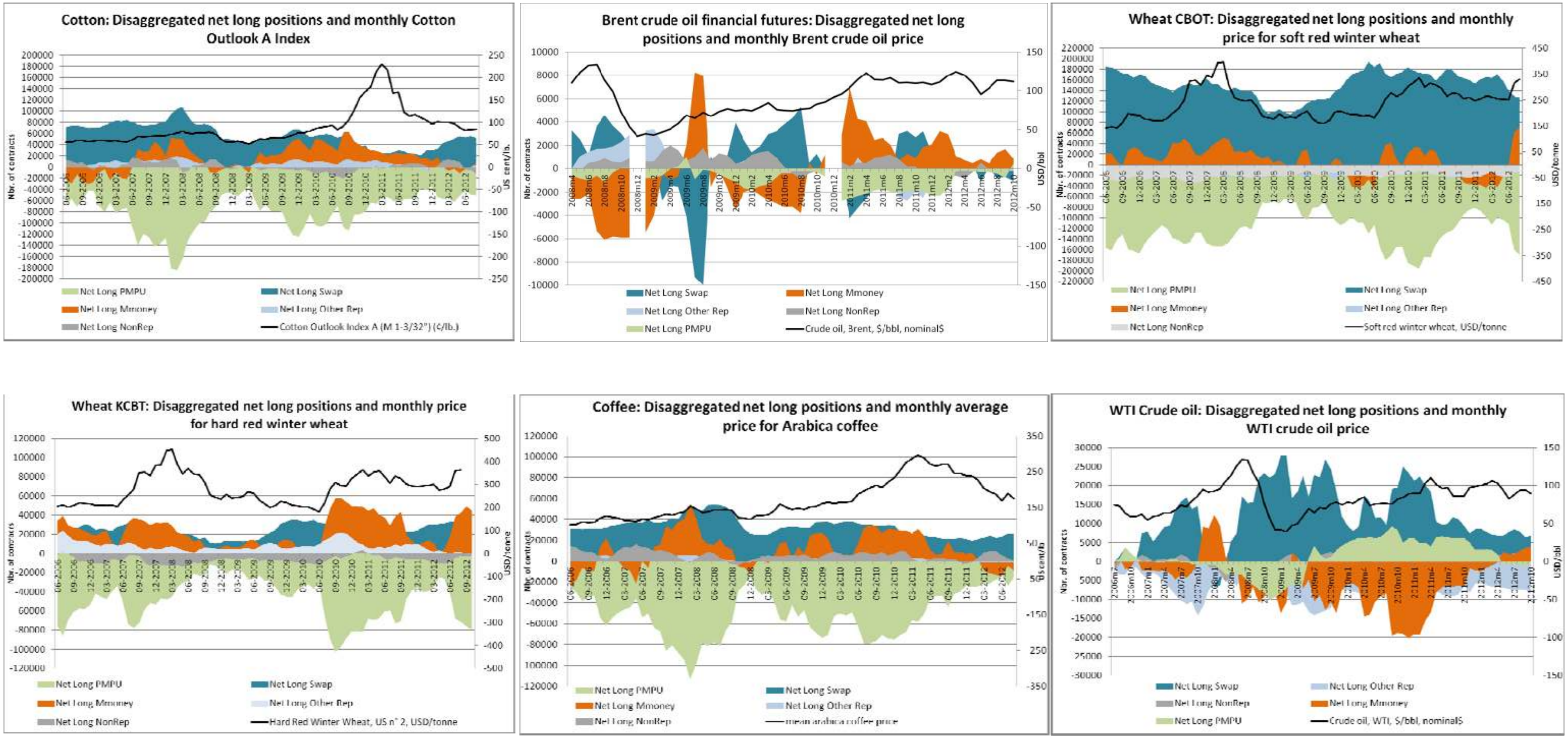
	Prod./ Merch	Swap dealers	Money managers	Other rep.	Non-rep	Prod./ Merch	Swap dealers	Money managers	Other rep.	Non-rep
	Cotton, ICE					**Coffee, ICE**				
2006	55%	1%	30%	5%	9%	64%	0%	23%	7%	7%
2007	69%	3%	16%	6%	6%	71%	1%	19%	5%	5%
2008	70%	7%	10%	7%	6%	76%	3%	10%	7%	4%
2009	69%	9%	9%	7%	7%	72%	7%	11%	3%	6%
2010	72%	7%	6%	10%	5%	75%	7%	10%	2%	6%
2011	62%	13%	8%	8%	9%	72%	8%	9%	4%	6%
2012	50%	6%	21%	14%	9%	55%	5%	27%	6%	7%
	Hard red winter wheat, KCBT					**Soft red winter wheat, CBOT**				
2006	68%	0%	4%	2%	26%	61%	2%	12%	8%	17%
2007	65%	0%	5%	4%	25%	52%	5%	15%	9%	19%
2008	60%	1%	5%	4%	30%	50%	5%	14%	13%	18%
2009	58%	0%	13%	3%	26%	43%	6%	22%	12%	18%
2010	67%	2%	8%	4%	19%	50%	6%	19%	9%	15%
2011	69%	3%	5%	4%	19%	51%	4%	18%	10%	16%
2012	64%	1%	9%	6%	20%	46%	5%	25%	10%	15%
	Brent crude oil financial					**WTI crude oil financial futures**				
2006						14%	8%	14%	14%	22%
2007						21%	21%	14%	20%	27%
2008	12%	37%	37%	0%	13%	13%	20%	29%	28%	12%
2009	11%	52%	20%	0%	16%	17%	19%	21%	34%	16%
2010	21%	40%	22%	2%	14%	23%	13%	30%	36%	12%
2011	17%	59%	4%	5%	14%	18%	7%	41%	26%	15%
2012	15%	57%	7%	5%	16%	9%	7%	50%	9%	20%

Source: CFTC's Disaggregated Commitments of Traders (DCOT) report (CFTC 2012)

Note: We consider time series from June 2006 to October 2012; for Brent crude oil we consider time series from April 2008 to October 2012. The proportion is calculated as a trader category's long position divided by sum of all trader categories' long positions. Spread positions are not considered.

In our analysis we use net long positions, i.e. traders' long positions minus traders' short positions, of trader classes, i.e. money managers, swap dealers and producers/merchants. These are presented in relation to monthly commodity prices in Figure 7. Net long positions are presented in a non-cumulative fashion so that the transition between positive and negative net long positions is better discernible. Unsurprisingly, net long positions of producers and merchants are negative, and of swap dealers positive for all commodities. Money managers take alternating, i.e. positive and negative net long positions, highlighting their active trading strategies. At first sight, the commodity prices seem to correlate most with money mangers' net long positions.

Figure 7: Net long positions and commodity prices



Source: CFTC's DCOT report (CFTC 2012) and UNCTADStat (2012)

Note: Own elaboration

5. Results

5.1. Bivariate VAR: weekly traders' net long positions and returns

Table 3 and 4 report the results of the bivariate Granger (non-)causality tests with weekly changes in net long positions and commodity returns. The models were estimated with an OLS estimator in STATA. We tested for unit roots using ADF tests without a trend but with a constant. We find changes in net long positions and commodity returns to be stationary. The adequate number of lags for the VAR model was chosen according to the AIC and FPE information criterion. We also tested the relation between commodity returns and total net long positions (not changes in net long positions), according to a testing procedure suggested by Toda and Yamamoto (1995) which provided similar results.[19] For each VAR model we perform a Lagrange Multiplier test for residual autocorrelation, and cannot reject the null hypothesis of no autocorrelation for all specified models.

We find that changes in net long positions of money managers can be used to predict commodity returns for coffee. Hence, in accordance with the "noise trader or bull-and-bear hypothesis" money managers' positions – regardless if they are based on fundamental information or not – move prices. Similarly, changes in producer and merchants' net long positions in coffee are found to drive commodity returns. For the remaining commodities neither changes in money managers' nor producers and merchants' net long positions seem to help predict commodity returns. Changes in index investors' positions also do not seem to be good predictors to forecast commodity returns. This confirms our observation that for the time period 2006-12 the share of index investors in total positions remained quite stable – quite contrary to the period 2002-06 and up to 2008 where their share increased strongly. On the other hand, we find weekly commodity returns seem to Granger-cause changes in money managers' net positions for coffee, HRW and SRW wheat; changes in producer and merchants' net positions for cotton, coffee and SRW wheat; and changes in swap dealers' positions for cotton. Similarly, previous research, suggests a tendency for returns to lead non-commercial traders' positions, concluding that this class of traders may utilize trend following strategies (Sanders et al. 2009; Büyükşahin/Harris 2009; Stoll/ Whaley 2009; Mayer 2012; Aulerich et al. 2012). Finally, we also investigate how changes in traders' net positions influence each other. Money managers tend to react most to other traders' positions which may additionally confirm their trend following behavior. Changes of money mangers' positions are affected by changes in producer and merchants' positions for coffee, SRW and HRW wheat and by swap dealers' positions for cotton. Money mangers' positions, in turn, only Granger-cause producers and merchants' positions for coffee and swap dealers' position positions for HRW wheat (see Appendix C).

[19] If the time series are integrated or cointegrated, Sims et al. (1990) found that conventional asymptotic theory is not applicable for hypothesis testing in levels. Therefore, Toda and Yamamoto (1995) suggest a testing procedure which is robust to the variables' integration and cointegration properties. With their procedure linear and non-linear restrictions on the VAR coefficients estimated in levels - and not differences - can be tested without focusing on the integration and cointegration properties of the time series. Granger (non-)causality tests are conducted by employing the Wald criterion (Toda/Yamamoto 1995). Also by employing this procedure we find that only for coffee, total net long positions of money managers and producers/merchants are found to Granger-cause commodity prices. However, the total net long positions of money managers in cotton, coffee, SRW and HRW wheat, as well as the index investors total net long positions of cotton and coffee, and the total net long positions of producers/merchants of cotton, coffee, SRW wheat and oil are found to be Granger-caused by commodity prices.

Table 3: Granger causality test results for the null hypothesis that changes in traders' net long positions do not lead commodity returns

	Trader category					
	Money Managers		Index Investors		Producers/ Merchants	
Market	Lag order p	p-value $a^i = 0 \;\; \forall i$	Lag order p	p-value $a^i = 0 \;\; \forall i$	Lag order p	p-value $a^i = 0 \;\; \forall i$
Cotton	1	0.815	1	0.960	1	0.663
Coffee	5	0.000**	2	0.136	3	0.000**
Wheat KCBT	1	0.511	1	0.249	1	0.172
Wheat CBOT	2	0.747	1	0.165	2	0.127
WTI crude oil	3	0.748	3	0.972	8	0.728

Source: own calculations.

Note: Granger causality is tested by Wald criterion. The lag order is determined by AIC and FPE criteria; *p* refers to the chosen lag order. a refers to the regression coefficient. For each commodity, Granger causality is tested under the null hypothesis that changes in traders' net long positions cannot be used to predict commodity returns, H_0: $a^i = 0 \;\; \forall$ i, where i represents the number of lags 1,..,p. Double (**) and single (*) asterisk denote statistical significance at the 1 % and 5 % level.

Table 4: Granger causality test results for the null hypothesis that commodity returns do not lead traders' net long positions

	Trader category					
	Money Managers		Index Investors		Producers/ Merchants	
Market	Lag order p	p-value $a^i = 0 \;\; \forall i$	Lag order p	p-value $a^i = 0 \;\; \forall i$	Lag order p	p-value $a^i = 0 \;\; \forall i$
Cotton	1	0.001**	1	0.021*	1	0.001**
Coffee	5	0.000**	2	0.070	3	0.000**
Wheat KCBT	1	0.035*	1	0.799	1	0.644
Wheat CBOT	2	0.005**	1	0.778	2	0.003**
WTI crude oil	3	0.556	3	0.959	8	0.131

Source: own calculations.

Note: Granger causality is tested by Wald criterion. The lag order is determined by AIC and FPE criteria; *p* refers to the chosen lag order. a refers to the regression coefficient. For each commodity, Granger causality is tested under the null hypothesis that commodity returns cannot be used to predict changes in traders' net long positions, H_0: $a^i = 0 \;\; \forall$ i, where i represents the number of lags 1,..,p. Double (**) and single (*) asterisk denote statistical significance at the 1 % and 5 % level.

5.2. Multivariate VAR: monthly fundamental, macro and financialisation variables and returns

For each commodity, we separately estimate a multivariate, reduced form VAR on a monthly basis with the four endogenous variables real prices, an index for global industrial production, commodity production/exports, and net long positions of money managers and swap dealers/index investors. All variables except traders' positions are taken in logarithms to eliminate their exponential trend. Unit root tests (ADF tests, without a trend, but usually with a constant) suggest that real prices, global industrial production and production/exports are integrated of order 1. Consequently we take the first differences of these variables; for real prices we therefore use real returns. The models were estimated in EViews.

In order to investigate the dynamics of the estimated model, we calculate impulse response functions which allow us to quantify the response to a shock in a certain variable. As we apply a Cholesky decomposition to the error terms to account for contemporaneous correlation, the ordering of the variables implies a certain economic logic. We assume global industrial production, which reflects commodity demand, to be the least endogenous variable of the system. It reflects global economic activity and is therefore likely to have a contemporaneous effect on all other variables. Furthermore, it is safe to assume that commodity production/exports, net long positions and real commodity prices do not have an effect on global industrial production in the same period.[20] Commodity supply, which is represented by production or exports, is assumed to have an impact on net long positions and real prices. The order of the last two variables is chosen according to the hypothesis that financialisation has a contemporaneous effect on real prices. The lag length of the estimated model was chosen according to the usual model selection criteria (FPE, AIC, SC and HQ). Most criteria suggest a lag of 1, which was consequently applied for all commodities. A constant term was included in the VAR.

The impulse responses of all variables are presented in Figures 8 to 13. Each column shows the responses of the four endogenous variables to a shock in a certain variable. The responses are represented in absolute deviations of the logarithmic variable, following a shock of one standard deviation of the error term of the shocked variable. The for our purpose most interesting impulse response graph is the reaction of real returns to a shock in net long positions.[21] The dynamic behavior of the model is fairly similar for all commodities, at least qualitatively. In contrast to the weekly, bivariate Granger tests, we find that all commodities exhibit a statistical significant response of real returns to a shock in net long positions of money managers for all commodities except WTI crude oil. The quantitative effect however varies to a certain extent. A positive impulse of net long positions of money managers is associated with an increase in real commodity returns. The responses of commodity prices to variations in net long positions are extraordinarily large. When we apply forecast error variance decompositions, we find that 50 % (coffee), 45 % (HRW wheat), 40 % (SRW wheat), 15 % (cotton) and 10 % (Brent crude oil) of the variations in real prices are explained by net long positions of money managers. This supports the hypothesis that money managers' positions can influence the behavior of commodity prices, in addition to fundamental and macroeconomic developments. The response fades after one month, which is fairly reasonable in the light of high-speed information-processing financial markets. A shock in net long positions has no significant impact on global industrial production and commodity production/exports. We estimated similar models with net long positions of swap dealers as a financialisation variable as well as with producers/merchants' positions. However, the results were insignificant for all commodities.

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[20] This is a reasonable assumption for all commodities except oil because oil prices usually have an impact on global economic activity. Nevertheless, this impact is unlikely to be observed within one or two months, and can therefore be discounted.

[21] The third column represents the responses to a shock in net long positions. The diagram in the last line within this column consequently is the reaction of real returns to this shock.

An interesting and somewhat puzzling result is that prices do not significantly respond to global industrial production or production/exports shocks. In the latter case, this may be explained by exports not only reflecting developments on the supply side but also on the demand side which might make them a weak (but still only available monthly) proxy for commodity supply. In the case of global industrial production however this is more surprising. Global demand is usually said to be a major factor for commodity price developments (IMF 2012). It is however a fairly broad measure of global economic activity and may therefore be not adequate to capture developments in the demand of specific commodities.

A shock in real prices positively affects net long positions of money managers only for coffee which may support their trend following behavior. For the other commodities, we find however no significant effect of a shock in real prices on money managers' net long positions and can hence not confirm trend following.

Figure 8: Impulse responses: Coffee

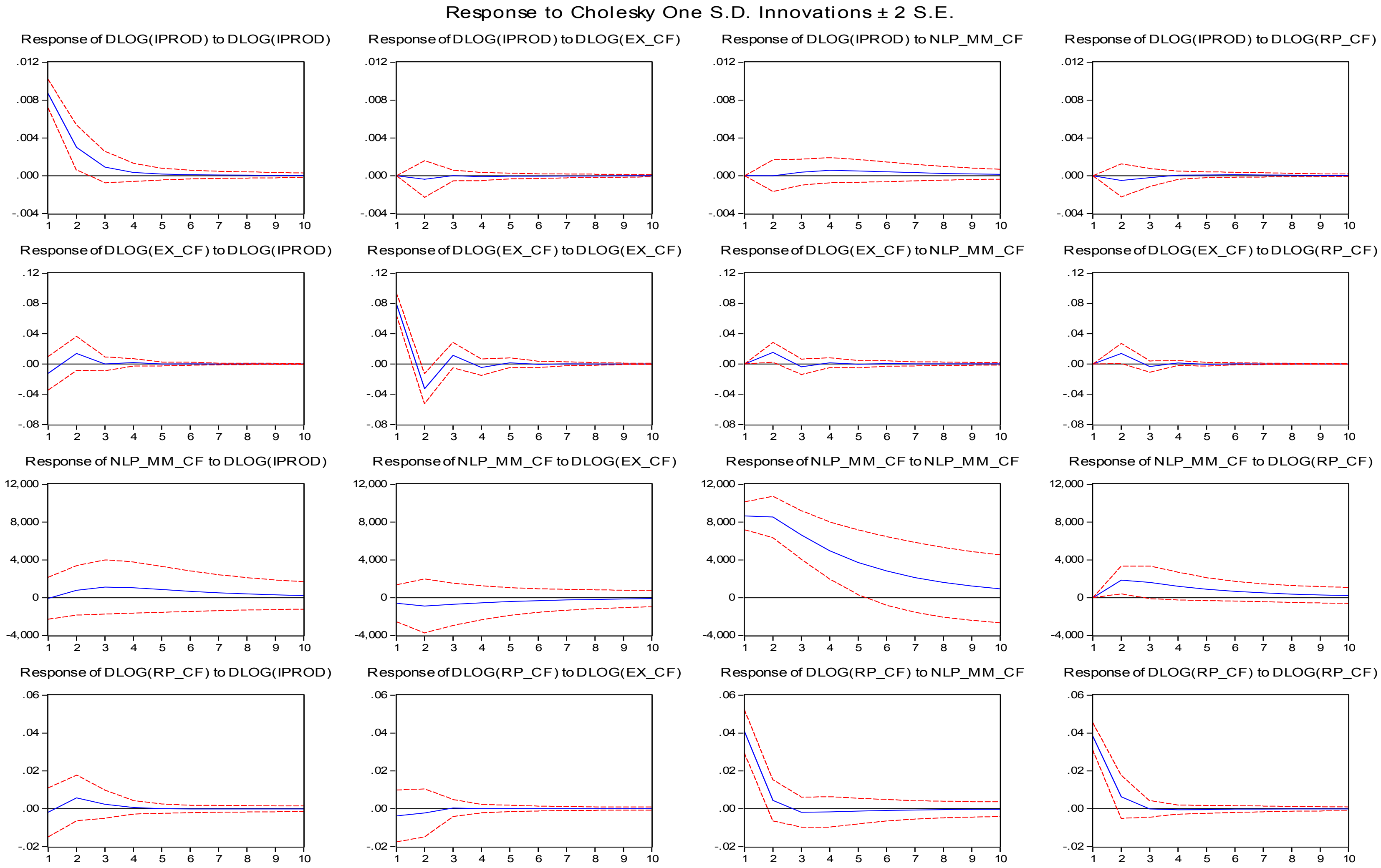


Figure 9: Impulse responses: Cotton

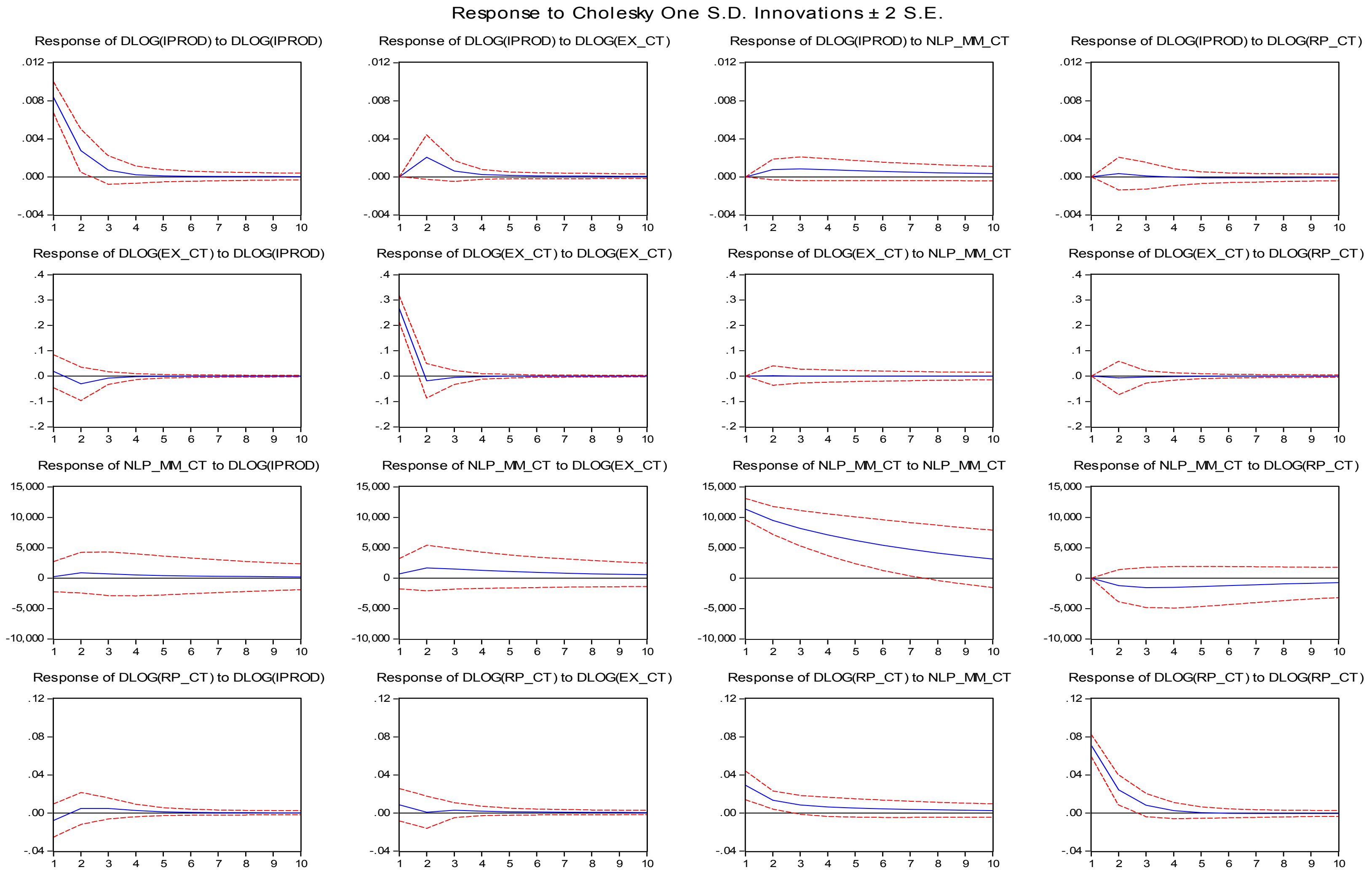


Figure 10: Impulse responses: SRW wheat

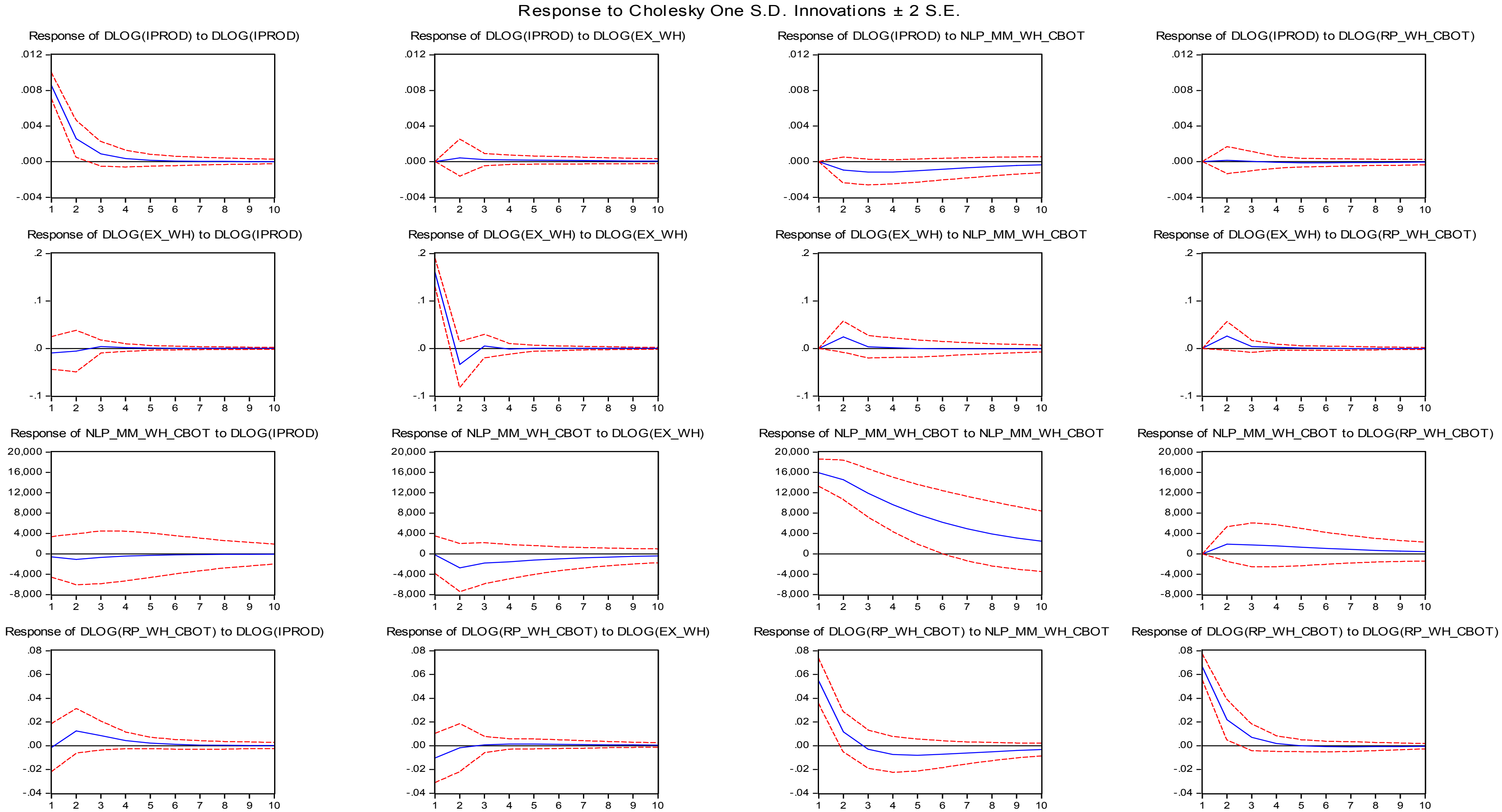


Figure 11: Impulse responses: HRW wheat

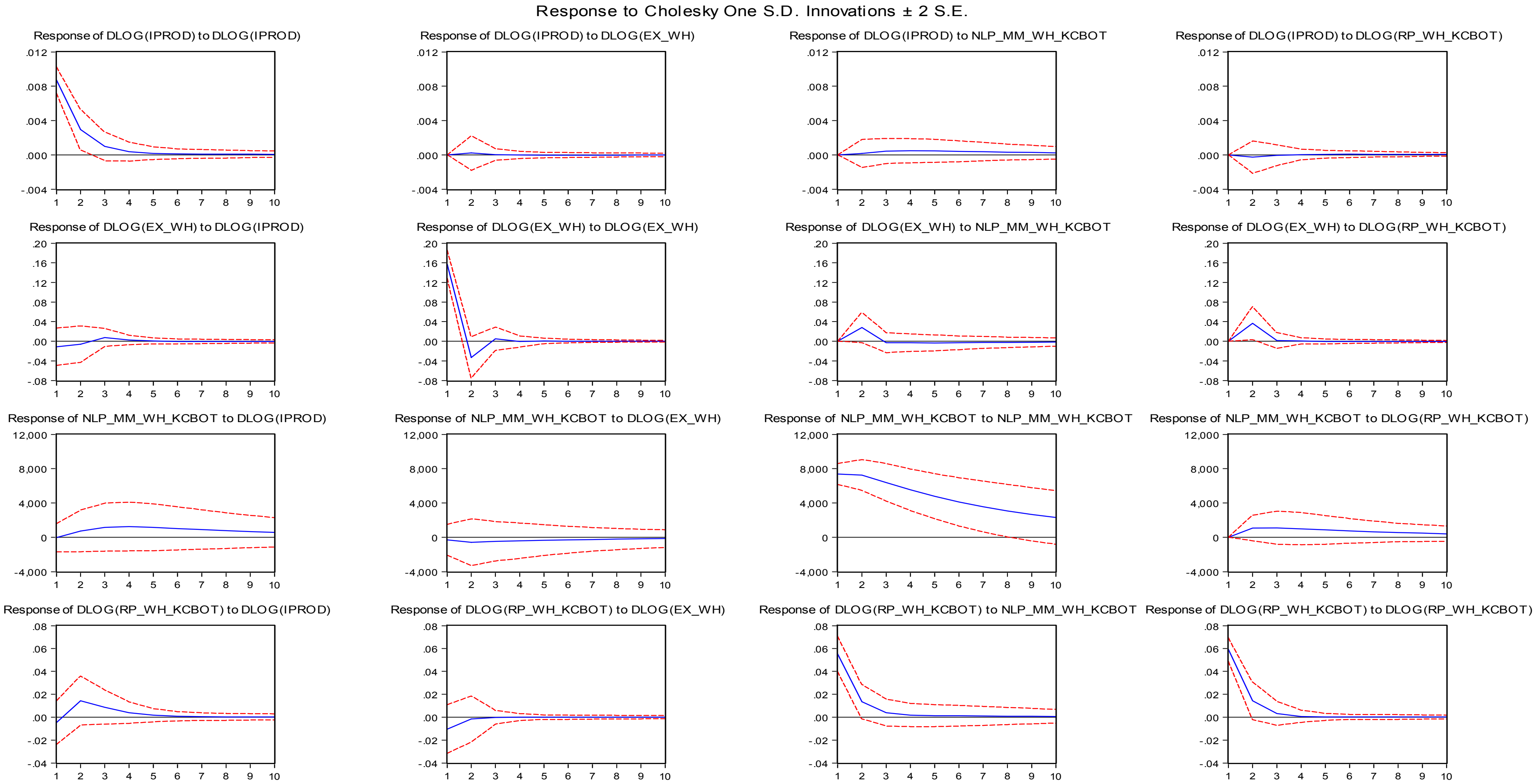


Figure 12: Impulse responses: Brent crude oil

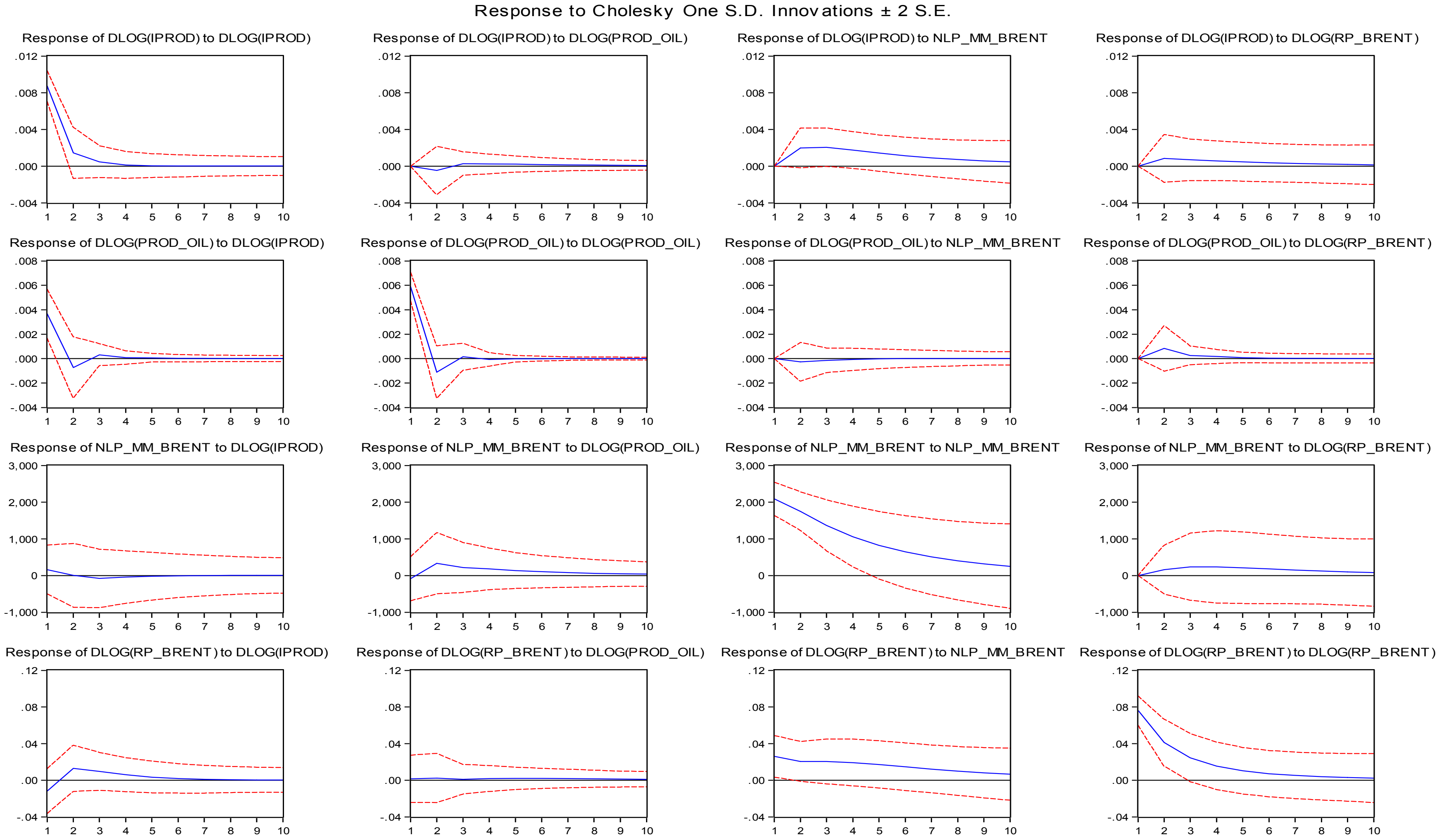
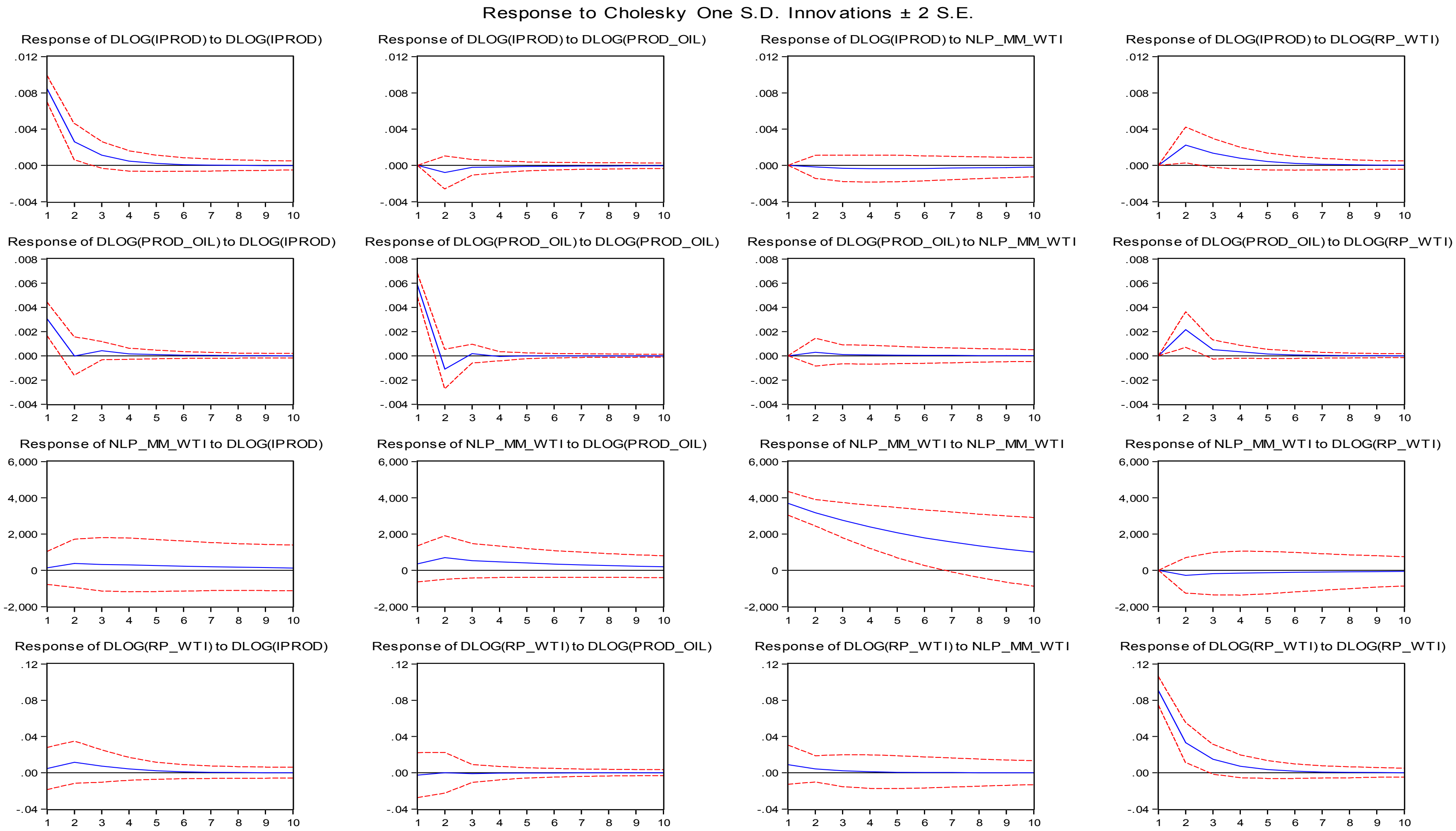


Figure 13: Impulse responses: WTI crude oil



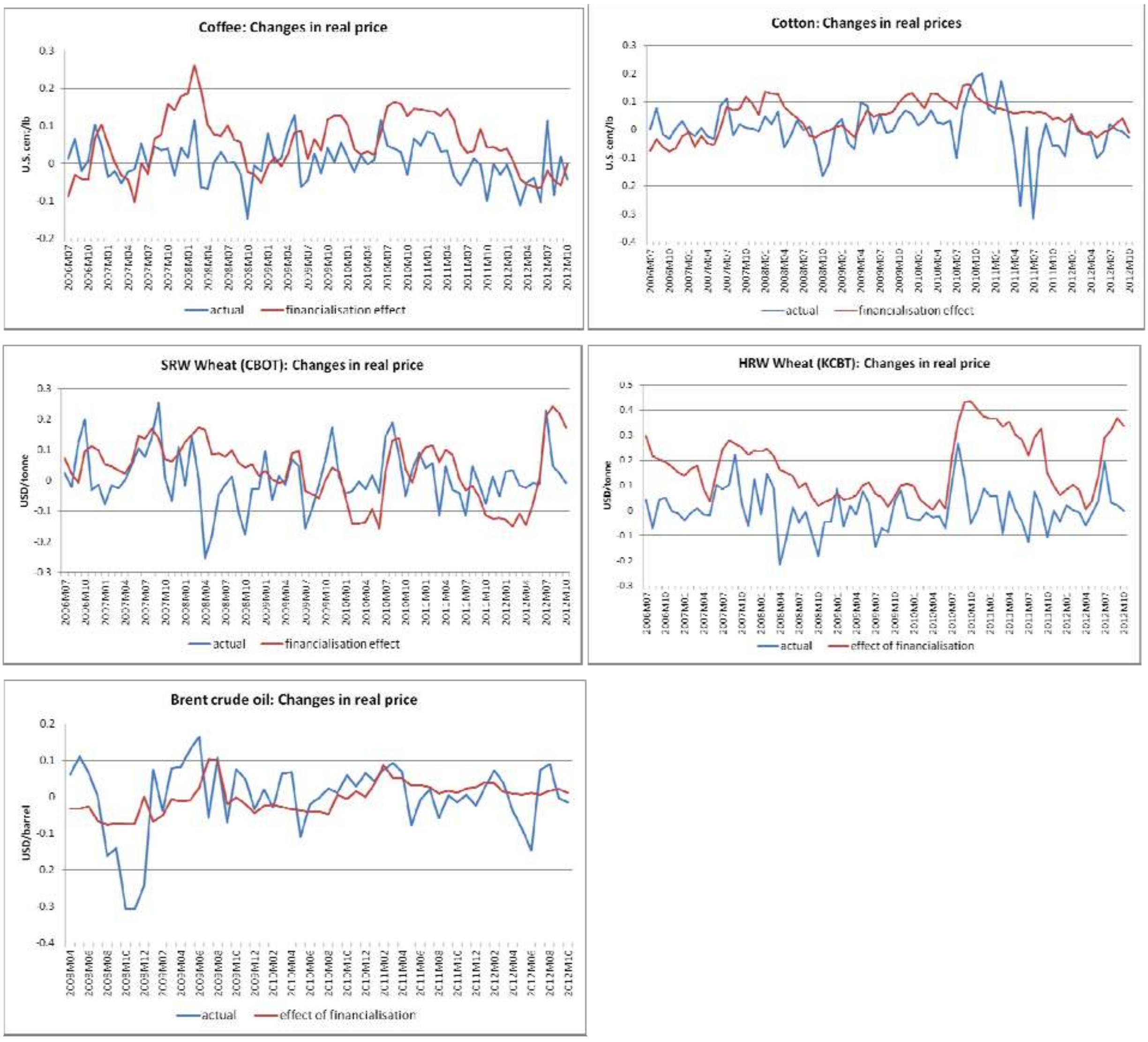
Source: Figure 8-13: own calculations.

Note Figure 8-13: D refers to first difference of the specific variable; LOG refers to the logarithmic form; IPROD refers to industrial production; EX refers to export volumes; NLP_MM refers to net long positions of money managers; RP refers to real price, which are taken in first difference; CF stands for coffee; CT for cotton; WH_CBOT for SRW wheat; WH_KCBOT for HRW wheat.

We included a series of exogenous variables in the estimation to check the robustness of the results. Similarly to other studies, we integrated the US real interest rate, the US REER, the S&P 500 index, and the oil price (in the case of all commodities but oil). Furthermore, we included up to two lags both of endogenous and exogenous variables, and applied a dummy for the period of extraordinary price hikes from September 2008 to August 2009, to see whether there was any structural break. None of this however altered the behavior of the model and the impulse response functions. The results prove to be fairly robust. We checked that residuals resemble white noise by examining autocorrelation diagrams and applying the usual residual tests for multivariate normality and autocorrelation.

Furthermore, we calculated the historical decomposition of real returns (Figure 14), which indicates how the commodity returns would have evolved if they were only driven by money managers' net long positions. We see that developments in real returns are projected fairly well by the variations in net long positions, in particular for coffee, but also for cotton, SRW and HRW wheat and Brent crude oil. For the latter, we find however also periods of large variations which cannot be explained by net long positions of money managers. Interestingly, some of the variations in hypothetical prices are even larger than the actual ones. This implies that other factors, which are not explained in the model actually counteracted the effect of financialisation.

Figure 14: Historical decomposition



Source: own calculations.

6. Conclusions

In the context of recent commodity price hikes, the effect of financial investors on commodity prices has been controversially debated in the academic and political sphere. Volume traded and positions held on commodity derivative markets and the share of financial investors have increased strongly in the 2000s. This is confirmed for the six focus commodities Arabica coffee, cotton, SRW and HRW wheat and WTI and Brent crude oil, although to different extents. Swap dealers/index investors have large shares in long positions compared to total long positions in coffee, cotton, SRW wheat and crude oil. The only exception is HRW wheat which is not to the same extent used as an asset by index investors. Money managers take alternating - long and short - positions and may have large shares on the long and short side of markets. Generally their share in total positions has increased in recent years for all focus commodities with the exception of crude oil. Commercial traders are generally net short, holding the largest share of short positions for all focus commodities.

Many empirical studies investigate the effect of index investors' positions on commodity prices. Due to their price-insensitive long-only trading strategies, this class of traders has been suggested to exert price pressure on increasing commodity prices. Empirical studies come to different results but the majority cannot confirm a broadly consistent effect of index investors on commodity prices, except for specific model assumptions or single commodities. In the wealth of empirical studies on this topic we see however particularly three shortcomings that this paper tries to address: (1) many analyses employ bivariate model approaches, assessing the effect of traders' positions and commodity returns without taking into account fundamental and macroeconomic factors; (2) the majority of studies investigates the effect of index investors but neglects the effect of money managers on commodity prices and their more active and short-term, largely technical and trend following trading strategies that may push prices up and down; (3) as a variable for financialisation we use net long positions by different classes of traders, taking into account that trading strategies can push prices up and down which is particularly important for money managers.

We investigate in particular the effect of money managers but also of swap dealers/index investors (and producers/merchants) on real price returns of the commodities Arabica coffee, cotton, SRW and HRW wheat, and WTI and Brent crude oil for the period June 2006 to October 2012. Similar to previous analyses, we firstly employ a bivariate VAR to test the effect of traders' net long positions on returns on a weekly basis. Secondly, we employ a multivariate VAR model on a monthly basis in which we control for fundamental drivers of commodity prices, including global commodity production or exports, global industrial demand, and macroeconomic factors, i.e. US REER, US interest rate, the oil price (except for oil) and a stock market index, in addition to the net positions of financial investors.

In the bivariate model framework, we find that changes in money mangers' net long positions only have an effect on real returns of coffee. Results of the multivariate VAR analyses indicate that there is a significant impact of money managers' net long positions on commodity prices for all commodities except WTI crude oil. Variance decompositions for the multivariate VAR show that between 10 and 50 % of the variation in prices can be explained by our financialisation variable (i.e. net long positions of money managers). However, neither in the bivariate or multivariate framework we can confirm an effect of swap dealers'/index investors' positions on commodity returns. We also find that commodity returns Granger-cause money managers' net long positions for all commodities except WTI crude oil within the bivariate framework. In the multivariate framework, we find an impulse response of money mangers' monthly net long positions to commodity returns only for coffee. These latter results may indicate the use of trend following trading strategies. As interactions between traders' positions and price movements are complex and hence rising (declining) prices may trigger buy (sell) signals which may then feedback on the price trend, Granger causality running from positions to price movements as well as from price movements to positions may be observed (Schulmeister 2012).

Overall, our results suggest that the controversially discussed hypothesis of financialisation of commodity derivatives markets can be supported. In our results, the main channel of influence of financialisation on commodity prices in recent years seems to be the diverse group of money managers whose net long positions have a significant impact on the prices of our focus commodities with the exception of WTI crude oil in a multivariate VAR framework, rather than the group of index investors. However the results have to be interpreted with caution. Firstly, monthly but also weekly data might be too coarse to statistically show lead-lag relationships, in particular in liquid markets where signals are incorporated quickly in traders' trading strategies. Secondly, the available data does not represent the roll period of index investors during which they participate more actively in the market and may hence have effects on prices and/or term structures in addition to money managers. Thirdly, the time series from June 2006 to October 2012 might be too short to properly capture the effect of in particular swap dealers/index investors that may have had an impact in earlier years when they entered the markets and their investments increased sharply. Fourthly, the relationship and interactions among different types of traders are complex which may make it difficult to see clear lead-lag relations between a certain class of traders' net positions and commodity prices. In particular, also commercial traders tend to pursue speculative in addition to hedging strategies with complex implications on prices and market structure that cannot be captured with the available CFTC data (for a qualitative analysis of the microstructure of commodity derivative markets see Heumesser/Staritz 2013).

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APPENDIX A: Variable sources, scale, units and computation

Variable	Scale	Computation	Source	Unit
Commodity prices				
Average Arabica coffe	monthly	Average of the price of:	UNCTADStat (2012)	US cent/lb
	monthly	Coffee, Colombian mild Arabicas, ex-dock USA (¢/lb.)	UNCTADStat (2012)	US cent/lb
	monthly	Coffee, Brazilian and other natural Arabicas, ex-dock USA (¢/lb.)	UNCTADStat (2012)	US cent/lb
	monthly	Coffee, other mild Arabicas, ex-dock USA (¢/lb.)	UNCTADStat (2012)	US cent/lb
	monthly	Coffee, other mild Arabicas, ex-dock EU (¢/lb.)	UNCTADStat (2012)	US cent/lb
Average Arabica coffe	weekly	Average of the prices of:	ICO (2012)	US cent/lb
	weekly	Coffee, Colombian mild Arabicas, ex-dock USA (¢/lb.)	ICO (2012)	US cent/lb
	weekly	Coffee, Brazilian and other natural Arabicas, ex-dock USA (¢/lb.)	ICO (2012)	US cent/lb
	weekly	Coffee, other mild Arabicas	ICO (2012)	US cent/lb
Cotton Outlook Index A (M 1-3/32"), CFR Far Eastern quotations	monthly		UNCTADStat (2012)	US cent/lb
Cotton Outlook A Index	weekly		FAO (2012)	US cent/lb
Soft red winter wheat	weekly, monthly		FAO (2012)	USD/tonne
Hard red winter wheat	weekly, monthly		FAO (2012)	USD/tonne
WTI crude petroleum	weekly, monthly		IEA (2013)	USD/barrel
Brent crude petroleum	weekly, monthly		IEA (2013)	USD/barrel
Dubai crude petroleum	weekly, monthly		IEA (2013)	USD/barrel

Variable	Scale	Computation	Source	Unit
Fundamental and macroeconomic variables				
US REER	monthly		FRED (2012)	
Global industrial production index	monthly		FRED (2012)	Front contract future
S&P 500 Stock market index	monthly		wikiposit (2012)	
US interest rate	monthly		BIS (2012)	
Consumer Price Index for All Urban Consumers	monthly	nominal, seasonally adjusted	World Bank Global Economic Monitoring	
Cotton exports quantities	monthly	Sum of export quantities of:		kg
	monthly	Cotton NCNC, Brazil	AliceWeb (2012)	kg
	monthly	Cotton Am Pima USA	USDA (2012)	kg
	monthly	Cotton Upland, USA	USDA (2012)	kg
	monthly	Cotton NCNC, EU 27	Eurostat	kg
	monthly	India	ICAC (upon request)	kg
	monthly	Australia	ICAC (upon request)	1000 60 kg bags
Coffee exports quantities	monthly		ICO (upon request)	100kg
Wheat export quantities	monthly	Sum of export quantities:		100kg
	monthly	USA	USDA (2012)	100kg
	monthly	Canada	CANSIM (2012)	100kg
	monthly	EU 27	Eurostat(2012)	100kg
Crude oil supply	monthly		IEA (2013)	1000 barrels per day

Variable	Scale	Computation	Source	Unit
Traders' positions				
Traders' net long positions, CBOT soft red winter wheat	weekly, monthly	Long positions minus short positions	CFTC (2012)	1000 contracts
Traders' net long positions, KCBT hard red winter wheat	weekly, monthly	Long positions minus short positions	CFTC (2012)	1000 contracts
Traders' net long positions, ICE cotton	weekly, monthly	Long positions minus short positions	CFTC (2012)	1000 contracts
Traders' net long positions, ICE coffee	weekly, monthly	Long positions minus short positions	CFTC (2012)	1000 contracts
Traders' net long positions, NYMEX WTI crude oil financial swaps	weekly, monthly	Long positions minus short positions	CFTC (2012)	1000 contracts

APPENDIX B: Summary statistics

Variables	Mean	Standard deviation	Min	Max	Nbr of obs.	Time interval
Commodity prices						
Weekly Average Arabica coffee price, US cent/lb.	169.8	54.1	99.6	311.7	331	06/2006-10/2012
Monthly Average Arabica coffee price, US cent/lb.	169.26	53	100.96	296.61	77	06/2006-10/2012
Real monthly average Arabica coffee price, US cent/lb.	1.39	0.37	.92	2.34	77	06/2006-10/2012
Weekly cotton outlook index, US cent/lb	81.46	34.2	40.7	208.06	331	06/2006-10/2012
Monthly cotton outlook index, US cent/lb	87.72	39.15	51.5	229.67	77	06/2006-10/2012
Real Monthly cotton outlook index, US cent/lb	.720	.29	.43	1.82	77	06/2006-10/2012
Weekly hard red winter wheat price (KCBT), USD/tonne	280.59	67.1	175	510	327	06/2006-10/2012
Monthly hard red winter wheat price (KCBT), USD/tonne	281.31	66.8	182.75	481.5	77	06/2006-10/2012
Real monthly hard red winter wheat price (KCBT), USD/tonne	2.33	.52	1.49	4.13	77	06/2006-10/2012
Weekly soft red winter wheat price (CBOT), USD/tonne	239.5	63.0	134.94	461.86	327	06/2006-10/2012
Monthly soft red winter wheat price (CBOT), USD/tonne	240.1	63.01	141.97	397.24	77	06/2006-10/2012
Real monthly soft red winter wheat price (CBOT), USD/tonne	1.98	.49	1.30	3.41	77	06/2006-10/2012
Weekly WTI crude oil price, USD/barrel	82.1	20.39	32.98	142.5	326	06/2006-10/2012
WTI crude oil price, USD/barrel	81.98	20.02	39.15	133.93	77	06/2006-10/2012
Real WTI crude oil price, USD/barrel	.68	.15	.33	1.13	77	06/2006-10/2012
Brent crude oil price, USD/barrel	86.4	23.82	41.58	133.87	77	06/2006-10/2012
Real Brent crude oil price, USD/barrel	.71	.17	.35	1.12	77	06/2006-10/2012

Variables	Mean	Standard deviation	Min	Max	Nbr of obs.	Time interval
Fundamental and macroeconomic variables						
Coffee export volumes, 1000 60 kg bags	8313.85	835.32	6750.99	10618.06	77	06/2006-10/2012
Cotton export volumes, 100 kg	4.51e+08	1.32e+08	2.09e+08	8.63e+08	77	06/2006-10/2012
Wheat export volumes, 100 kg	7.17e+09	1.14e+09	4.88e+09	1.14e+10	77	06/2006-10/2012
Crude oil supply, 1000 barrels per day	85884.82	1722.54	82809.09	89044.55	77	06/2006-10/2012
Industrial production index	94.09	5.13	83.45	100.74	77	06/2006-10/2012
US REER	100.14	4.42	93	112.2	77	06/2006-10/2012
US Interest rate	1.72	2.16	.125	5.25	77	06/2006-10/2012
S&P 500 Stock market index	1242.3	191.26	757.1	1539.6	77	06/2006-10/2012
Consumer Price Index for All Urban Consumers	120.3	6.89	109	132.83	77	06/2006-10/2012

Variables	Mean	Standard deviation	Min	Max	Nbr of obs.	Time interval
Traders' positions						
Monthly net long positions money manager, coffee	10696.89	16884.87	-24101.7	55406	77	06/2006-10/2012
Monthly net long positions swap dealer, coffee	33086.57	8732.63	19055	54092.25	77	06/2006-10/2012
Weekly net long positions producers/merchants, coffee	-51374.42	23149.8	-116698	-10787	331	06/2006-10/2012
Weekly net long positions money managers, coffee	10878.37	17241.69	-25757	59121	331	06/2006-10/2012
Weekly net long positions swap dealers, coffee	33108.9	8792.5	18236	55085	331	06/2006-10/2012
Monthly net long positions money manager, cotton	15885.28	23643.61	-30497	63295.5	77	06/2006-10/2012
Monthly net long positions swap dealer, cotton	57122.62	20392.47	20392.25	81277.8	77	06/2006-10/2012
Weekly net long positions producers/merchants, cotton	-80380.31	34718.95	-204443	-26346	331	06/2006-10/2012
Weekly net long positions money managers, cotton	16170.86	24018.47	-32778	71982	331	06/2006-10/2012
Weekly net long positions swap dealers, cotton	57106.31	20462.55	19061	115477	331	06/2006-10/2012
Monthly net long positions money manager, soft red winter wheat (CBOT)	10194.36	28331.75	-45647.8	70624	77	06/2006-10/2012
Monthly net long positions swap dealer, soft red winter wheat (CBOT)	150797.7	25545.67	94598.8	194073.3	77	06/2006-10/2012
Weekly net long positions money managers, soft red winter wheat (CBOT)	9749.604	29335.46	-56406	73662	331	06/2006-10/2012
Weekly net long positions swap dealers, soft red winter wheat (CBOT)	150979	25409.06	92716	197384	331	06/2006-10/2012
Weekly net long positions producers/merchants, soft red winter wheat (CBOT)	-125027.4	34339.03	-210060	-57473	331	06/2006-10/2012
Monthly net long positions money manager, hard red winter wheat (KCBT)	23177.21	16023.51	383	57971.5	77	06/2006-10/2012
Monthly net long positions swap dealer, hard red winter wheat (KCBT)	24396.66	7109.35	10448.25	38674.5	77	06/2006-10/2012
Weekly net long positions producers/merchants, hard red winter wheat (KCBT)	-48668.68	22507.27	-107719	-10385	331	06/2006-10/2012
Weekly net long positions money manager, hard red winter wheat (KCBT)	22870.97	16196.15	-3855	61669	331	06/2006-10/2012
Weekly net long positions swap dealer, hard red winter wheat (KCBT)	24314.02	7104.187	9802	39562	331	06/2006-10/2012
Monthly net long positions money manager, WTI crude oil financial swaps	-5348.16	7128.2	-20181.5	12334.5	77	07/2006-10/2012
Monthly net long positions swap dealer, WTI crude oil financial swaps	12374.39	7976.149	-6796.25	27859.5	77	07/2006-10/2012
Weekly net long positions producers/merchants, WTI crude oil financial swaps	995.37	4695.1	-10563	9512	326	06/2006-10/2012
Weekly net long positions money manager, WTI crude oil financial swaps	-5402.4	7318.5	-23405	15479	326	06/2006-10/2012
Weekly net long positions swap dealer, WTI crude oil financial swaps	12471	8182.8	-12650	29698	326	06/2006-10/2012
Monthly net long positions money manager, Brent crude oil financial swaps	-215.97	3393.4	-6057.5	8248.2	53	04/2008-10/2012
Monthly net long positions swap dealer, Brent crude oil financial swaps	516.67	3055.25	-9967	5316.2	53	04/2008-10/2012

APPENDIX C: Effect of changes in traders' net long positions on changes in other traders' net long positions

Effect on money managers' net long positions:

	Swap dealers		Producer/Merchants	
Market	Lag order p	p-value $a^i = 0 \quad \forall i$	Lag order p	p-value $a^i = 0 \quad \forall i$
Cotton	1	0.399	1	0.199
Coffee	2	0.215	4	0.002**
Wheat KCBT	1	0.651	1	0.004**
Wheat CBOT	1	0.535	2	0.022*
Oil WTI fin. swaps	2	0.932	2	0.236

Source: own calculations.

Note: Granger causality is tested by Wald criterion. The lag order is determined by AIC and FPE criteria; *p* refers to the chosen lag order. a refers to the regression coefficient. For each commodity, Granger causality is tested under the null hypothesis that a change in swap dealers/index investors' (producer/merchants') net long positions cannot be used to predict changes in money mangers' net long positions, H_0: $a^i = 0 \quad \forall$ i, where i represents the lag orders 1,..,p. Double (**) and single (*) asterisk denote statistical significance at the 1 % and 5 % level.

Effect on swap dealers/index investors' net long positions:

	Money Mangers		Producer/Merchants	
Market	Lag order p	p-value $a^i = 0 \quad \forall i$	Lag order p	p-value $a^i = 0 \quad \forall i$
Cotton	1	0.155	1	0.013
Coffee	2	0.338	2	0.285
Wheat KCBT	1	0.064	1	0.126
Wheat CBOT	1	0.566	1	0.939
Oil WTI fin. swaps	2	0.500	1	0.130

Source: own calculations.

Note: Granger causality is tested by Wald criterion. The lag order is determined by AIC and FPE criteria; *p* refers to the chosen lag order. a refers to the regression coefficient. For each commodity, Granger causality is tested under the null hypothesis that a change in money managers' (producer/merchants') net long positions cannot be used to predict changes in swap dealers/index investors' net long positions, H_0: $a^i = 0 \quad \forall$ i, where i represents the lag orders 1,..,p. Double (**) and single (*) asterisk denote statistical significance at the 1 % and 5 % level.

Effect on producer/merchant s' net long positions:

	Money Mangers		Swap dealers	
Market, k	Lag order p	p-value $a^i = 0 \quad \forall i$	Lag order p	p-value $a^i = 0 \quad \forall i$
Cotton	1	0.284	1	0.104
Coffee	4	0.054	2	0.738
Wheat KCBT	1	0.560	1	0.920
Wheat CBOT	2	0.571	1	0.826
Oil WTI fin. swaps	2	0.666	1	0.814

Source: own calculations.

Note: Granger causality is tested by Wald criterion. The lag order is determined by AIC and FPE criteria; *p* refers to the chosen lag order. a refers to the regression coefficient. For each commodity, Granger causality is tested under the null hypothesis that a change in money managers' (swap dealers/index investors') net long positions cannot be used to predict changes in producer/merchants' net long positions, H_0: $a^i = 0 \quad \forall$ i, where i represents the lag orders 1,..,p. Double (**) and single (*) asterisk denote statistical significance at the 1 % and 5 % level.