STUDY

DETERMINANTS FOR THE LEVEL AND VOLATILITY OF AGRICULTURAL COMMODITY PRICES ON INTERNATIONAL MARKETS

ARE BIOFUELS RESPONSIBLE FOR PRICE VOLATILITY AND FOOD INSECURITY?

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at the proposal of the Verband der Deutschen Biokraftstoffindustrie e. V. and
Union zur Förderung von Öl- und Proteinpflanzen e. V.

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STUDY OUTLINE

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1 Problems statement and research questions

With the world-wide explosion in prices for agricultural commodities and basic foodstuffs in the period 2007 to 2008 and the subsequent collapse in 2009 caused by the recession, an intensive discussion has begun on the possible negative consequences of high and volatile prices for world food security. Especially in countries that import foodstuffs, violent protests and revolts have erupted in this respect against the drastic inflation of food prices affecting, above all, the urban population. And the recurring price high in 2010/11, which with minor fluctuations is still on-going, has revived this discussion, meanwhile also triggering world-wide political reactions. Export restrictions have thus been imposed in many exporting developing and emerging countries, which has in principle intensified the price rise even further, at the expense of the importing nations. Against this background, the G20 Group therefore agreed at its summit in November 2011, under the French presidency, that agricultural commodity markets required stricter regulation, while proposing measures for curbing prices and hence supposedly safeguarding world food security. The former French president, Nicolas Sarkozy, considered market speculators in particular to be the main cause of volatility and overheated markets with record prices. Since then banks, index funds and hedge funds have above all been in the crossfire of criticism (SCHUMANN, 2011). As a result and against this background, price and position limits as well as increased regulatory capital requirements for commodity future markets, for example, are being demanded in the EU as well. And with the amendments to the EU financial market guidelines, the introduction of position limits and of minimum time boundaries for computer-aided high-frequency trading (also trading), as well as a financial transaction tax, could emerge.

Public and published opinion also appears to clearly point the finger at other guilty parties. The UN special rapporteur De SCHUTTER, for example, maintains that biofuel promotion destroys the rainforest and drives food prices (AGRA-EUROPE, 2011). And in their Global Hunger Index report (WELTHUNGERHILFE and IFPRI, 2011), the organisation Welthungerhilfe, together with the International Food Policy Research Institute (IFPRI), clearly state that: “Biofuels are the main cause of higher and more volatile prices”. Finally, the “High Level Panel of Experts on Food Security” appointed by the United Nations (WILKINSON et al., 2013) also made its position clear in its preliminary report when it maintained that biofuels have played a predominant role in the increase in level and volatility of food prices since 2004. OXFAM (2012) goes one step further by demanding that the EU stop subventions for biofuels, which, it says, could help millions of starving people. Not least against the background of this public pressure, in the autumn of 2012, the Commission laid out proposals for revision of its previous biofuel policy. This includes among other things a demand to reduce the use of "first-generation" biofuels from 10% to 5% by 2020.

In particular, non-governmental organisations (NGOs), the media, churches and certain development institutions have followed the zeitgeist by increasingly homing in on the biofuels industry, banks and speculators as the main groups responsible for hunger, poverty, misery and injustice in the world. Against the background of this market-critical and in some cases economically damaging development, the main tasks are to objectify the emotional discussions, to break down the bogeyman images, to correct evidently false statements and to find an approach to cause-related solutions, firstly for the doubtless existing hunger and poverty problems in developing countries and, secondly, for dealing with volatile markets on the other. Meanwhile, contrary to this somewhat general and one-sided fingerpointing, extensive scientific literature on the numerous factors that determine pricing on the agricultural commodities markets and on the global food situation has fortunately been published which presents a somewhat more differentiated picture than the current discussion would suggest. Up until now, most quantitative contributions have concentrated on just a few determinants, and therefore cannot adequately cover such complex events. Against the background of these facts, the following questions arise with regard to research for the present study (see also Fig. 1.1):

- What developments have taken place in the levels and the volatilities of agricultural commodity prices, the markets and policies for biofuels, as well as in the world food situation, and what further development is forecast?

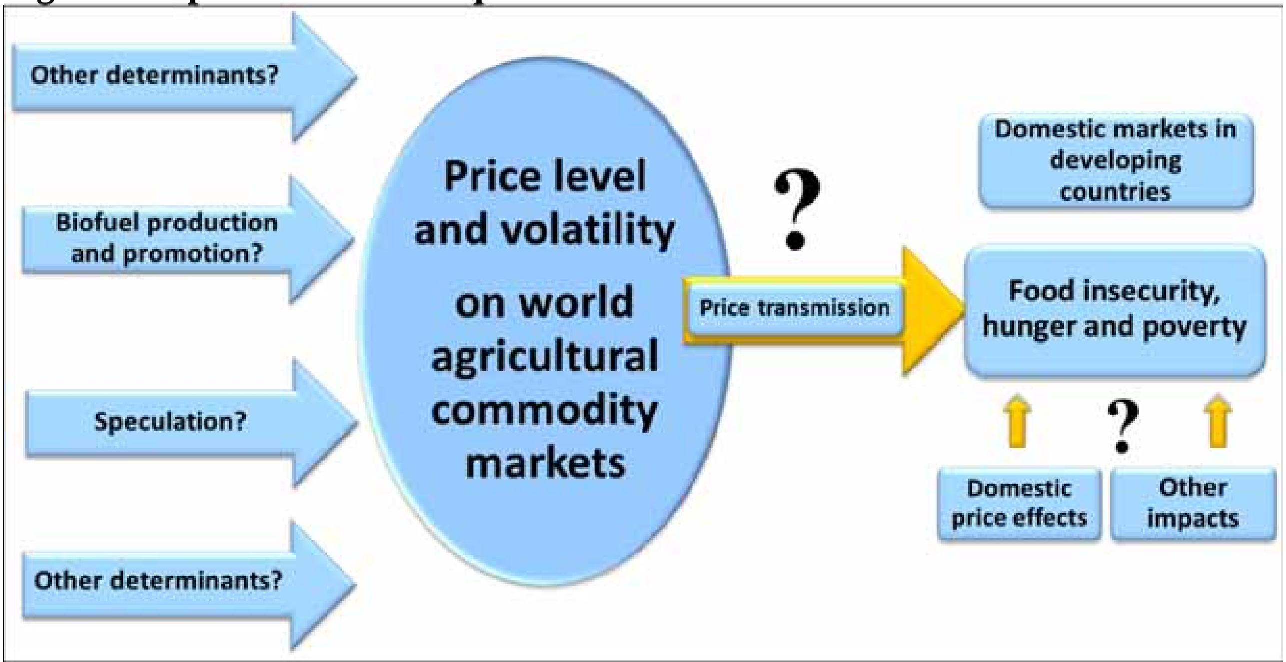
- What factors contribute significantly to the pricing on international agricultural commodity markets, more precisely with respect to the level of prices and their volatility?

- What is the estimated quantitative contribution of the individual factors? What role is played by world-wide biofuel subsidies and speculation, and what is the significance of the weather, the political environment, the oil price increase and other macroeconomic influences?

- How is pricing for agricultural commodities on the world markets transmitted to the domestic markets of developing countries? Do country-specific influential factors for pricing exist that are independent of the global market?

- What are the main causes of hunger and poverty in developing countries and what role do higher and more volatile prices play on world agricultural markets? Do they really exacerbate hunger, as is claimed by many?

Fig. 1.1: Important research questions



Source: Own representation

In this context, it is also interesting to mention that almost the entire agricultural economy and virtually all prominent institutions, such as the World Bank, OECD, FAO and IFPRI, took an entirely different view before 2007/08. Until then, it was believed that low world market prices for agricultural commodities, caused above all by protection and surplus production in the industrialised countries, were destroying the production fundamentals in poor countries and contributing significantly to hunger and poverty. (For more on this contradiction and the role of development institutions and the media, see also ANDERSON et al., 2013; SWINNEN, 2011; SWINNEN et al., 2011 and Box 1.1). Whether high or low agricultural prices are now exacerbating the hunger situation has since then been an open question which also requires a differentiated way of looking at things (see FAO, 2011).

Box 1.1.: High or low prices: What are the causes of hunger and poverty?

FAO (2005): „The long-term downward trend in agricultural commodity prices threatens the food security of hundreds of millions of people in some of the world's poorest developing countries"

IFPRI (2008): ...rapidly rising food prices began further threaten the food security of poor people around the world"

Explaining the contradiction (see Swinnen, 2011)

"[..] all these [international] organisations face a demand to demonstrate the importance of their work. Focusing their reports and analyses on those hurt by price changes may fit in such strategy to show relevance and importance – and may thus help in securing and raising funds."

Source: SWINNEN 2011

These five problem areas will be addressed as part of an analysis of the more recent relevant literature and of our own empirical calculations. Following the introduction, **CHAPTER 2** will first provide an overview of the price development of agricultural commodities, of biofuels themselves and of the world food situation. In **CHAPTER 3**, the causes of high and volatile agricultural commodity prices will then be discussed and the quantitative contribution of the individual influential factors estimated. Here the influence of biofuels and speculation will be examined using econometric methods and with the aid of model simulations. In all, eight potential factors that influence pricing will be analysed.

CHAPTER 4 deals with the main causes of hunger and poverty and the possible consequences of higher and more volatile prices on the global markets for the price situation on the domestic markets in the developing countries themselves. In **CHAPTER 5**, several popular theories from critics of biofuels and speculation will be examined. The report closes in **CHAPTER 6** with several thoughts and conclusions for policy-making and in **CHAPTER 7** with a concluding summary.

2 Overview of facts and figures

In the following, an overview of the facts and figures on pricing on the world market, on the development of the biofuels markets and policies and on the world food situation will be presented. The chapter will close with an interim conclusion which will identify approaches for further treatment and derive initial hypotheses for empirical investigation.

2.1 Price volatility and price level of agricultural prices

The subject matter of the section "Volatility and Level of Agricultural Commodity Prices" is the development of the global market price for agricultural commodities on international markets. Here we are dealing firstly with the volatility, and secondly with the price level. What we understand by volatility are the price fluctuations around a normally trend-adjusted mean value. There are several indicators that can be used for measuring this. For this the annualised historical volatility on the basis of monthly data is used (see GILBERT and MORGAN, 2011; LEDEBUR and SCHMITZ, 2011). Interesting questions here are: What is the magnitude of the volatility on individual markets? How has the volatility developed over time? How is it likely to develop in the future? A first glance at the time series of price volatilities for five agricultural commodities and crude oil from 1960 to 2012 (Fig. 2.1) shows that

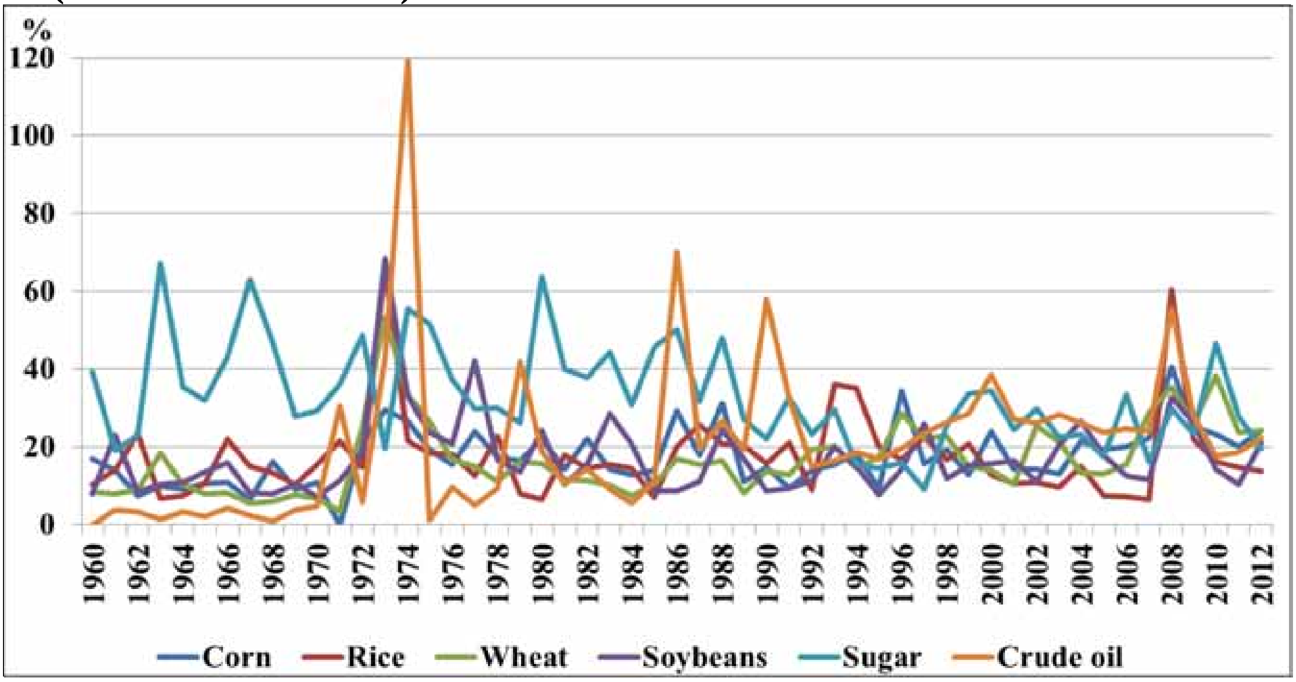
- the situation in the 60s and 70s was, with the exception of sugar, relatively stable, and volatilities of up to a maximum of only 20% occurred;

- sugar prices had been fluctuating between 20% and 60% since as early as the 60s and up into the 80s;

- with the oil price explosion at the beginning of the 70s (price volatility for crude oil: 120%), the overall level of volatility for agricultural commodities was increased slightly to about 10% to 30%;

- this volatility level has remained relatively constant until today and, at least for certain products, temporarily climbed again to 40% at the most during the 2007/08 oil price bubble.

Fig. 2.1: Development of price volatility for agricultural commodities and crude oil (Jan. 1960 - Dec. 2012) in %



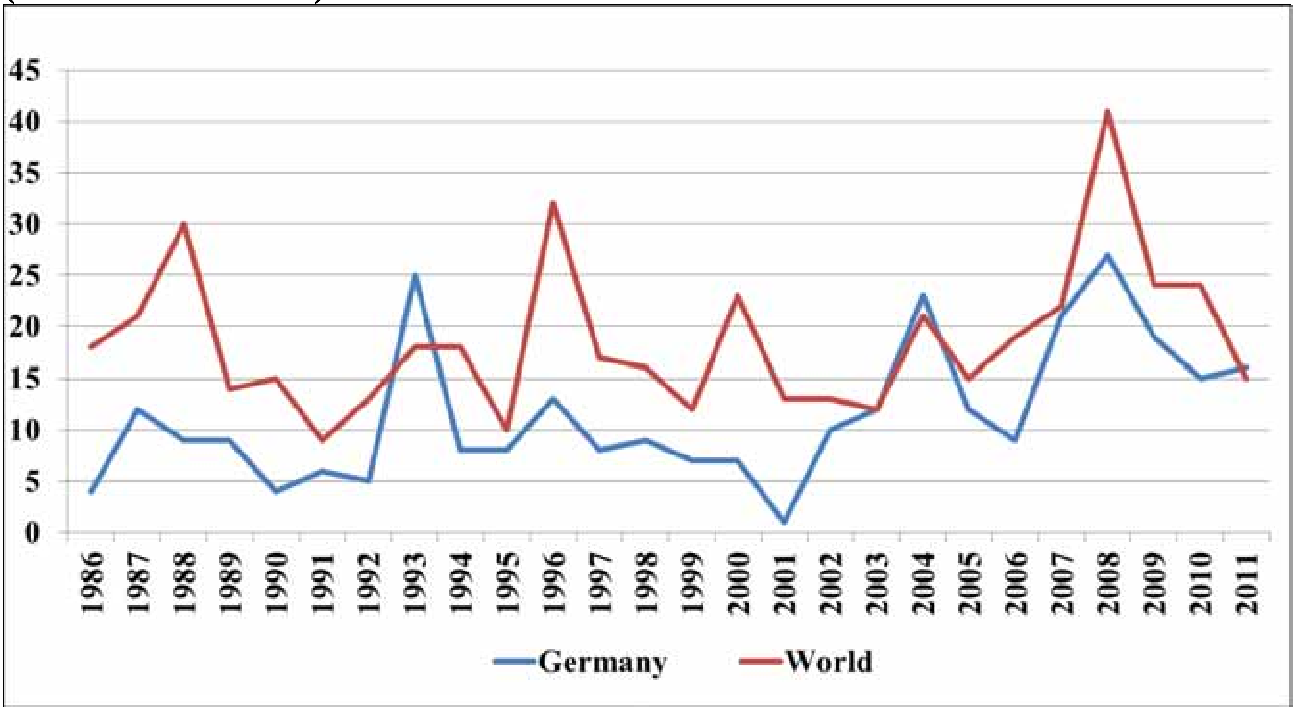
Source: Own calculations (database: WORLD BANK)

Currently (2012) the value for sugar and soybeans is around 20%, for wheat and maize around 25%, for rice 15% and for crude oil a little over 20% (see Figs. A1 to A9 in Appendix A). Conspicuous is the development of volatility for sugar and soybeans, which fell from the high values in the 60s and 70s to volatilities between 10% and 45%. Finally the marked deviation for rice must be mentioned, which in 2008 reached about 60%, as did also crude oil. However, no clear upwards trend in volatilities can be derived from these figures (see also OECD, 2011), even if the price fluctuations for animal products are included (see Figs. A7 to A9 in Appendix A)

How this development will continue is therefore a matter of dispute in the scientific literature. The observed climate change, with an increase in the frequency, extent and duration of weather extremes, and the resulting yield risks argue in favour of greater price fluctuations in the future. The increasing international exchange of commodities entails new risks in the area of plant and animal diseases. In contrast to this, greater price stability can be expected from the international removal of protections and further liberalisation steps within the framework of the WTO negotiations, because more open markets provide a greater buffering volume and therefore stabilization potential, in the event of supply and demand shocks. A critical glance at the current state of WTO negotiations, however, casts doubt on whether a multilateral removal of protections can really succeed. An increase in the number of bilateral trade agreements being concluded can be observed world-wide, which is often at the expense of third parties and therefore not really going in the direction of free trade. Countries are also reacting with increasing frequency to shocks on the international markets with ad-hoc trade policy measures such as export restrictions, even going as far as export bans, or with import facilitations. Both have the effect, at least in the short term, of increasing the volatility, as will be shown in Chapter 3.1.

It is not possible at present to clearly estimate which of these influential factors might in the end prevail. But lower volatilities are to be assumed even less in the future, and the entire agricultural and food branch would be well advised to expect a certain basic risk level for price, yield and income in the future, and to utilise all available risk management instruments. This applies in particular for EU agriculture and its market partners, who have been confronted with increasing price volatilities in the EU agricultural markets for some years as a result of the gradual liberalisation of the market regulations and have meanwhile reached the volatility level of world markets for the most important products or are increasingly approaching this. Fig. 2.2 shows this for the maize price in Germany and on the world market (see also LEDEBUR and SCHMITZ, 2011; O'CONNOR and KEANE, 2011). Administered market prices that are essentially stabilised through intervention, threshold and guide prices are therefore a thing of the past. The state mandated risk management that is collectively uniform for all farms and firms due to market regulations must therefore more than ever before be replaced in the future by an individual risk strategy that is to be applied to the risk aversion, the risk exposure and location-specific prerequisites of the businesses. This makes more sense from the business point of view and is more efficient for the national economy than a collectively mandated risk protection through market regulations. Examples of the range of company internal and external risk management instruments can be found in Box 2.1. The individual choice of suitable instruments should be left to the agricultural companies and not distorted in the one or the other “political” direction by state organisations.

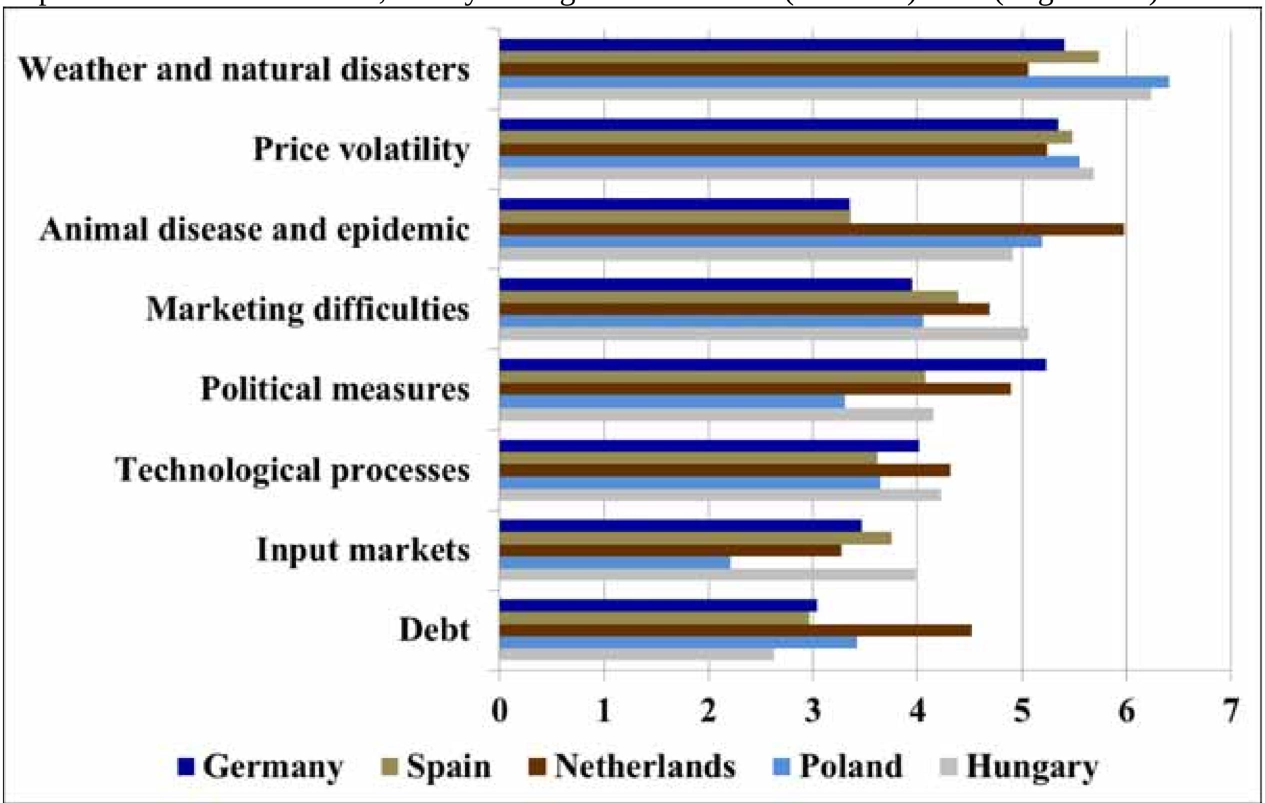
Fig. 2.2: Annualized maize price volatility on German and world markets (Jan.1986-Dec.2012) in %



Source: Own calculation (database: GERMAN FEDERAL OFFICE FOR STATISTICS, UNCTADSTAT)

Fig. 2.3: Rating sources of risk

Importance of sources of risk; survey among farmers from 1 (no effect) till 7 (large effect)



Source: Székely und Pálinkás (2009), in Deutsche Bank Research: Risikomanagement in der Landwirtschaft, 11/2010

Box 2.1: Risk management

- **Farmers have to cope with numerous business-internal and business-external risks**
- **Numerous instruments are available to them for risk management, e.g.**

Business-internal	**Business-external**
• **Non-cultivation**	• **Non-farm employment**
• **Plant protection**	• **Vertical cooperation**
• **Variety selection**	• **Contract farming**
• **Crop rotations**	• **Credit borrowing**
• **Sprinkler irrigation**	• **Futures markets**
• **Biogas**	• **Forward contracts**
• **Farm shop**	• **Insurance contracts**

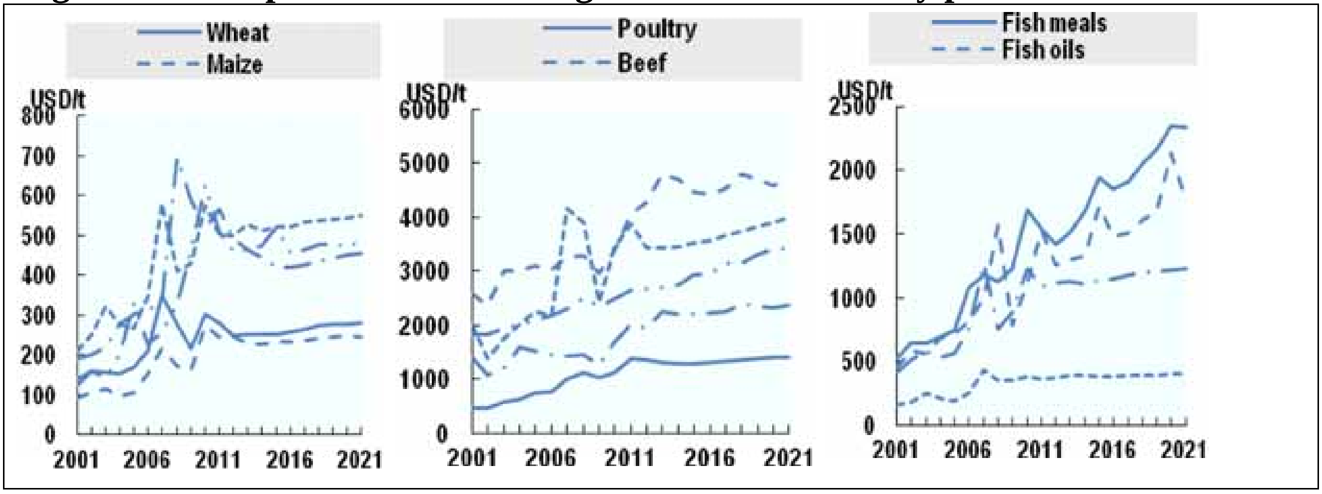
Noted items: Politics should not favour single solutions or discriminate them!

Source: Own representation

The fact that farmers, apart from natural risks, also perceive and fear above all political interference, i.e. political risks, is shown in Fig. 2.3. Here, politics in Germany are quoted together with the price volatility as the second most important source of risk.

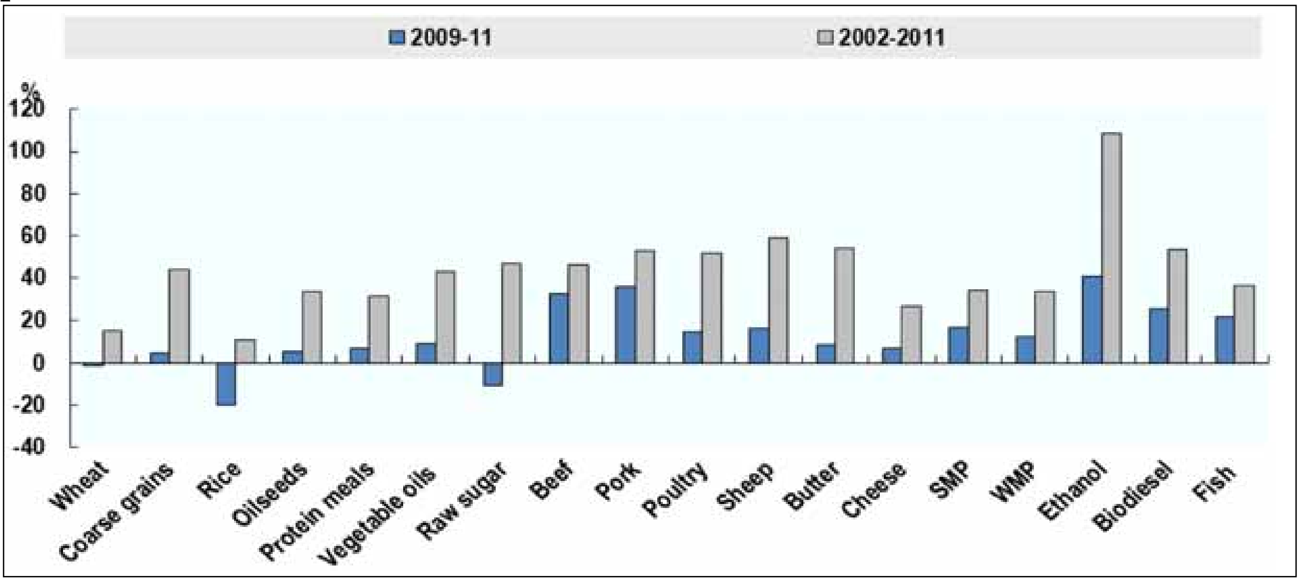
With regard to the development of the long-term level of agricultural commodity prices a more uniform picture becomes apparent in the literature. Most research institutes expect a rise in prices over the next decade until 2021 in comparison with the period 2002 to 2011. Figs. 2.4 and 2.5 show these developments for selected products. Particularly high price rises of 40% to 60% are expected for meat products, butter, raw sugar, vegetable oils and coarse grain. And even in comparison with the current period 2009-2011, the OECD and FAO still reckon with a further price rise for 16 out of 18 products. Price reductions are assumed only for wheat, raw sugar and rice (see Fig. 2.5). Worth mentioning are the price forecasts for ethanol and biodiesel, which in a decade comparison assume an increase of about 110% and 50%, respectively.

Fig. 2.4: Development of nominal agricultural commodity prices 2001 – 2021



Source: OECD-FAO 2012

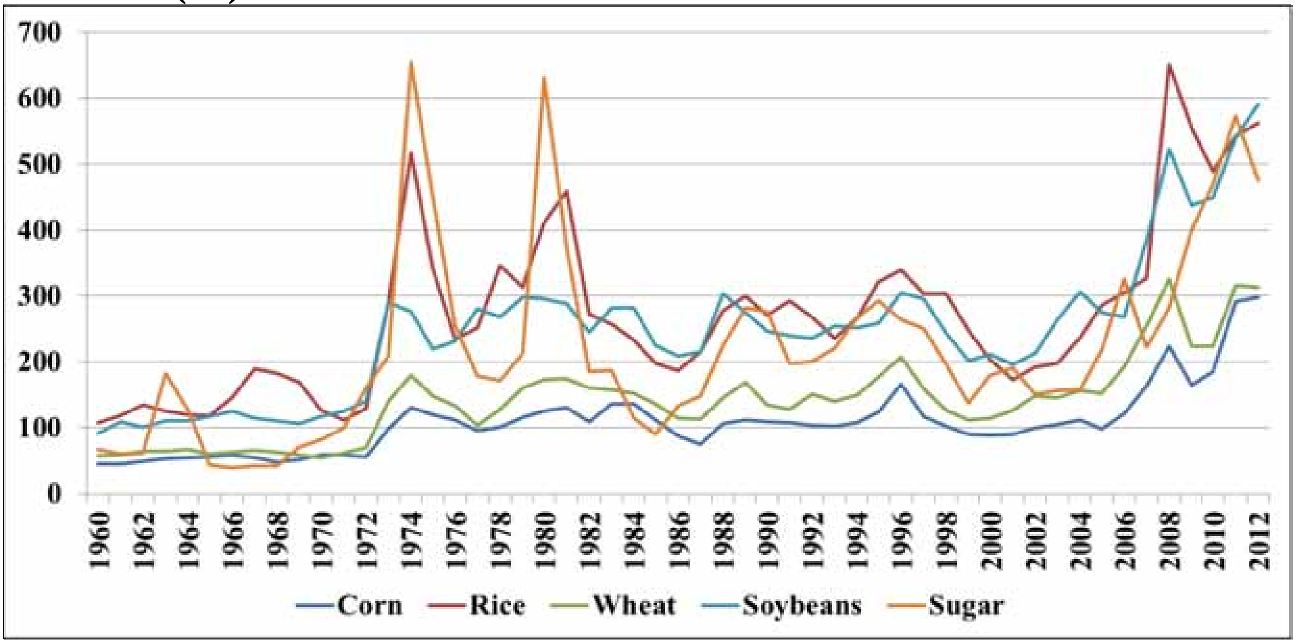
Fig. 2.5: Change of average nominal prices in 2012-21 relative to different base periods



Source: OECD-FAO 2012:

Looking back at the price levels up until 1960, three development phases can be distinguished (Fig. 2.6). In the 60s up until the beginning of the 70s, the prices were at a low level. With the start of the first oil crisis in 1973, the level increased for all agricultural commodities shown, with particularly severe jumps for raw sugar and rice, and then took a sideways course of development until about 2006. In this phase, only raw sugar and rice again reacted significantly to the second oil crisis in 1980/81 with price increases. From 2006 to 2008 the third phase finally began, again starting with an oil price explosion which was interrupted only by a short-term fall as a result of the global financial crisis and the subsequent recession in 2009. Otherwise the whole agricultural price level seems to have plateaued at a higher level, with smaller upwards and downwards deviations (see also Fig. 2.7).

Fig. 2.6: Level of agricultural commodity prices on international markets 1960-2012 ($/t)



Source: Own representation (database: WORLD BANK)

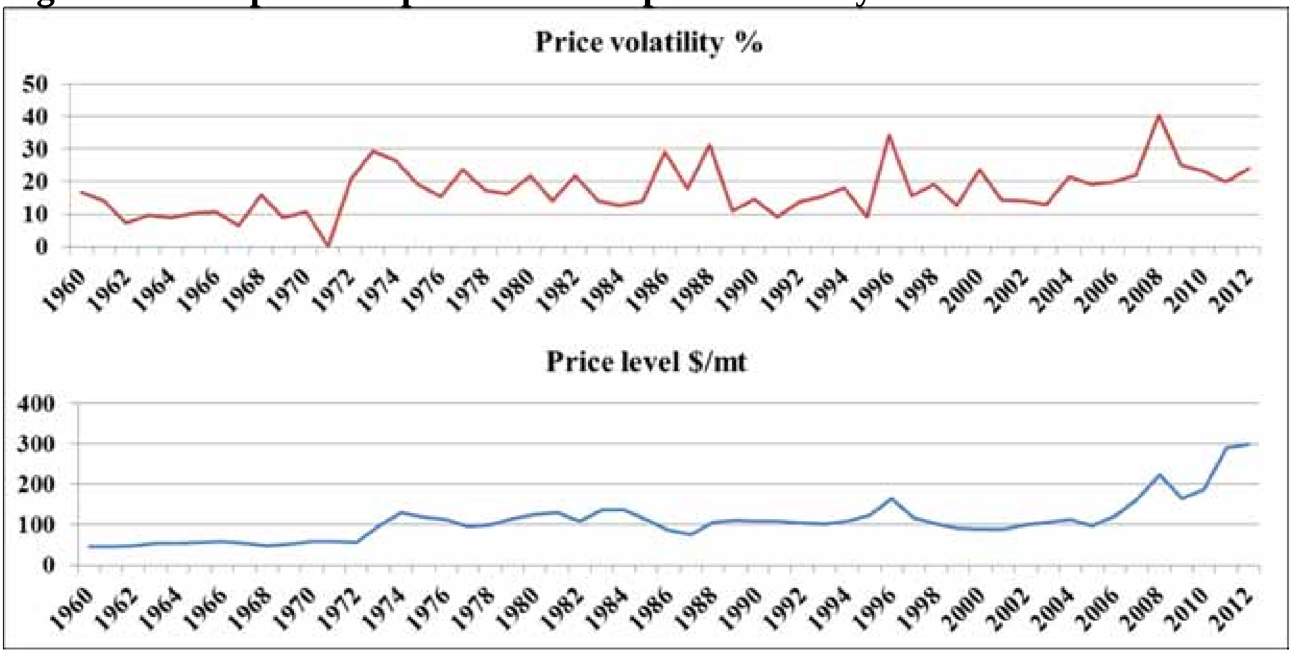
According to the FAO in April 2013, meat prices are currently remaining steady at about the previous level, while the price levels for grain, oils and fats and sugar have fallen. Conspicuous, however, is the rapid rise in the price of dairy products of more than 30% since January, caused by the droughts and losses of production in New Zealand. Therefore oil prices and weather conditions still seem to be having an on-going effect on pricing on the international agricultural commodities markets.

Fig. 2.7: FAO Food Price Index, January 1990 to April 2013

Source: FAO (2013)

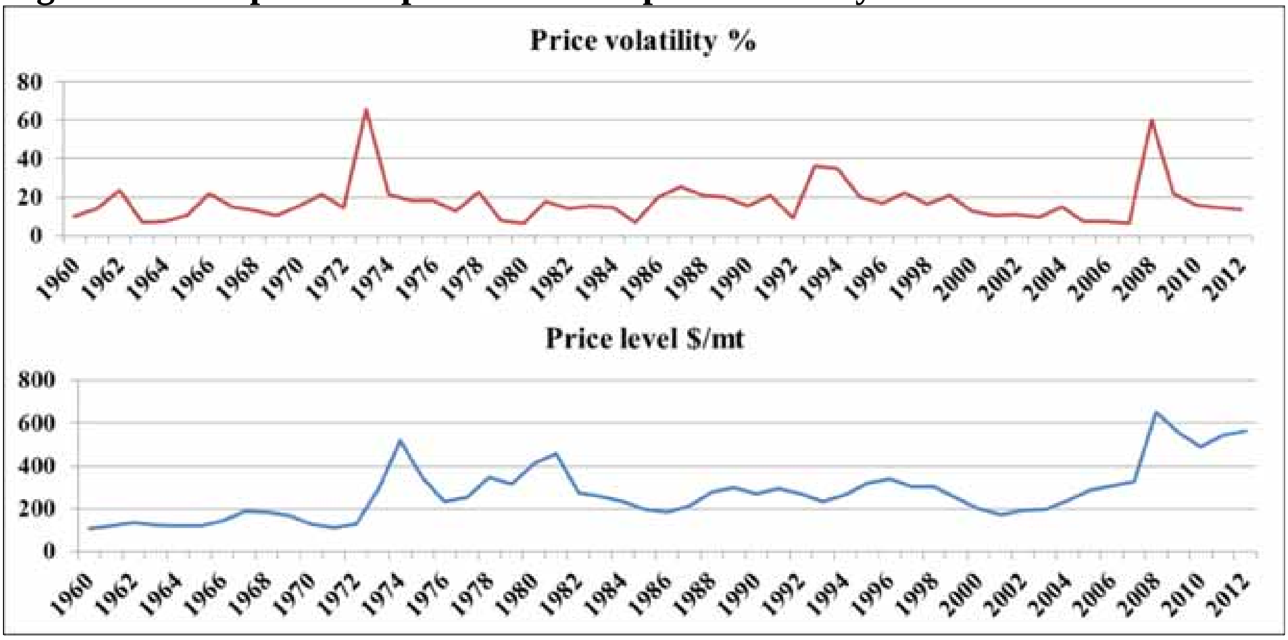
In closing, the question remains to be clarified as to whether there is a connection between price level and price volatility. This is difficult to recognise at first glance, as would be suggested by Figs. 2.8 to 2.10 for maize, rice and wheat. However, the correlation coefficients between level and volatility certainly do show a significant positive connection, between 30% and 50% at least for the products maize, rice and wheat.

Fig. 2.8: Development of price level and price volatility for maize 1960 – 2012



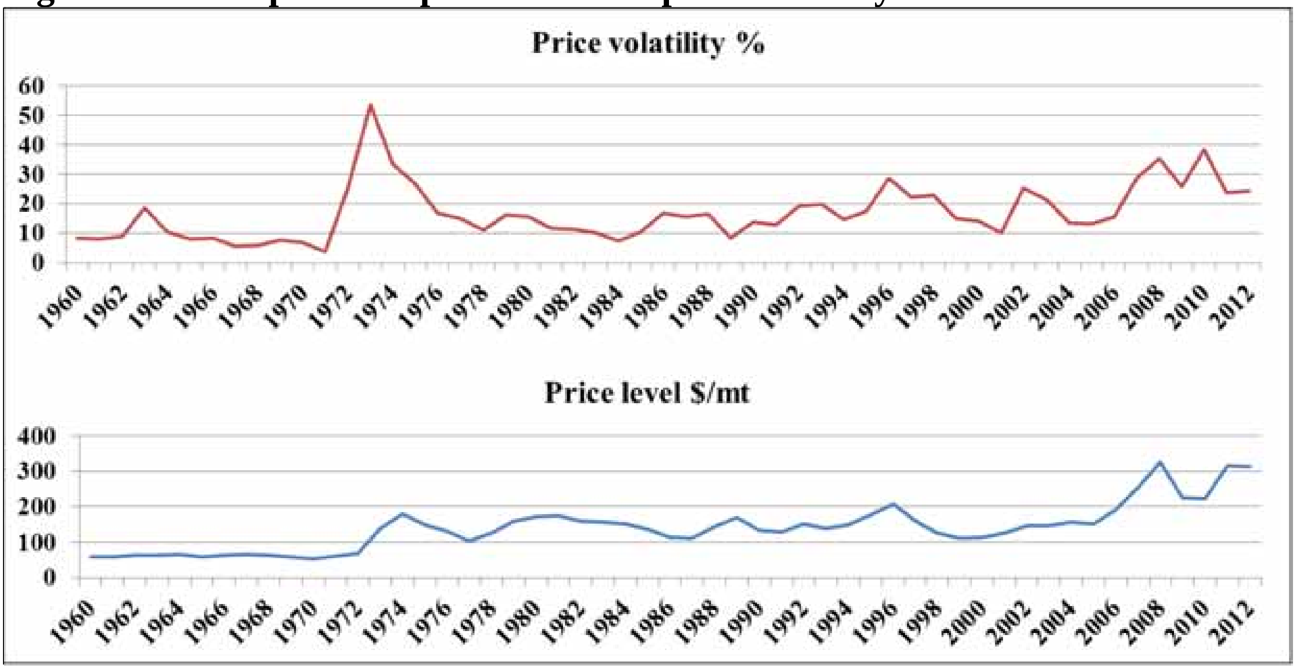
Source: Own calculation (database: WORLD BANK)

Fig. 2.9: Development of price level and price volatility for rice 1960 – 2012



Source: Own calculations (database: WORLD BANK)

Fig. 2.10: Development of price level and price volatility for wheat 1960 – 2012



Source: Own calculations (database: WORLD BANK)

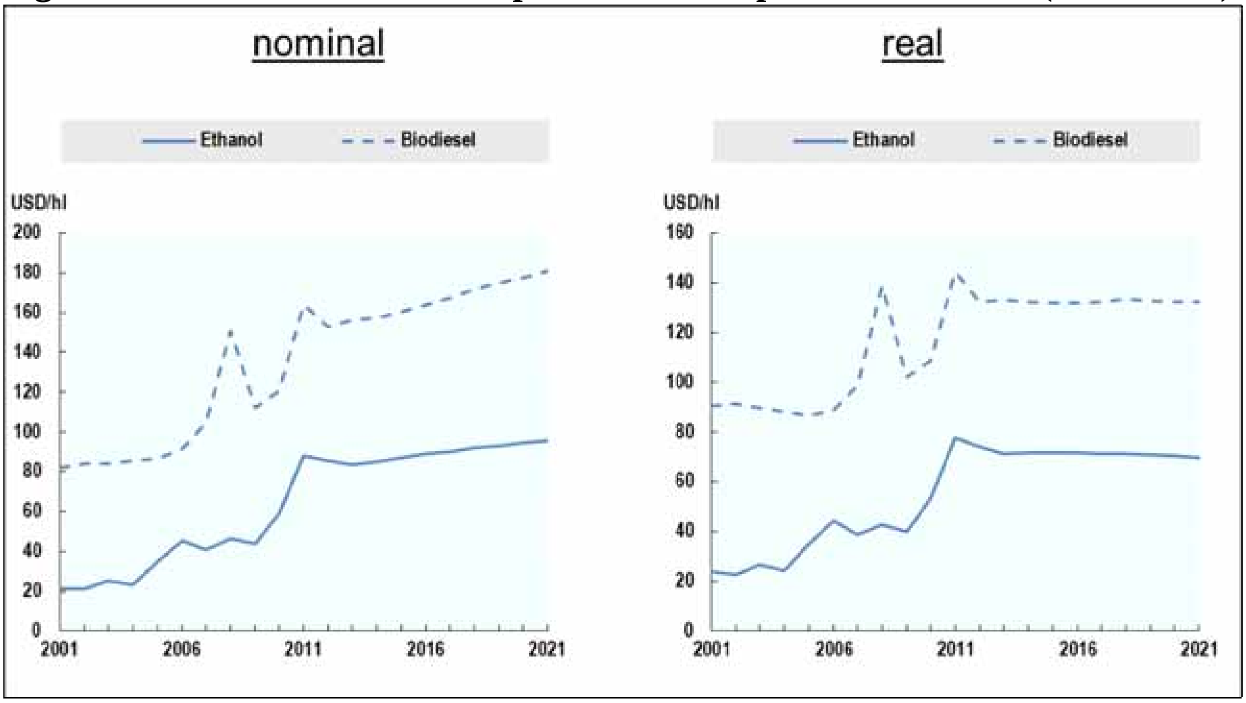
Accordingly, higher agricultural prices tend to lead to higher price fluctuations, even if this does not necessarily apply to individual years. But this means at the same time that there must be common determinants to explain the level and the volatility of agricultural commodity prices. This will be examined in Chapter 3.

2.2 Biofuel markets and policies

The biofuel markets are very closely connected to the agricultural commodity markets. For example, 40% of EU vegetable oils, 50% of Brazilian sugar cane and about 40% of the US maize production are used in the production of biofuels. Against this background it is obvious that we must also concern ourselves with the further development of the ethanol and biodiesel markets. These again depend not only on the prices for agricultural commodities, but also and above all on the oil prices and the individual biofuel policies. To be applied in this case above all are biofuel mandates, tax reliefs and import duties. Between these conflicting priorities, the prices and production of ethanol and biodiesel have been moving sharply upwards since 2005 (see Figs. 2.11 to 2.13). For example, the prices up until 2011 for biodiesel have nominally doubled, and quadrupled for ethanol. The OECD and FAO estimate that by 2021 there will be a further nominal price increase compared with the average for 2009 - 2012 of 50% for ethanol and of 37% for biodiesel, which corresponds to an inflation-adjusted growth of about zero. The growth dynamic in the global production of ethanol and biodiesel will also continue, although somewhat weakened, until 2021. Following a five-fold increase for biodiesel from 2005 to 2011/12 and a doubling for ethanol, a further growth for biodiesel of 95% and 84% for ethanol by 2021 compared with 2009 - 2011 is expected, i.e. almost a further doubling. In contrast, the global trade with biofuels measured against the production level would appear rather insignificant, with currently 4% for ethanol and 10% for biodiesel, however with an expected upwards tendency for ethanol by 2021, mainly as a result of the politically induced bilateral growth in trade between the USA and Brazil.

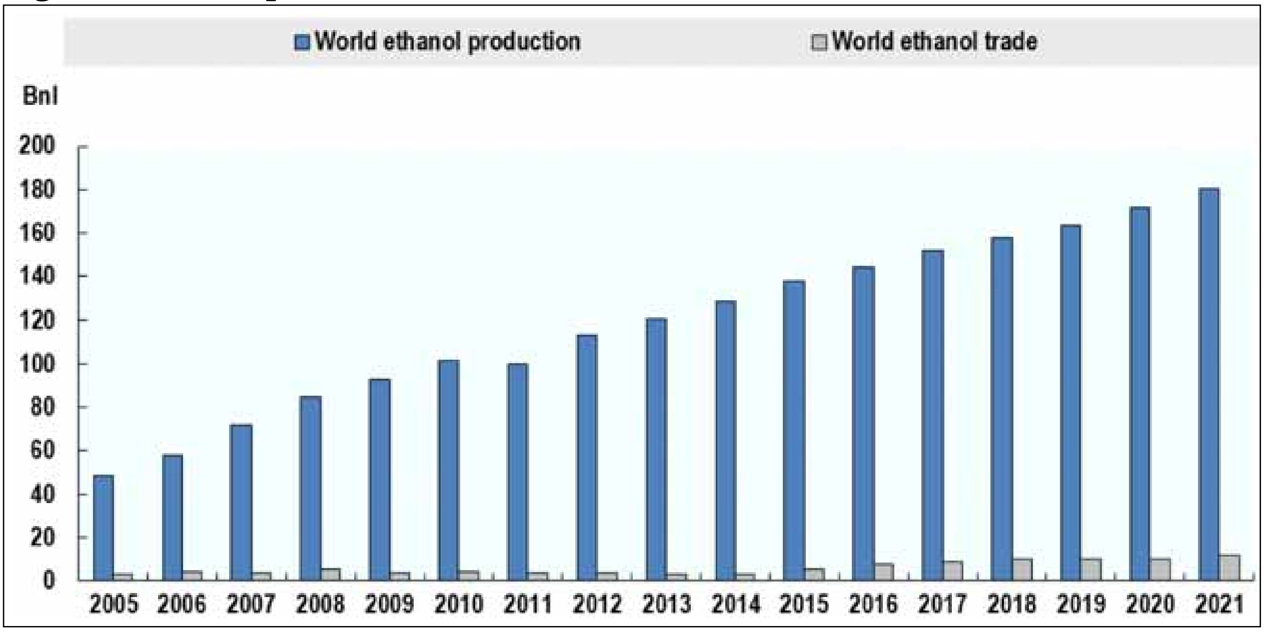
The largest producer and consumer on the biodiesel market with a production share of 48.9% (∅ 2009-11) is without doubt the EU (see Fig. 2.14), for which, however, an import demand of one to two billion litres is forecast, also for the future. Significant exporters in this connection are Argentina, which will double its exports by 2021, Malaysia and Thailand. On the other hand, with a production share of 48.6%, the largest producer and consumer of ethanol after Brazil are the USA (see Figs. 2.15 and 2.16). However, whilst the USA are developing an ever increasing net import demand of over eight billion litres in the forecasting period, Brazil is significantly expanding its ethanol exports to over 11.5 billion litres. Additional remarkable changes in trade result from the loss of external protection for EU ethanol imports (+150%) and on a considerably lower level for Argentinean and Thai ethanol exports.

Fig. 2.11: Ethanol and biodiesel prices over the period 2001-2021 (worldwide)



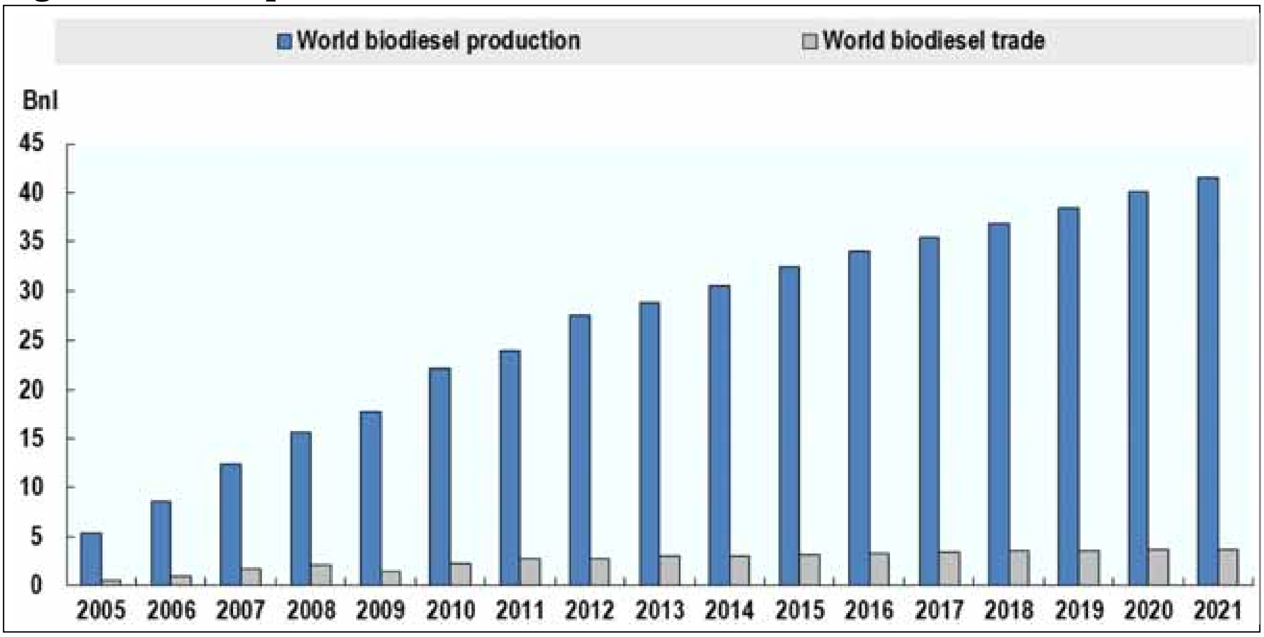
Source: OECD-FAO 2012

Fig. 2.12: Development of the world ethanol market 2005 - 2021



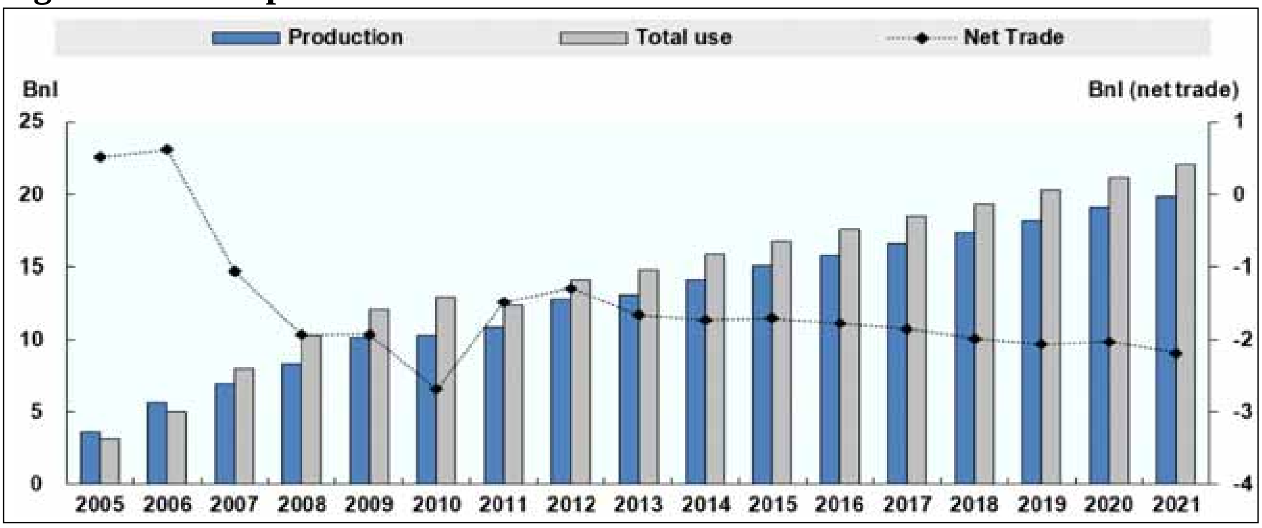
Source: OECD-FAO 2012

Fig. 2.13: Development of the world biodiesel market 2005 - 2021



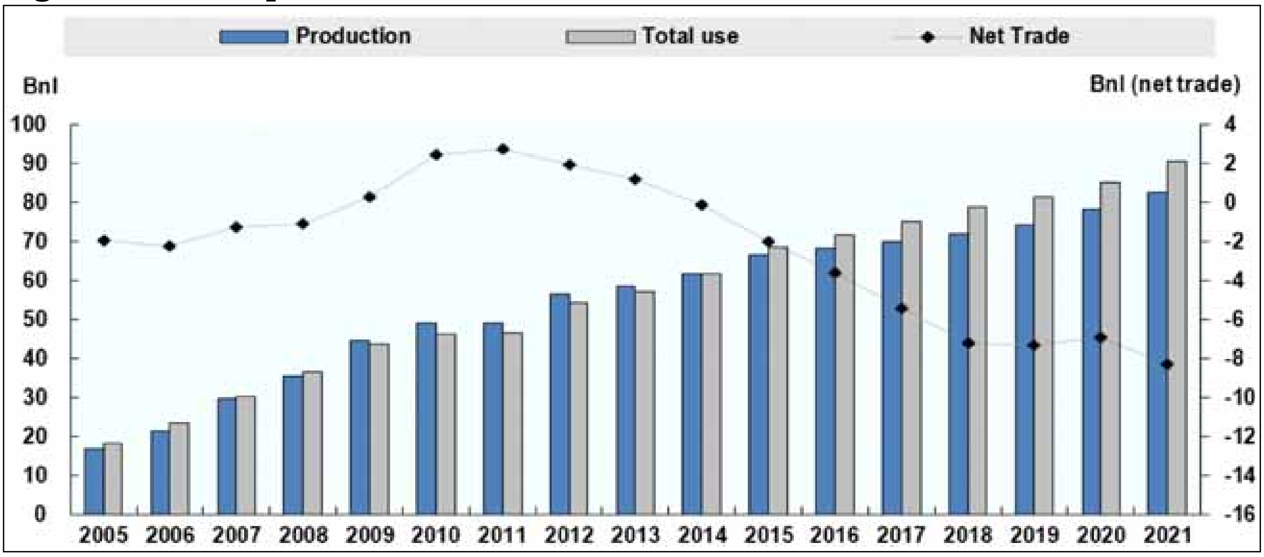
Source: OECD-FAO 2012

Fig. 2.14: Development of EU-biodiesel market 2005 - 2021



Source: OECD-FAO 2012

Fig. 2.15: Development of US-ethanol market 2005 - 2021



Source: OECD-FAO 2012

Furthermore, in 2012, 70% of the world's biodiesel production will result from vegetable oils and equally 72% of the world's ethanol production from coarse grain and sugar cane. This is then 31.2% of the world's sugar production from cane and beet, 13.6% of the world's grain production and 16.1% of the world's vegetable oil production which will be used for biofuel production. (see Table 2.1). The share in individual countries here are very different. For example, Argentina uses more than 70% of vegetable oils for biodiesel production, Thailand 55%, the EU about 50% and Brazil over 35% (see Fig. 2.17). Also for ethanol production there are considerable national differences. As mentioned at the start, 40% of US maize production and 50% of Brazilian sugar cane production is used for the manufacture of ethanol. This brief overview of the global market situation and market forecast for biofuels might suffice here.

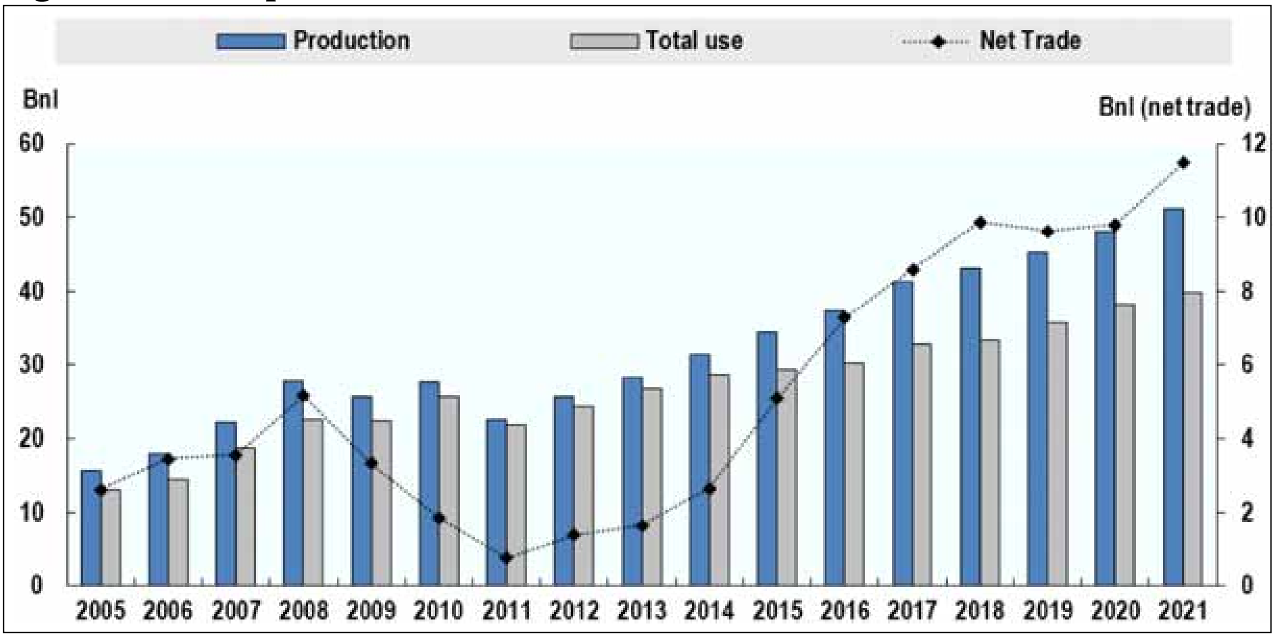
Table 2.1: Share of world commodity production used for biofuel production

Products as raw materials	2012	2021
Wheat	**1.2 %**	**2.1 %**
Coarse grain	**13.4 %**	**13.6 %**
Oilseeds	**13.5 %**	**16.1 %**
Sugar	**19.2 %**	**31.2 %**

Source: OECD-FAO 2012

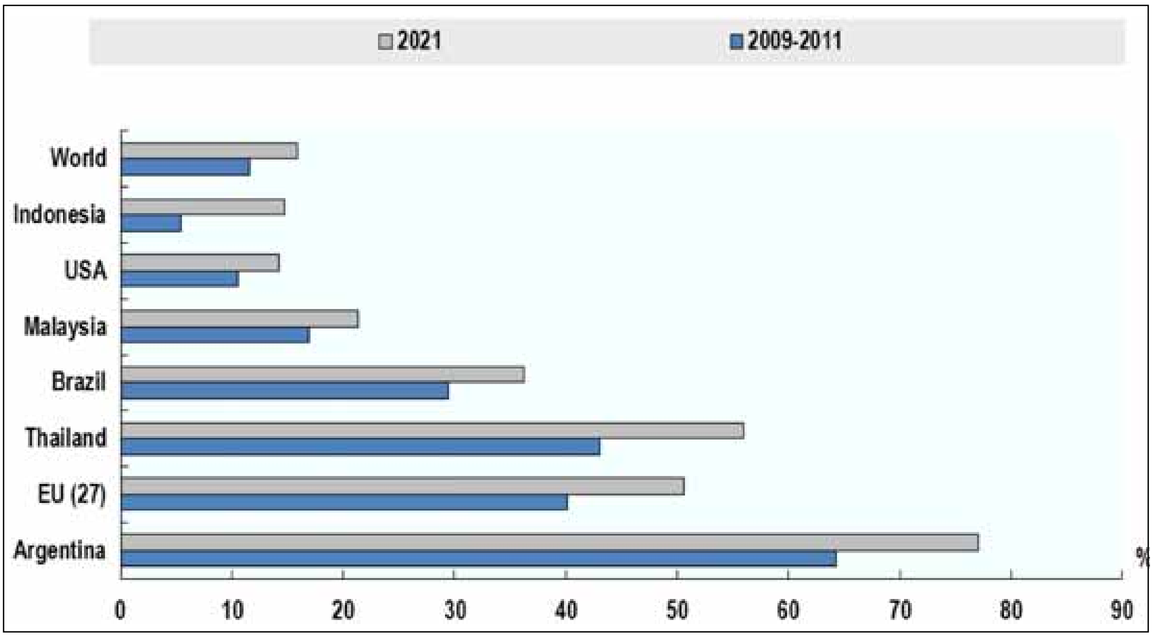
It remains to be stated that despite some uncertainties regarding biofuel policies, macroeconomic framework conditions and crude oil prices, a further significant growth in biofuel production must be anticipated. But how large this growth actually turns out depends precisely on these determinants. For the oil price, an increase from 84.1 US dollars per barrel (∅ 2009-11) to 142.4 US dollars in 2021 is forecast according to OECD-FAO (2012), an increase of almost 70%. However, should the extraction of shale oil in the USA gain further significance, a moderate rise in the oil price would certainly be envisaged. The consequence of this would also be a smaller growth in biofuel production.

Fig. 2.16: Development of the Brazilian ethanol market 2005 - 2021



Source: OECD-FAO 2012

Fig. 2.17: Share of vegetable oil consumption used for biodiesel production in selected countries



Source: OECD-FAO 2012

Finally the question remains of how biofuel policies in the most important production regions will further develop. These are without doubt the EU and the USA, each of which has a share of just short of 50% of the global production of biodiesel and ethanol. In the EU Directive 2009/28 EC for the promotion of the use of energy from renewable sources, published in the Official Journal of the EU dated 5 June 2009, the mandatory target was to increase the share of renewable energy in the transport sector to 10% by 2020. At the same time, fuel suppliers were required in 2009 to reduce greenhouse gas emissions by at least 6% by 2020, for which great significance was attached to the admixture of biofuels (amendment to the fuel quality directive 98/70 EC dated 28 December 1998, EU Commission, 2012). In addition, sustainability criteria including minimum savings to be achieved in greenhouse gas emissions were established in both directives. The current sustainability criteria for biofuels include the provision that the emissions must be at least 35% lower (from 2017 at least 50%) than those of the fossil fuels that they replace. Aside from this, the raw materials must not originate from particularly carbon-rich areas or areas worthy of protection, such as rain forests or peat bogs. Meanwhile it seems that the EU would like to move away from these targets and is proposing among other things a cap on first-generation biofuels of 5%. The elimination of subsidies after 2020 and the introduction of a penalty value in the calculation of greenhouse gases to take account of indirect land use changes (iLUC factors) are also envisaged. Should this proposal become reality, a considerable burden on the biofuel sector would be expected, in particular for biodiesel production. It therefore makes sense to look more closely at and to examine the scientific grounds of the EU proposal. In the meantime this has happened and there are now serious doubts about the validity and correctness of the calculation of the iLUC factors, as well as the derivation of the 5% boundary for first-generation biofuels (see FINKBEINER, 2013).

The Commission will have to account for these justifiable objections and also, bearing in mind the protection of confidence of a whole industry and its market partners, if not retract its proposal, considerably relax it. Incidentally, a sensible and targeted climate protection policy should not draw on individual phenomena, but cover all factors that lead to direct and indirect land use changes, therefore alongside plant and animal production, also the use of forests and green areas for other agricultural purposes (e.g. timber industry, demands for firewood, settlement areas, oleochemistry). After all, in the whole discussion the fact is ignored that a large share of the increased demand for agricultural commodities will be satisfied less by the additional use of land area (see also the potential estimates of ZEDDIES et al., 2012), and more through increases in intensity and yield (see Table 2.2). If one follows the current debate around biofuel policies in Germany and the EU, one can realistically expect that the aim to subsidise biofuel production at least until 2021 will be basically maintained, but that the original counting dynamics will be somewhat reduced, despite the relaxation of the proposals of the current Commission. The growth rates of the EU biofuel production will become somewhat lower and will not reach the level that was established in the original national action plan of the EU, for example for biodiesel, namely an approximate doubling of the quantities from 2010 to 2020 (see Table 2.3).

Table 2.2: Average annual growth rates in world rice, wheat and maize production

	1960 – 2011	1992 – 2001	2002 - 2011
Production	**2.4**	**0.9**	**2.5**
of which yield	**1.9**	**1.4**	**1.9**
of which area	**0.5**	**-0.5**	**0.7**

Source: TOWNSEND (o.J.), in OECD-FAO 2012

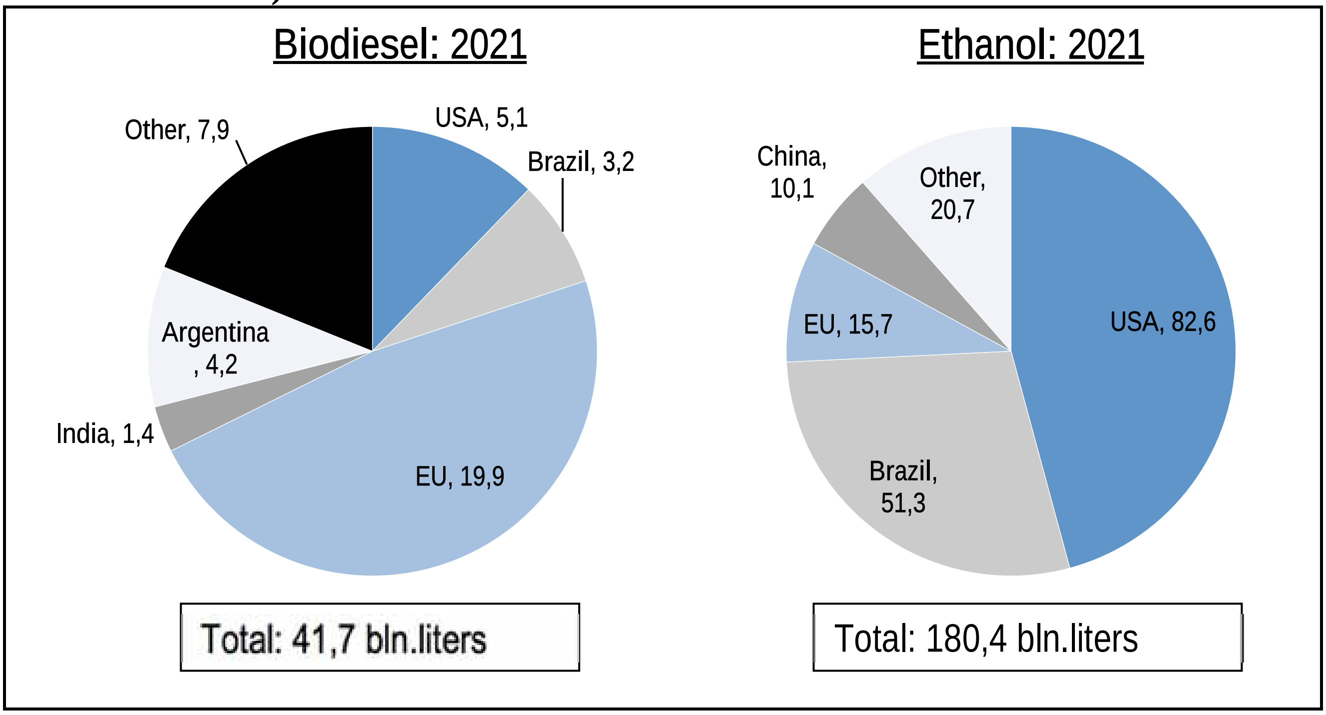
Table 2.3: National action plans – EU biodiesel usage in transport sector (million tons)

Country \ Year	2005	2010	2015	2020
Germany	1.873	2.420	3.255	5.184
Spain	0.170	1.716	2.530	3.616
France	0.382	2.526	2.770	3.325
Great Britain	0.060	1.004	2.136	2.872
Italy	0.209	1.012	1.603	2.193
Netherlands	0	0.162	0.407	0.643
Czech Republic	0.003	0.225	0.405	0.577
Portugal	0	0.327	0.472	0.525
Finland	0	0.174	0.349	0.501
Austria	0.04	0.322	0.360	0.478
Total	**2.737**	**10.723**	**13.452**	**19.914**
Total EU-27	**2.753**	**11.225**	**14.613**	**21.83**

Source: Netherlands Energy Research Centre, quoted in UFOP (2011)

In the USA, the discussion on biofuels runs less critically. There the climate protection problems are less in the foreground of the debate, but rather the wish to achieve greater energy independence. Thus with the two Renewable Fuel Standards (RFS 1 and 2) published in 2005 and 2007, ambitious expansion targets have been formulated (see SCHNEPF and YACOBUCCI, 2013). In particular in RFS 2 there is the provision for an increase in the minimum consumption of biofuels from 9 billion gallons (1 gallon = 3.785 litres) in 2008 to 36 billion gallons in 2022, of which 16 billion gallons is for cellulose-based biofuels (second generation) and an upper boundary of 15 billion gallons for maize starch-based ethanol from 2015. Moreover there are separate and convoluted consumption quotas for conventional biodiesel and for "second generation biofuels", e.g. based on sugar cane, sorghum and wheat. The share of maize used in the production of ethanol will therefore more than halve, from 87% in 2012 to 42% in 2022. In the USA one is also banking on a further increase in second-generation biofuels, which are expected to grow to a 44% share of the total minimum consumption volume by 2014. To fulfil the consumption quotas, the US mineral oil companies will to a certain extent have to import sugar cane ethanol from Brazil, while at the same time the biofuel manufacturers will be exporting maize ethanol to Brazil. A further problem results from establishing minimum consumption amounts in units of quantity rather than in percent, as is normal in the EU and in many other countries. With the current decline in fuel consumption in the USA, the 10% mark (blend wall) has been reached. Higher admixtures fail on the fact that no vehicle approvals have yet been issued. It is expected that biofuel production will increase also in the USA, however at reduced rates and with an amended raw material composition.

Fig. 2.18: Biodiesel and ethanol production in 2021 (main countries, billion liters)



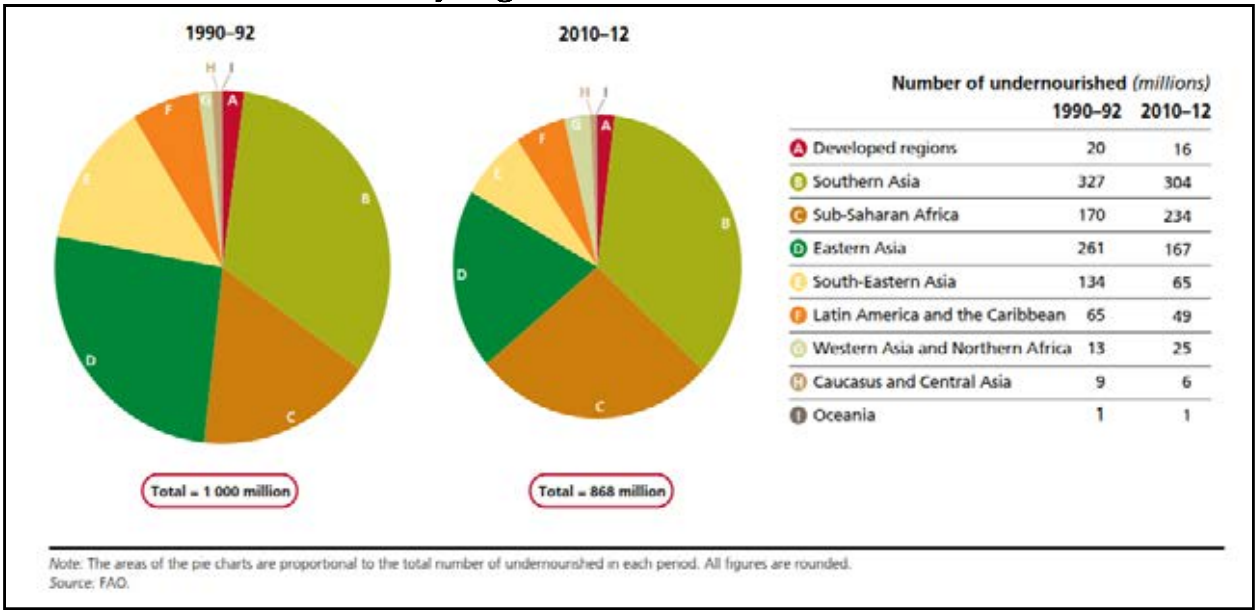
Source: OECD-FAO 2012

In contrast to the decelerating growth of these two large producers and consumers of biofuels, numerous emerging and developing countries are considerably expanding their biofuel production and are also pursuing ambitious development goals for the future. And the focus there is still on the use of traditional raw materials (first generation) for the manufacture of biofuels. An increased promotion of second-generation biofuels, as is planned in the EU and the USA, can only be recognised on a small scale in emerging and developing countries. Therefore until at least 2021, the growth in the world production of biodiesel and ethanol, as predicted by the OECD/FAO, will approximately double and will more or less revert back to using the same raw materials. The production shares between the countries will only change a little. The USA, the EU and Brazil will remain the main players (see Fig. 2.18)

2.3 Trends of the food and nutrition situation

According to the FAO report on the world food situation from 2012 (FAO, 2012a), the number of undernourished people in the period 2010 – 2012 is estimated to be 868 million (see Fig. 2.19).

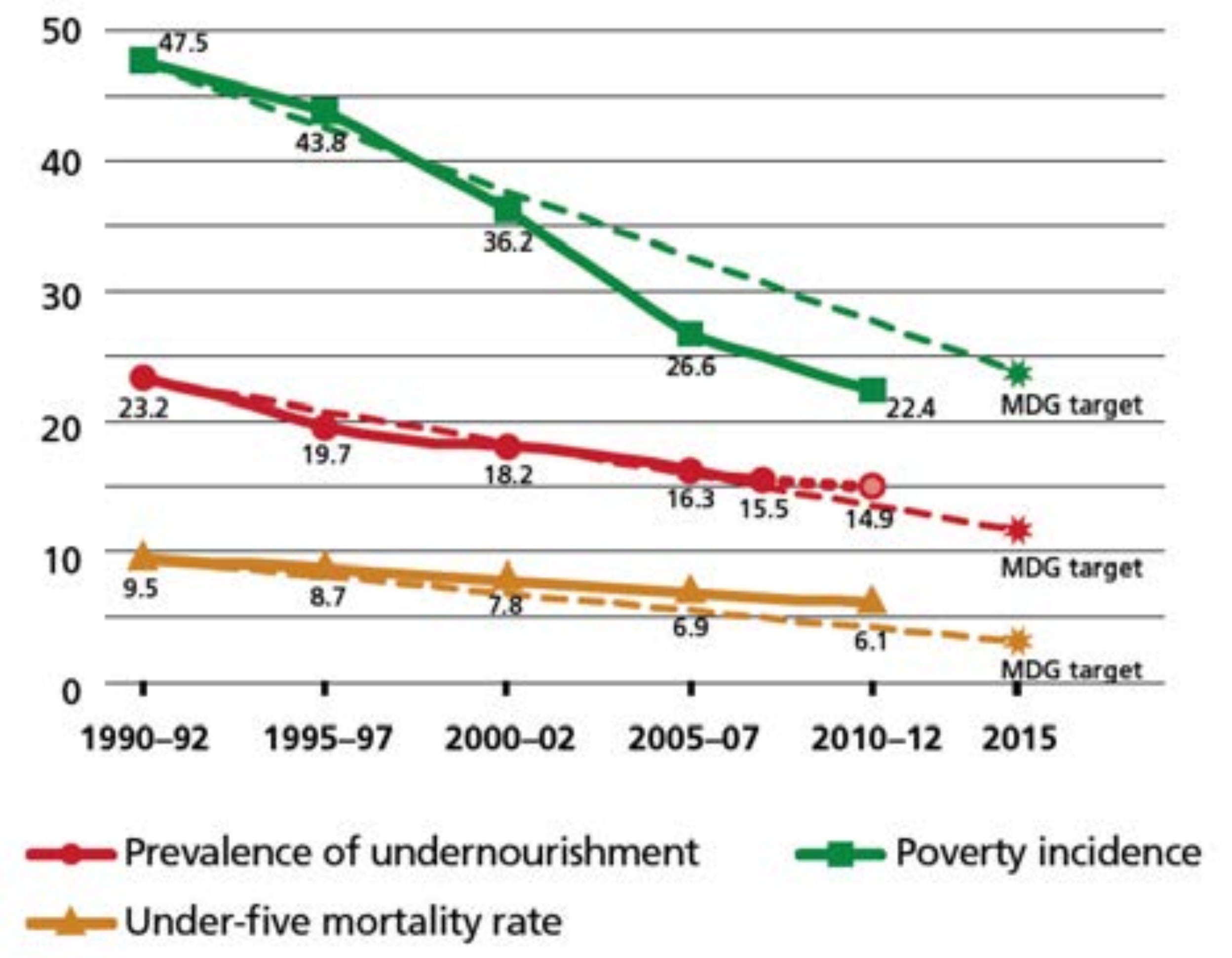
Fig. 2.19: The distribution of hunger in the world is changing. Number of undernourished by region, 1990–92 and 2010–12



Source: FAO 2012a

That is 12.5% of the world population, therefore every eighth person. Of these, 852 million people live in the developing countries alone, which represents a 14.9% share of the local population. With 327 million, the majority of undernourished persons are to be found in South Asia. In second place is sub-Saharan Africa, with 234 million starving people. Relative to the population numbers, however, sub-Saharan Africa is considerably ahead, with a share of undernourished of 26.8%, compared with 17.6% in South Asia. In contrast, the number of starving people in Latin America and the Caribbean is comparatively low at 49 million, which is 8.3% of the population. In spite of the still unsatisfactory world food situation, the circumstances have on average improved considerably since 1990-92. Whereas there were a billion people suffering from hunger at the beginning of the 90s, this is currently estimated to be 868 million, therefore 13.2% fewer. The share of undernourished people in developing countries has therefore almost halved from 23.2% in 1990-92 to 14.9% in 2010-12 (see Fig. 2.20).

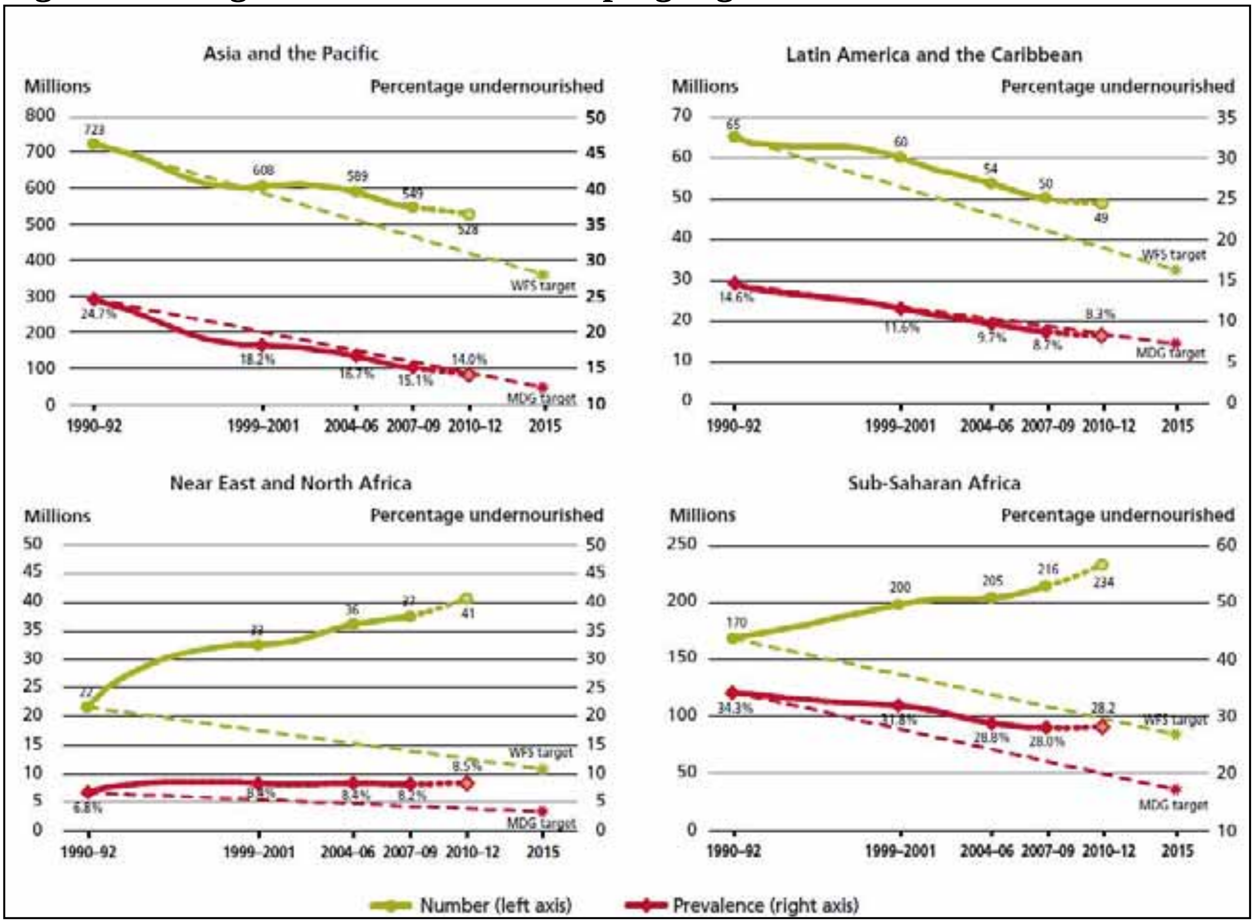
Fig. 2.20: Poverty, undernourishment and child mortality in the developing n world



Source: FAO 2012a

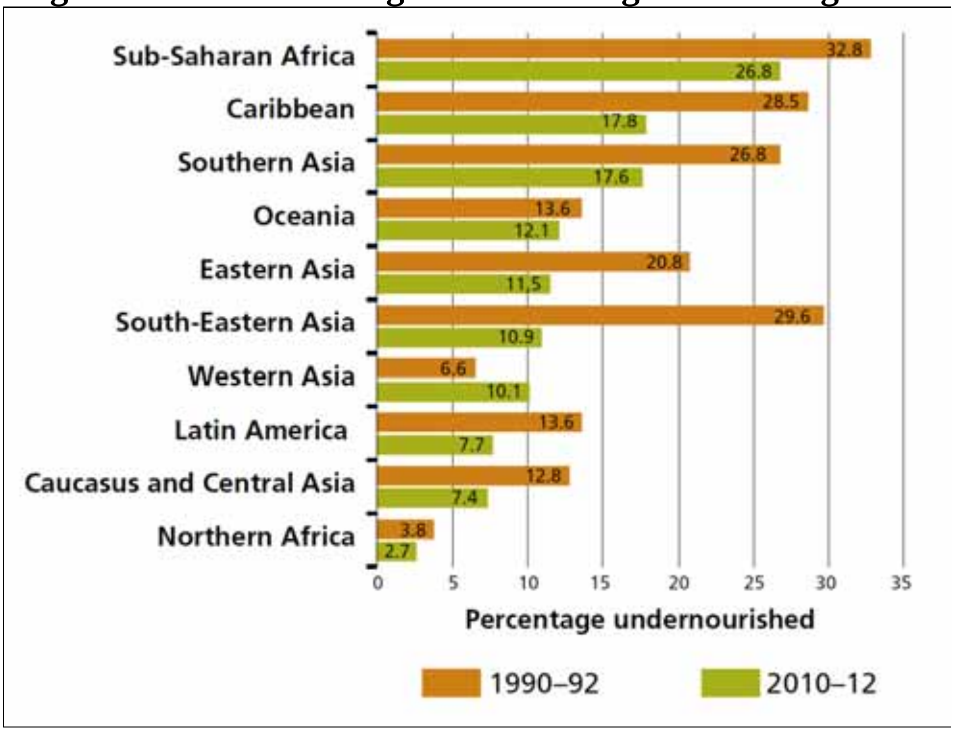
Achievement of the "Millennium Development Goals", namely the halving of hunger by 2015 measured against the situation in 1990, is therefore moving into the realms of possibility. The same applies to child mortality in children under five, the share of which has fallen from 9.5% to 6.1% in the same period. The goal of halving poverty in the developing countries has already been more than achieved. Since 1990-92, the share of poor people in those countries has fallen from 47.5% of the population to 22.4% in 2010-12 (see Fig. 2.20). Poverty in this case is defined as the share of people who live below the poverty threshold and are therefore not able to achieve a minimum standard of living. So although the world food situation has distinctly improved on average, the developments in individual countries and regions of the world are very different (see Figs. 2.21 and 2.22).

Fig. 2.21: Hunger trends in the developing regions 1990 - 2012



Source: FAO 2012a

Fig. 2.22: Progress towards meeting the MDG target across regions



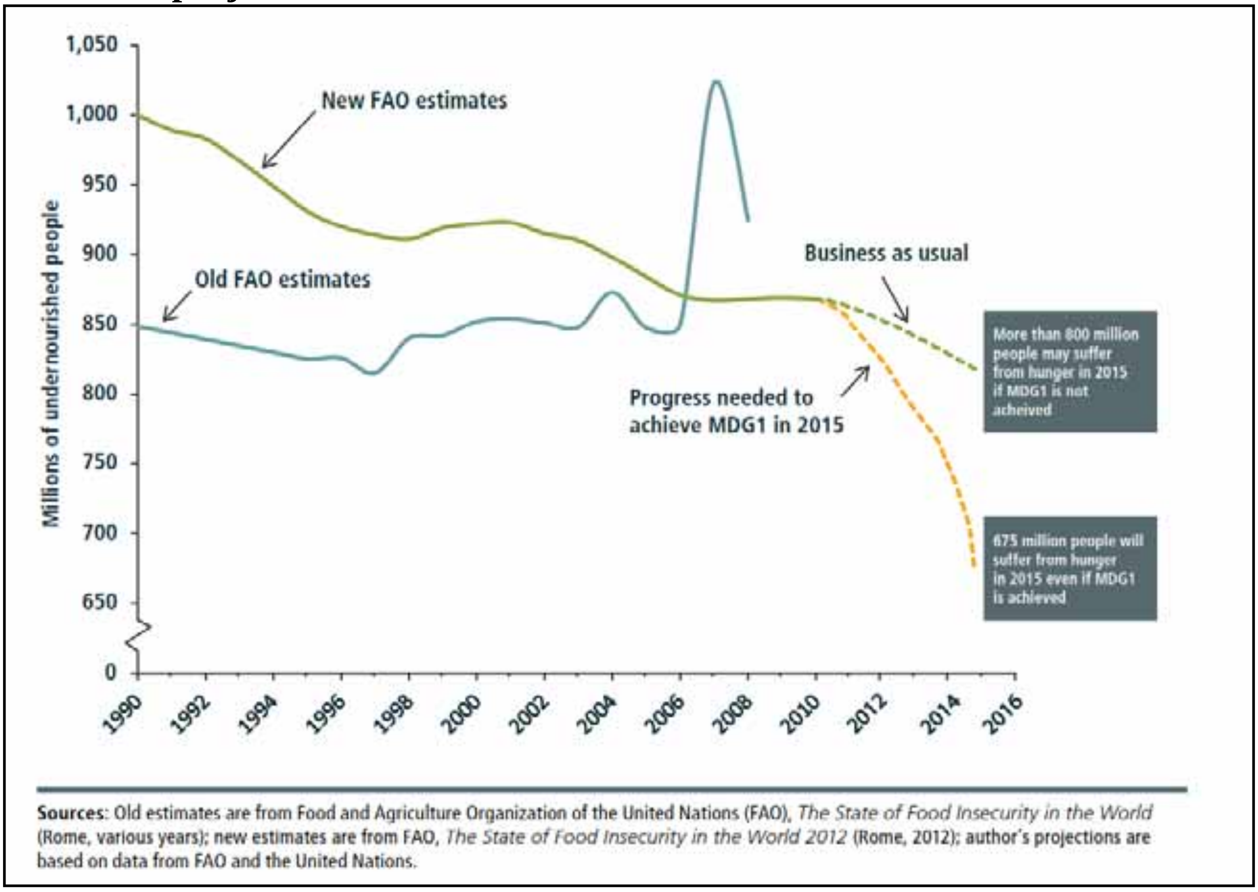
Source: FAO 2012a

Accordingly, developments in Asia and in the Pacific Rim as well as in Latin America and the Caribbean have proceeded in an above-average positive direction. The greatest advances have been made in South-East Asia in countries such as Thailand, Vietnam, Cambodia and Indonesia, where the share of undernourished people has fallen from just short of 30% to 10.9%. In contrast, the share of starving people in Western Asia has increased from 6.6% to 10.1%, and in the Middle East together with North Africa from 6.8% to 8.5%. However, taking North Africa on its own, the share according to Fig. 2.22 has fallen from 3.8% to 2.7%, meaning that the increase in Fig. 2.21 must be attributed entirely to the Middle East alone. With a reduction of the share from 32.8% to 26.8%, the advances in Sub-Saharan Africa must be termed more modest, particularly as the absolute number of starving has actually increased from 170 million to 234 million people. In the fight against hunger and poverty in the world, particular attention must be directed towards Africa, for which the positive developments in Asian countries could take on an exemplary function. Here the growth in agriculture, particularly the growth in yield, as well as the development of rural areas seem to play a central role. Even so, according to estimates of the FAO, 70% to 80% of the poor and the undernourished can be found in rural areas.

In its 2012 report on the world food situation, the FAO points out that, as a result of improved estimating methods and an extended data basis, it must correct its previously quoted number of starving people. The revised numbers show higher values for the 90s and considerably lower values for the period 2007 to 2010, where the number of undernourished had originally been estimated to be over one billion people (see Fig. 2.23)

The FAO explains this by the fact that the effects of the global recession on the developing countries and the transmission of the agricultural price explosion from the world markets to the domestic markets of poor countries had been overestimated. If this argumentation is correct, it would have a central significance for the subsequent deliberations. The simple formula: “high and volatile prices for agricultural commodities exacerbate hunger in the world” could no longer be preserved. What therefore needs to be examined is, firstly, how high the price transmission from the world markets to the domestic markets really is, secondly, whether observable domestic price increases in poor countries are world market-driven or home-made, and finally thirdly, whether producer price increases are not more likely to reduce hunger and poverty in rural regions and therefore for the country on the whole. This will be examined in the chapters that follow.

Fig. 2.23: Old and new FAO estimates for worldwide undernourishment and projections till 2015



Source: IFPRI 2013

Despite carrying out the necessary correction of its own data, the FAO would clearly, although not completely, like to part from its previous argumentation pattern, maintaining that the reduction in the number of starving people has at least slowed down considerably since 2007 and that the increasing food prices have an exacerbating effect on hunger, specifically with regard to pure calorie requirements and the supply of micronutrients and vitamins. Although the significance of agricultural growth for fighting poverty and hunger is reported on extensively in its 2012 publication, the possible positive contribution of increasing agricultural prices is not explicitly addressed.

Instead, the significance of yield increases, of ownership rights, of non-agricultural income and of labour-intensive smallholder farming is emphasised, all of which is not wrong. However, the decisive question of whether agricultural price increases can also make an important contribution to fighting poverty and hunger in rural areas remains unanswered. This is presumably because in the previous year's report (FAO, 2011) exactly the opposite was claimed, and it is not possible to “back-pedal” so quickly. Here one could read that even the rural areas are to be looked upon as net food purchasers, and therefore would also be negatively affected by price increases. Meanwhile serious doubts have arisen regarding this theory (see Chapter 4.1).

Finally the FAO also attempts to defend its present line of argumentation by attributing the low price elasticity of the hunger figures to its indicator (Prevalence of Undernourishment) which allegedly measures only chronic undernourishment on a yearly basis, but does not take into account the consequences of short-term price spikes for the hunger situation. Against this background it proposes the use of further indicators, which is basically welcomed. In spite of this, one must ask why the previous price spikes on the world market lasting more than a year have not been reflected in the corresponding increase in hunger, or the price collapse in the corresponding reduction in hunger. Perhaps the connection between the world and the domestic markets is not all that close, as claimed by the FAO, and it is possibly shrinking domestic prices that are exacerbating hunger, not rising prices. And perhaps there are very different factors which are responsible for the poverty and hunger situation in developing countries, other than the level and the volatility of world market prices. These questions will be addressed in the following.

2.4 Interim results – correlation versus causality?

What interim conclusion can now be drawn from this overview, and how can the facts and numbers gained be used in that which follows? With regard to the pricing of agricultural commodities on the world markets, it can be established that

- the large price movements of the past six years in the long-term view since 1960 create no exception, and therefore no significant upwards trend in the volatility can be recognised, with the exception for EU internal markets which have so far been protected through market regulations;

- but in the future lower volatilities than before cannot be expected, therefore clever risk management by farmers must play a central role;

- the tendency will be for a rise in the price level of agricultural commodities and biofuels, and the oil price seems to play a certain role for shifts in the level.

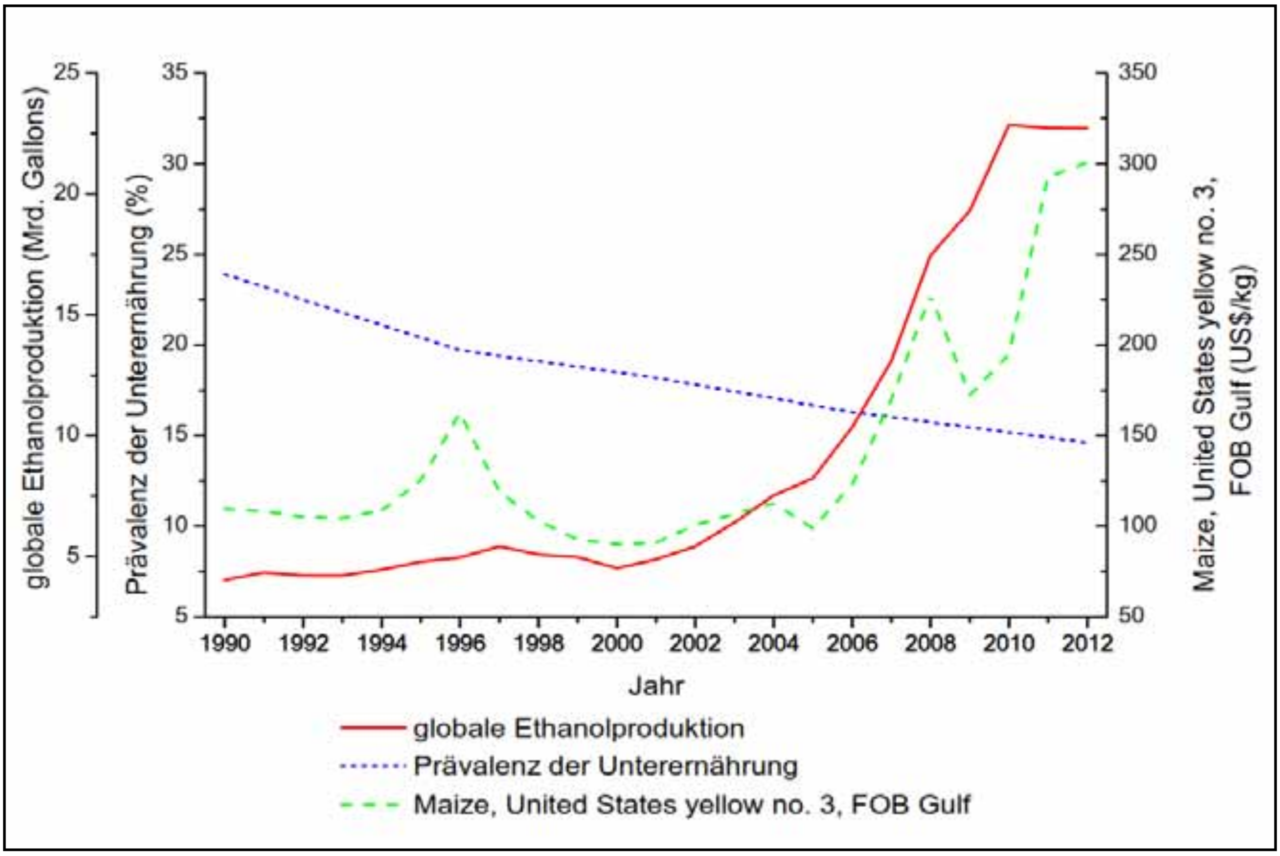
With regard to the biofuel markets, it remains to be stated that despite some uncertainties regarding biofuel policies, macroeconomic framework conditions and crude oil prices, a further significant growth in biofuel production must be anticipated. Here too, strong impulses seem to emanate from the oil price and from politics. The shift of promotion structures towards second-generation biofuels in the EU and the USA will be more than compensated at least until 2020 by the expansion of conventional biofuel production in numerous emerging and developing countries. The dynamics in the biofuel markets will therefore continue, also with recourse mainly to first-generation raw materials. The food-versus-fuel discussion will continue for this reason, also bearing in mind the world food situation.

This has developed by and large in a positive, if not yet satisfactory way, as is shown by the revised FAO data. With a few exceptions, the number of undernourished has fallen considerably since 1990, and there has also been a reduction in poverty and child mortality. Although the FAO believes it can recognise a weakening of the positive trend in the numbers of starving as a result of increasing and volatile prices since 2007, there is certainly no statistical proof of this link.

This leads us o the decisive question of whether there is a causal relationship between the increase in biofuel production based on raw materials which in principle could also serve as food and feedstuffs, the changed pricing situation on the world markets for agricultural commodities and, finally, the subsequent world food situation.

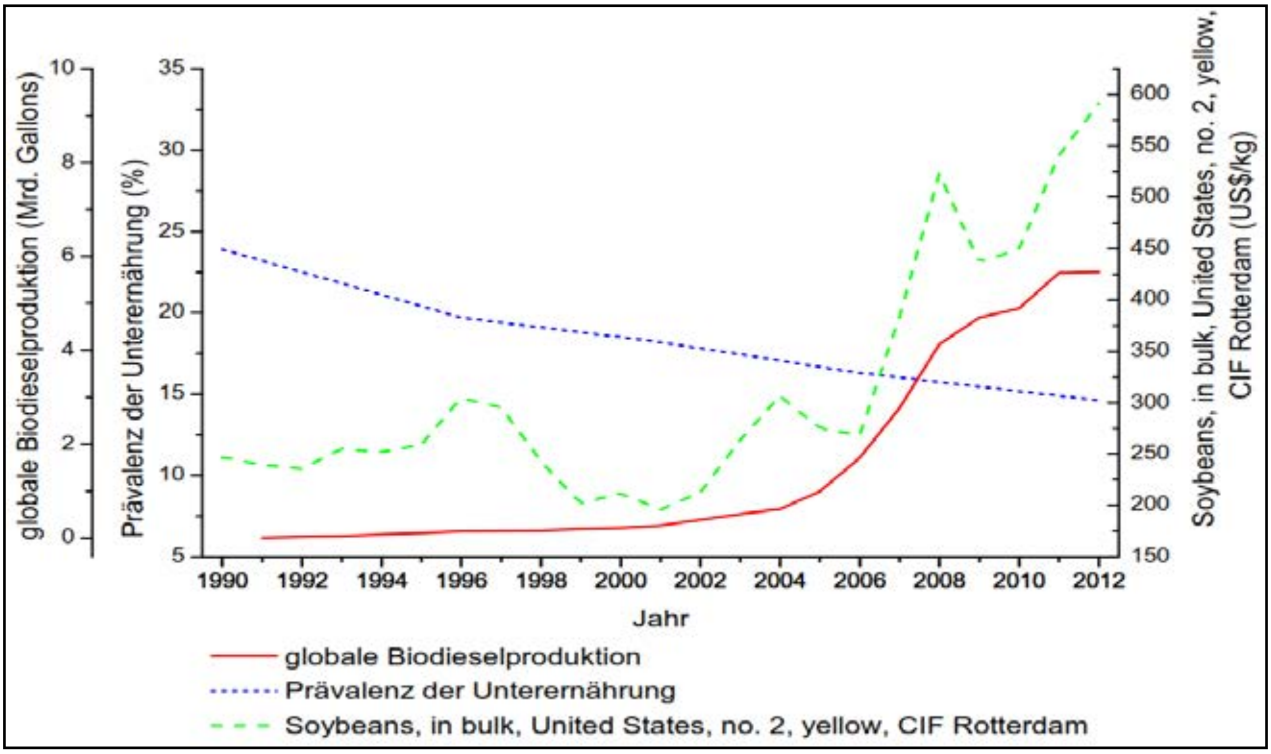
If one thinks in terms of categories of correlation, one could upon first glance at Figs. 2.24 and 2.25 perceive a link between the increase in biofuel production and the price increase for ethanol or for soybeans. Precisely this argumentation can be heard from many critics of biofuel policies. Incidentally, the arguments of the opponents of institutional speculators also follow the same pattern, attempting to explain the increase in futures and spot prices with the increasing involvement of index funds and banks, for which it is not at all clear whether speculators push the futures prices higher or the reverse, that is that high and volatile futures and spot prices attract the speculators (see Fig. 2.26). To be consistent, one must also derive from Fig. 2.24 and Fig. 2.25 that the hunger in the world is reduced by increasing agricultural prices and the increased production of biofuels. However, both interpretations are inadmissible without the inclusion of further explanatory factors for the pricing and for the world food situation and without a corresponding statistically secure analysis. The mere observation of two time series does not allow conclusions to be drawn on causal relationships, even though this happens time and again in public discussion and, unfortunately, also in articles by scientists. Needed for this purpose are econometric estimations and structural market simulation models, which are to be used in **CHAPTER 3**.

Fig. 2.24: Development of ethanol production, prices for maize and undernourishment



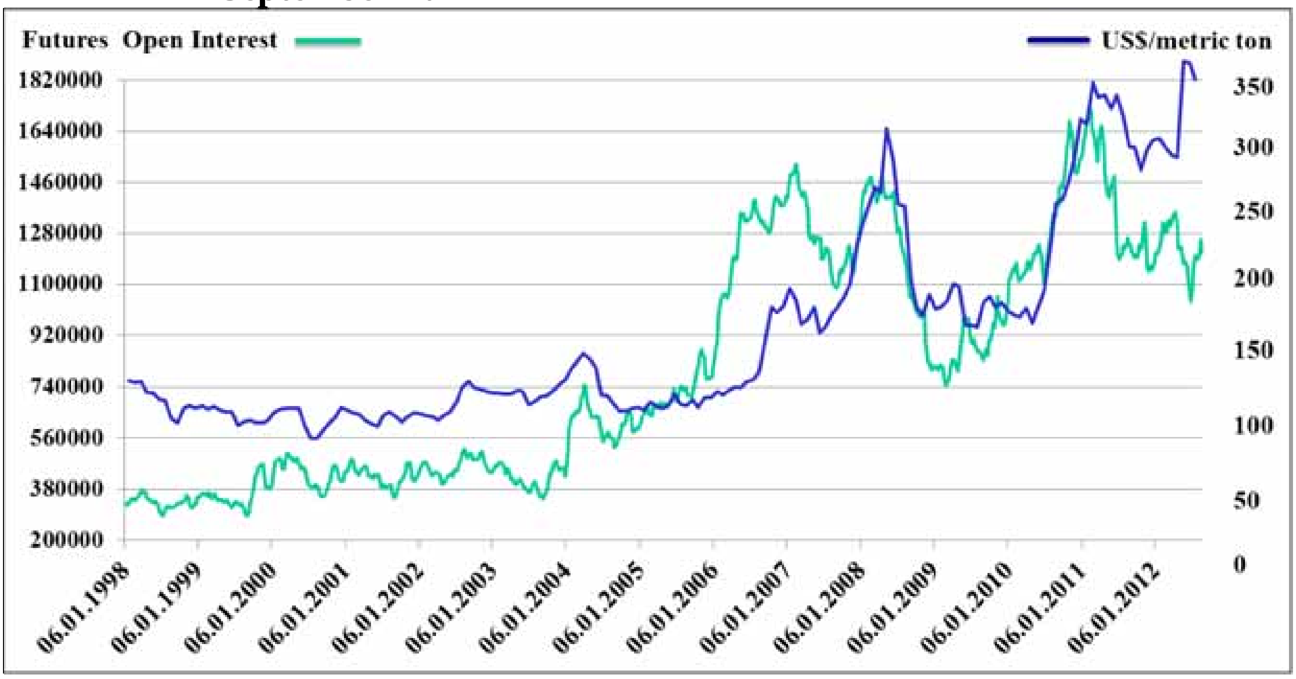
Source: Own representation based on data from UNCTADSTAT (maize price), FAO 2012 (Prevalence of undernourishment), F.O. Licht (ethanol production)

Fig. 2.25: Development of biodiesel production, prices for soybeans and undernourishment



Source: Own representation based on data from UNCTADSTAT (soybean prices), FAO 2012 (Prevalence of undernourishment), F.O. Licht (biodiesel production)

Fig. 2.26: Futures open interest and spot market prices for maize January 1998 – September 2012



Source: Own representation based on data from the WORLD BANK (Maize price), US Commodity Futures Trading Commission (Futures Open Interest).

3 Causes of high and volatile prices on international markets

The task in the following is to clarify which main determinants fundamentally affect the pricing situation in the world markets for agricultural commodities and in which direction, what quantitative effect the individual determinants have and what role biofuels and speculation play here. For this purpose a literature survey of more recent publications will first be undertaken followed by our own empirical analysis based on current data and using various econometric and market simulation methods.

3.1 Main drivers of the price situation

The more recent literature discusses a whole series of influential factors on the pricing situation in the world market for agricultural commodities (see Box 3.1). The weather plays a central role here, as its changeability as a result of climate change, particularly in the past six years, has had a significant influence on agricultural production and markets. Thus the price spike of 2007/08 was certainly also due to the simultaneous harvest losses on several continents, and the price collapse of 2009 was preceded by two record harvests. Furthermore, drought and floods in 2010/11 caused a renewed price high on numerous agricultural commodity markets. Finally, the price high for maize in 2012 could also be explained by the extreme drought in the USA. The weather is therefore evidently a primary factor in explaining price volatility, both in the high-frequency and low-frequency range, i.e. in the fluctuation range from less than to more than one harvest year (see ROACHE, 2010 and see Fig. 3.1) Besides the weather, other factors include animal and plant diseases that have turned out to be a new source of risk amid ever more intensive commodity exchanges worldwide, which can lead to hefty price reactions on the supply and demand side.

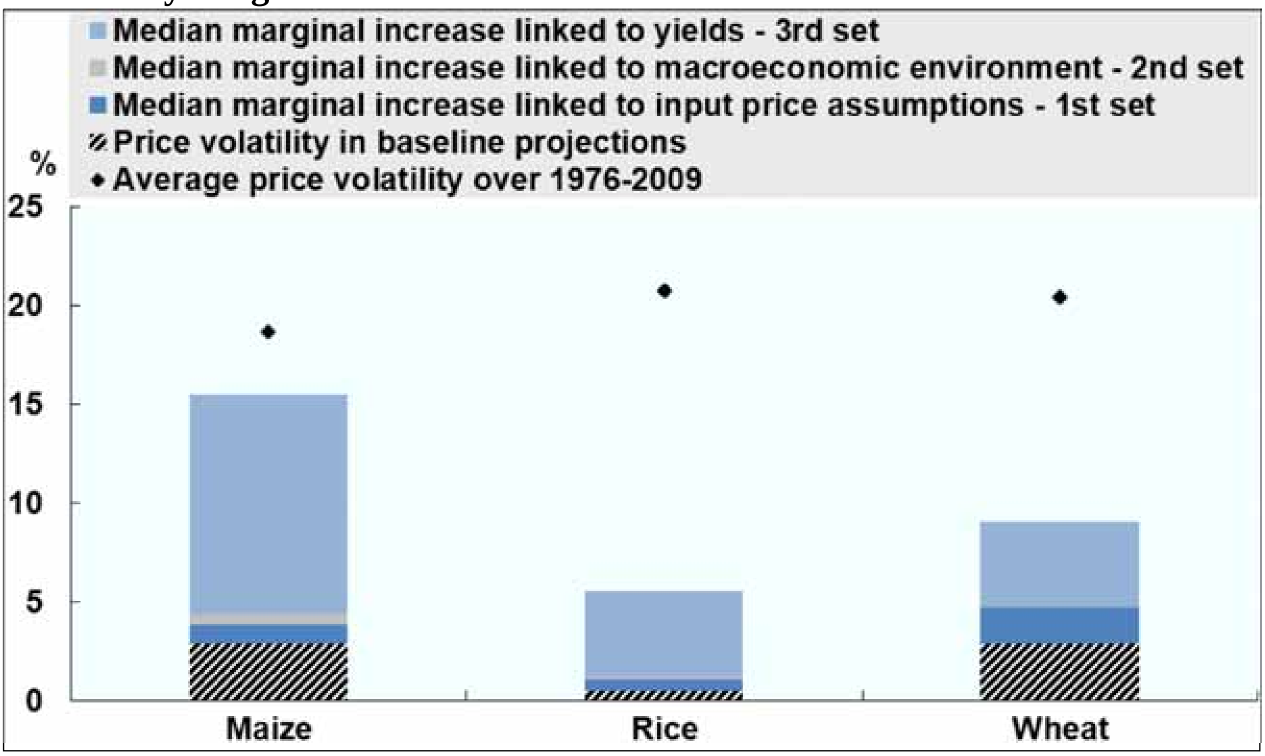
Box 3.1: Key drivers of high and volatile agricultural commodity prices

- Weather extrems, climate change, plant and animal deseases
- Stock-to-use ratio and thin markets
- Exchange rates (weak Dollar)
- Oil prices, interest and freight rates, inflation
- Land and water scarcity
- Population and income growth
- Dietary changes
- Reduced yield growth
- Trade policy adjustments
- Financialisation of agricultural markets and speculation
- Production and promotion of biofuels

Source: Own representation

* Red colour indicates eight drivers used as explaining variables in the econometric estimations in chapter 3.3.

Fig. 3.1: Contribution of individual production components to the price volatility of agricultural commodities

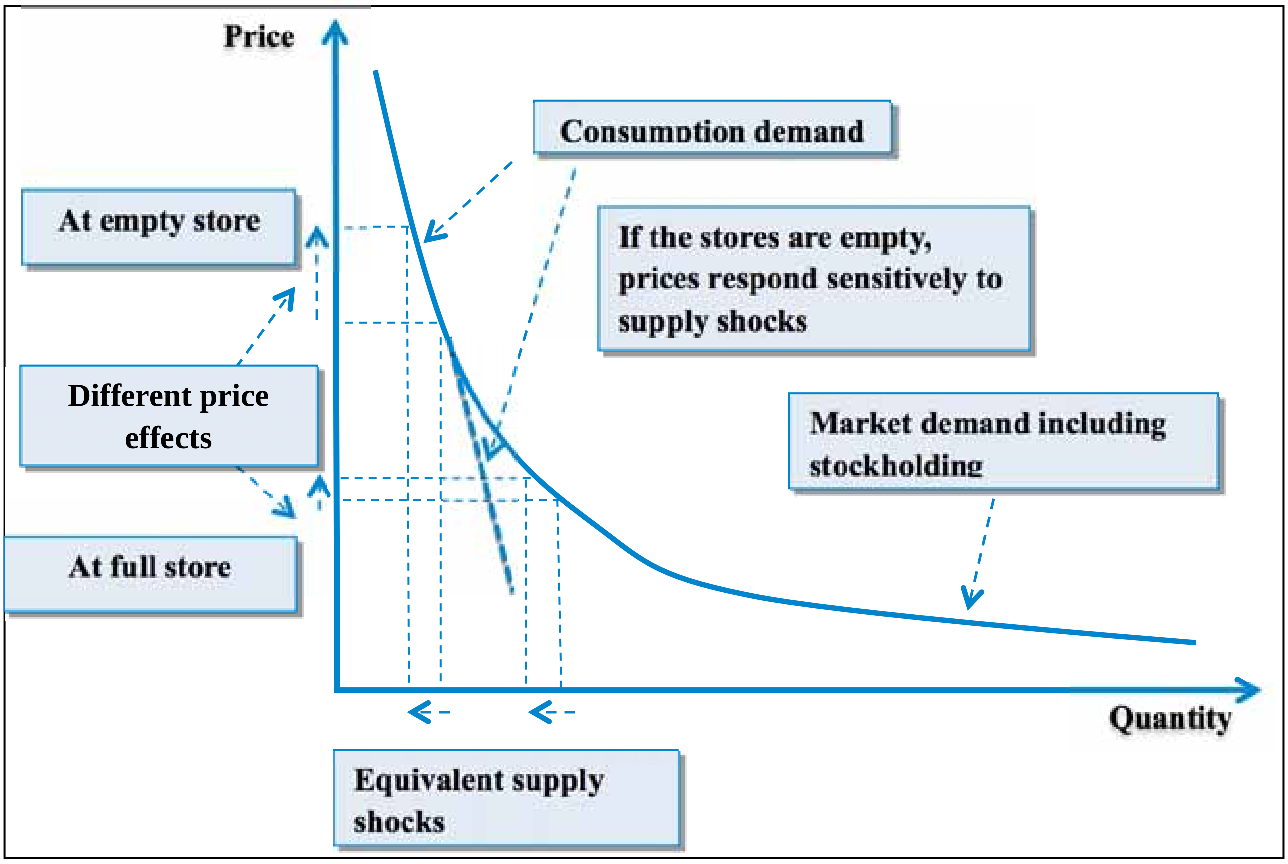


Source: OECD-FAO 2011

Whether prices react to such shocks or other shocks in an extreme or moderate manner depends primarily on the "stock-to-use" ratio. If stocks are low, the markets react extremely nervous to production failures or sudden boosts in demand with overshooting prices. This was typically the case in 2007/08. Figure 3.2 explains this situation.

The steep linear demand curve including the dotted part represents the pure consumption demand, e.g. for cereals. As a basic foodstuff, the demand curve takes a inelastic course, as expected. In the event of falling prices, however, an increasing tendency towards speculative stockholding demand ensues, with the expectation of being able to sell the commodity later at a higher price. This makes the demand curve in the lower area more elastic. If unexpected shocks in the supply now occur, these cause very different price effects, even in the case of equivalent quantity changes (see Fig. 3.2). In the case of empty stores, supply shortages lead to extreme price fluctuations upwards, while only low price rises are to be noted when stores are full. It is therefore not surprising that numerous investigations reveal a close negative correlation between price level and stock level (or more precisely "stock to use ratio"), without the causality relationship being clearly explained by this (see WRIGHT, 2008 and 2009, and BOBENRIETH and WRIGHT, 2009). If stocks are at the lower level for a longer time period, price volatility will also increase in the event of persistent supply and demand shocks. Knowledge of private, public and semi-public stockholding activities and quantities therefore also plays a critical role in predicting future price volatilities. These have not been recorded properly until now. The establishment of greater transparency in this area could make an important contribution to stabilising world markets.

Fig. 3.2: Significance of stockholding for price volatility due to supply shocks

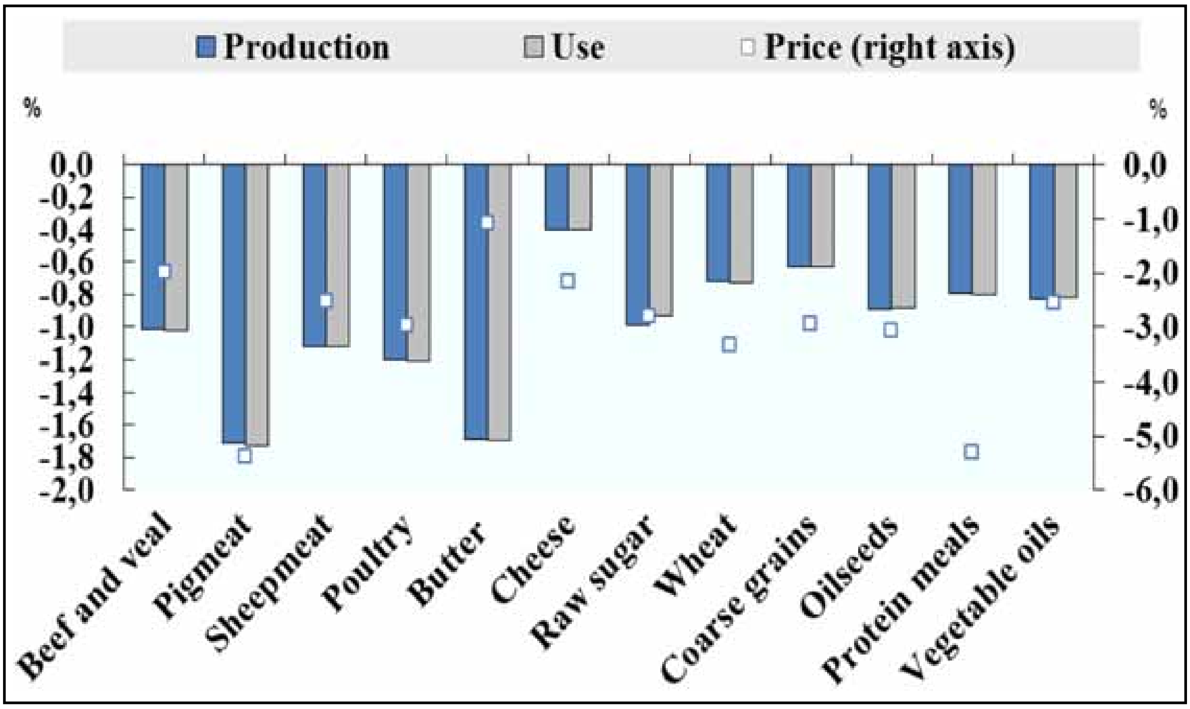


Source: Wright 2009

Occasionally, the existence of thin markets is held responsible for price volatilities (see TANGERMANN, 2011). The term "thin" markets is used if the trade volumes only account for a small share in comparison to the world supply and world demand, as for example with sugar. However, more intense price fluctuations only occur if the domestic markets are decoupled from the world market at the same time, and if signals from there only lead to minor reactions to supply and demand. Import demand and export supply elasticities are then especially low, with shocks being reflected in intense price movements.

The macroeconomic and cross-sector factors that influence agricultural commodity prices include without doubt exchange rates, interest rates, inflation and money supply as well as oil prices, freight costs and the income growth rates. In the form of real income rises, the latter have the long-term effect of increasing the demand for agricultural commodities and, together with population growth and altered dietary habits towards an increased consumption of animal products, are an important reason for explaining the continuous price level rise expected in the future. However, price volatility in the low-frequency range is affected if the gross domestic product of the most important trading nations fluctuates due to economic factors, thereby exceeding certain upper and lower boundaries of change rates. This was the case in the last financial crisis of 2009, when agricultural prices also severely collapsed. Just a 10% lower growth in the BRIC countries would in accordance with Fig. 3.3 have meant an average price drop for crop products of 2.5% and a drop of about 3% to 5% for animal products.

Fig. 3.3: Impact on consumption and world prices of a 10% lower GDP growth in BRIC countries

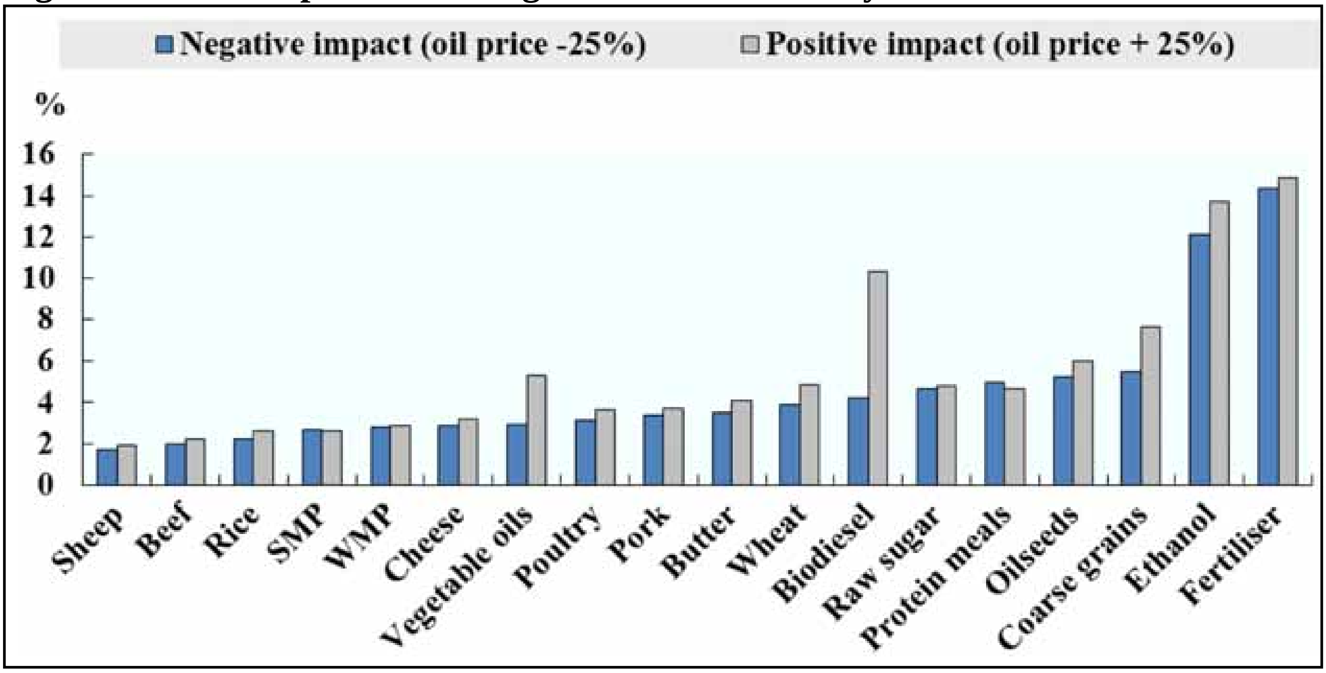


Source: OECD-FAO 2012

Rising oil prices have a dual effect on agricultural commodity prices. On the one hand, they make the inputs from agriculture and the food industry more expensive in terms of energy, freight costs and fertilizers. On the other hand, they render the use of bioenergy more attractive. In terms of supply and demand, agricultural commodity prices are therefore driven upwards by this, and upwards of a certain crude oil price, a close correlation with the agricultural commodity prices results on a purely statistical basis. The OECD/FAO estimate that a 10% oil price rise will lead to a 2.3% rise in wheat prices and a 3.3% rise in the maize and oilseed prices (see OECD-FAO, 2008). The potential lowering effect on agricultural prices of an oil price increase as a result of falling real income in the countries concerned therefore seems to be clearly overcompensated by the two price-driving influential factors. Newer calculations of the OECD/FAO (2012) show the predicted effects on the price of agricultural commodities, biofuels and fertilizers triggered by an increase in oil prices, alternatively for a

25% lower and a 25% higher increase (see Fig. 3.4). At 15%, the price effects are particularly obvious for the latter, but also for biofuels and the raw materials necessary for their manufacture.

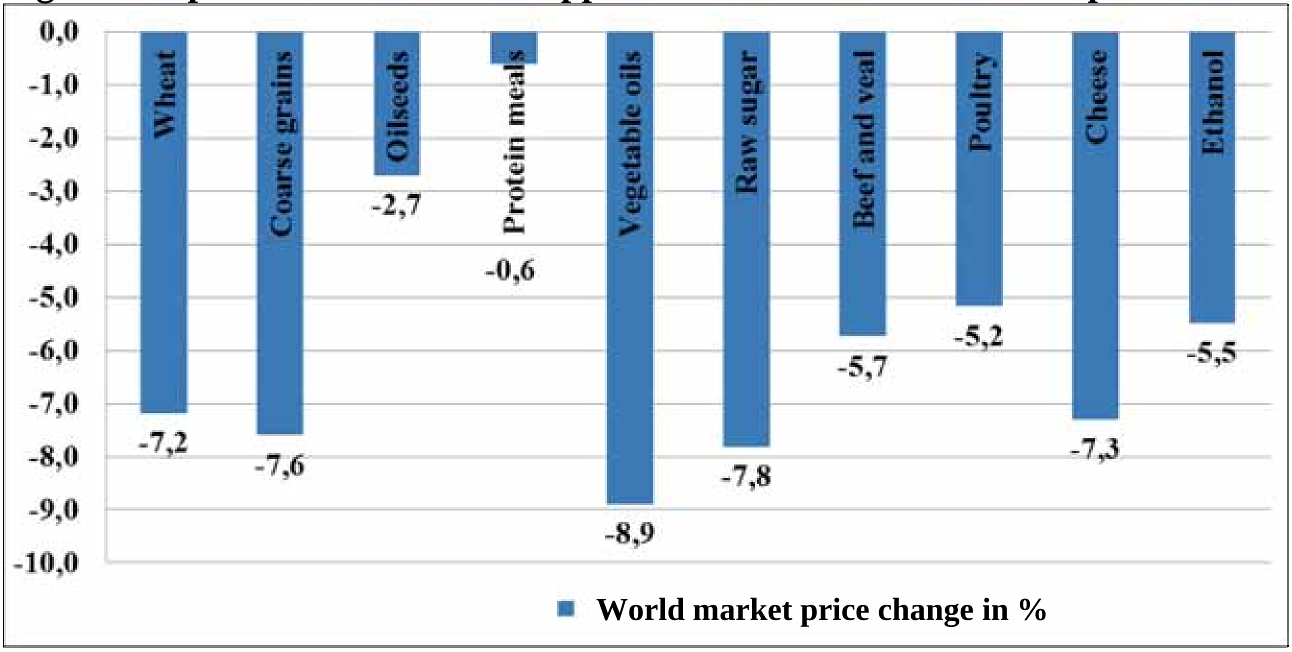
Fig. 3.4: Crude oil prices affect agricultural commodity and biofuels markets



Source: OECD-FAO 2012

A significant effect on the agricultural commodity prices is also to be expected from exchange rates, which are usually invoiced in dollars in international commerce. If the value of the dollar falls against the currency of the main trading countries, i.e. if the currency of the latter becomes stronger, there will be a retention of export supply and the demand for imports will be stimulated, with the effect of a world-wide price increase, as possibly occurred in the devaluation phase of the dollar in the period 2002 to 2008. TANGERMANN (2011) estimates the exchange rate-price elasticity for this period to be 0.1 to 0.3, i.e. a 10% dollar devaluation would lead to a 1% to 3% price increase. MITCHELL (2009), however, even concludes an elasticity of 0.75 in his empirical analysis. The OECD estimates it to be on average 0.5; for grain, oilseeds, raw sugar and cheese even 0.7 to 0.9 (see Fig. 3.5).

Fig. 3.5: Impact in 2021 of a 10% appreciation of the USD on world prices

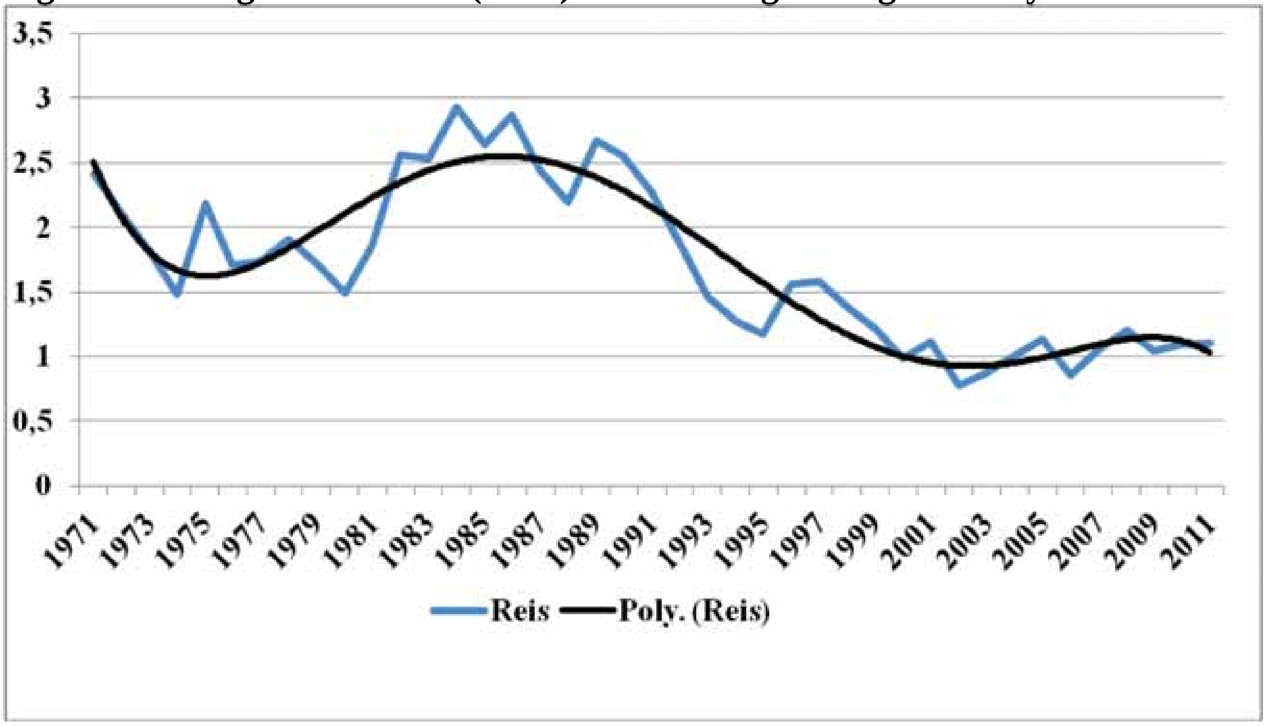


Source: OECD-FAO 2012

Last not least the lax monetary policy of the USA has pushed interest rates to an historic low and flooded national economies with high liquidity. In the event of simultaneous higher inflation, a flight to material assets and commodities is presumed and hence also an increase in demand for agricultural commodities. However, this chain of argumentation is not entirely conclusive, because a physical multiple demand for stockholding agricultural commodities would have to be associated with this, which did not occur in the time period from 2002 to 2008. In contrast, the stockholding dropped to historic lows. A multiple demand for financial products in the agricultural commodity area has evidently had no or hardly any effect on the spot markets (see Section 3.2 on the financialisation of the agricultural markets).

Nevertheless, in the long run, the internationally rising shortage of land and water will not be insignificant on the supply side. Rising lease and land prices coupled with increased commitment to direct investments in land (unilaterally assigned the term “land grabbing”) are clear indications for this. Water is not scarce everywhere, but in developing countries in particular, a serious shortfall is looming in the next few years, quite apart from the problems with water quality. As central input factors of agricultural production, this shortage will also be reflected in higher agricultural prices, ceteris paribus. The tendential decline of growth rates in yield since the 1960s with regard to crop products that are important for nutrition, such as wheat, maize and rice, work in the same direction, unless the trend is reversed by a second green revolution (see Figs. 3.6, 3.7 and 3.8).

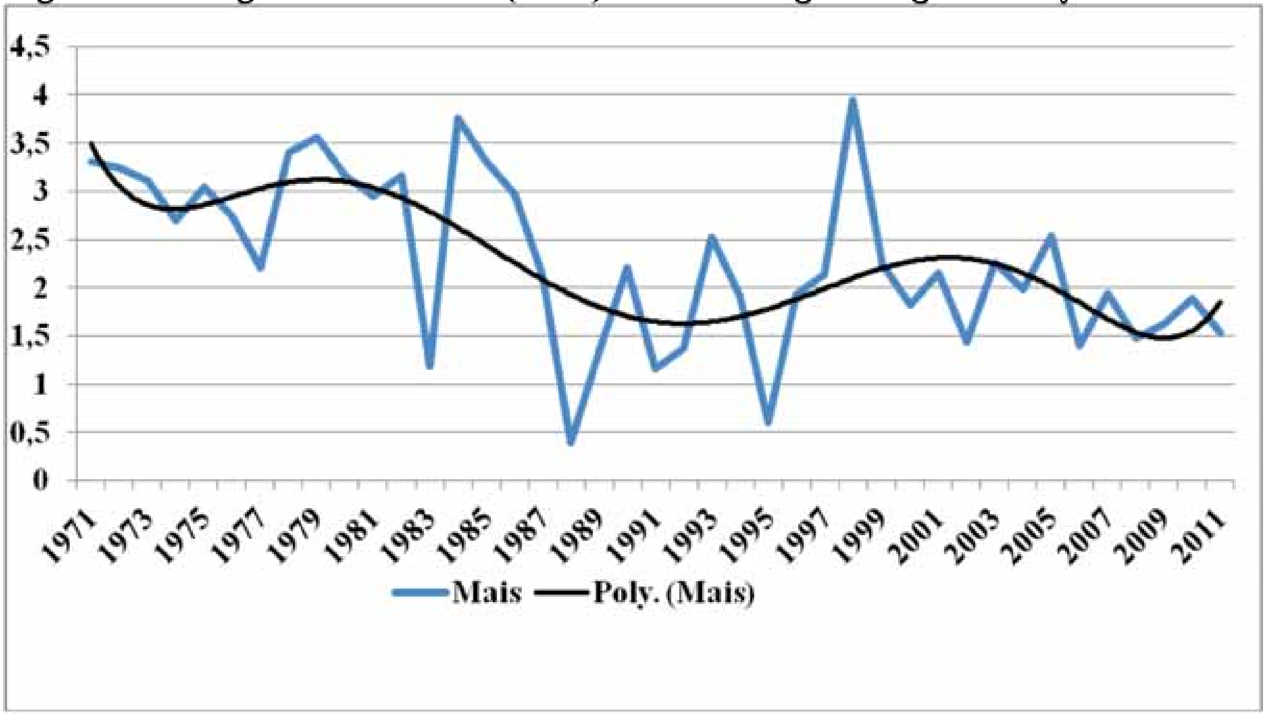
Fig. 3.6: Yield growth of rice (in %) with moving average for 10 years



Source: Own estimations (database: FAOSTAT)

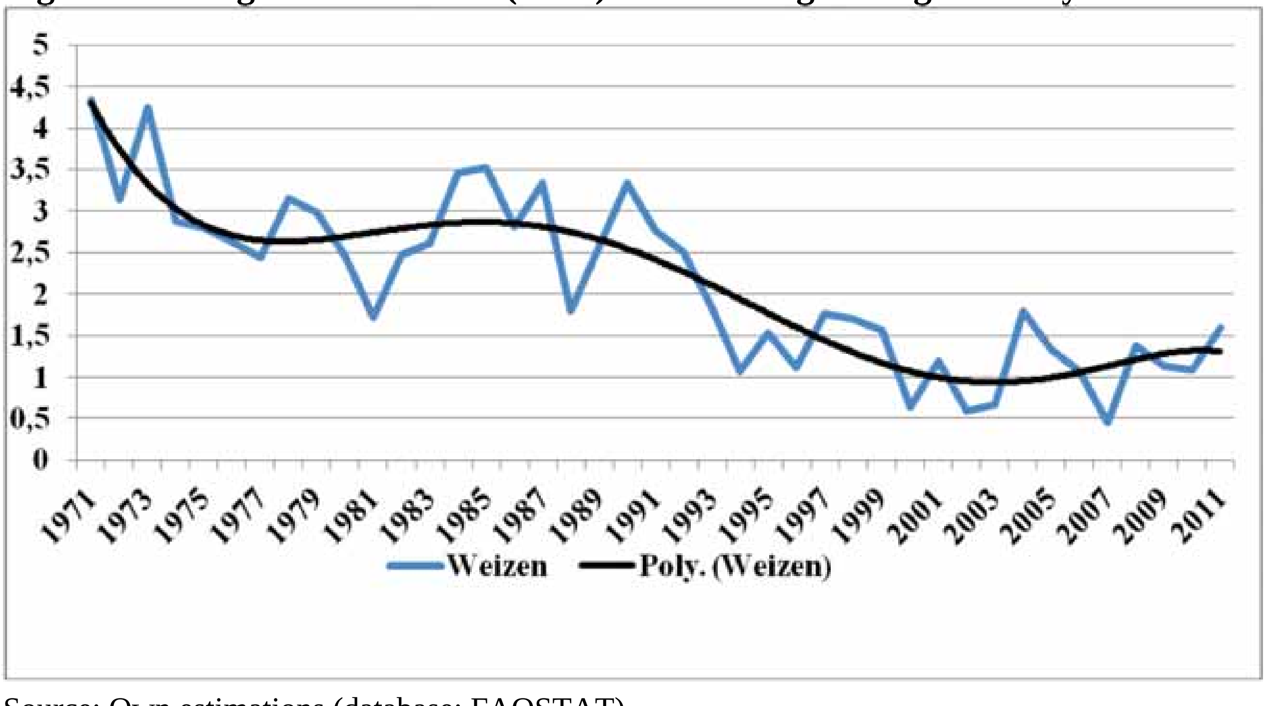
The significance of unexpected ad hoc export restrictions and ease of importations in the event of rising prices for agricultural commodities, as could be observed in numerous countries during the price spikes of 2007/08 and 2010/11, are emphasised by most authors. As with the oil price, these measures result in a dual effect. Firstly, export restrictions and ease of importations lead to increased scarcity in the world markets, driving the price level even higher.

Fig. 3.7: Yield growth of maize (in %) with moving average for 10 years



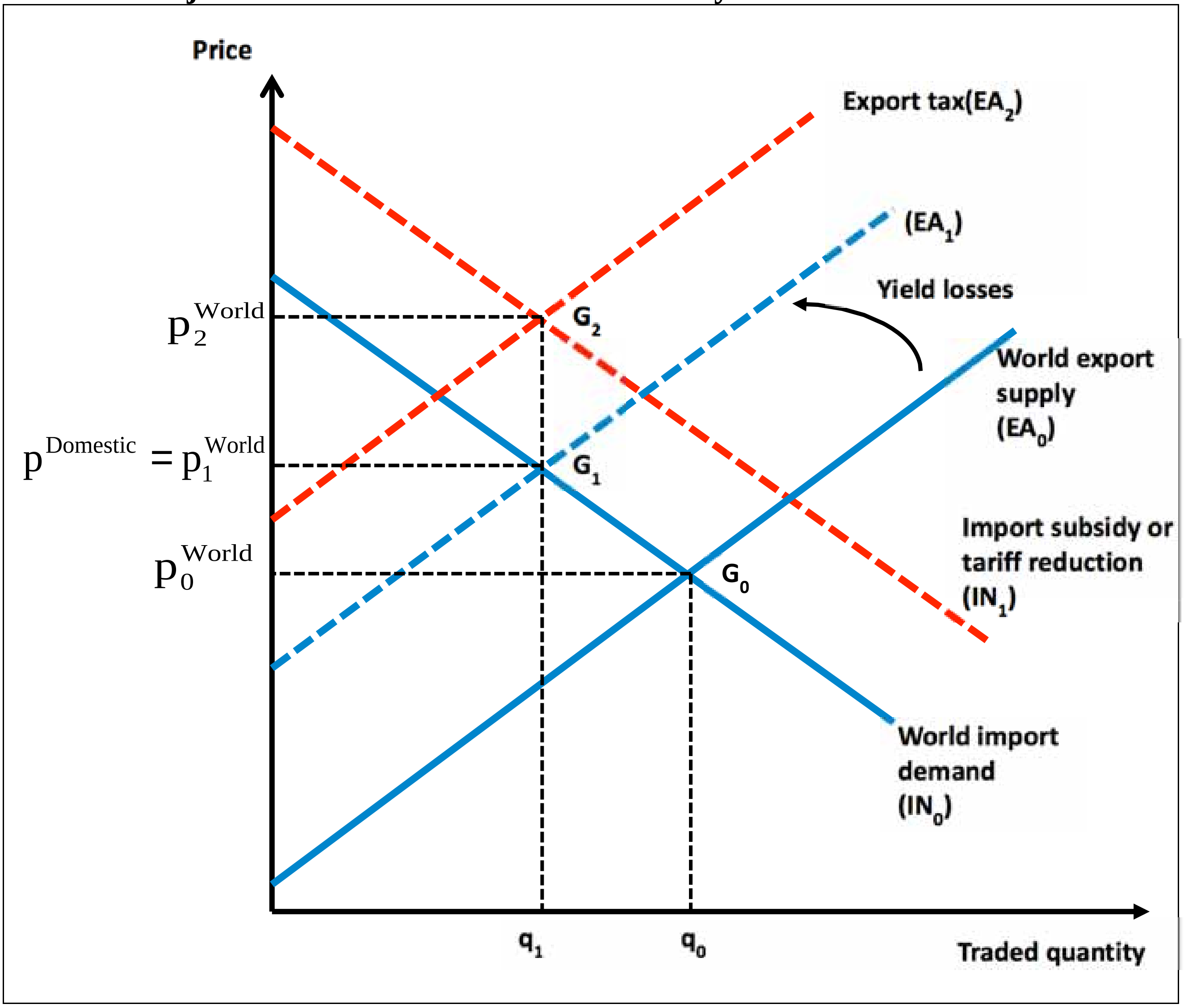
Source: Own estimations (database: FAOSTAT)

Fig. 3.8: Yield growth of wheat (in %) with moving average for 10 years



Source: Own estimations (database: FAOSTAT)

Fig. 3.9: Price effects due to yield losses and corresponding ad-hoc trade policy adjustments on international commodity markets



Source: Own representation based on ANDERSON and NELGEN 2012

Fig. 3.9 shows once again the price-driving effects of ad hoc measures in trade policies, such as export restrictions and import relaxations (or a reduction in import tariffs), which at the same time are taken in many countries as a reaction to a sudden price high. The price high itself can have been caused, for example, by a crop failure as a result of global adverse weather conditions. This results in a new world market equilibrium (G_1) at a higher price (p_1World) and a lower trade volume (q_1). If numerous trade partners now react with export restrictions and import relaxations in order to prevent national price rises, then a higher price level will result (p_2World) on the world market. But a national price reduction to a level below p_1World would only be possible if there were solely export restrictions or import relaxations, or if only a few countries (small country assumption) made corresponding changes to their trade policies. In the event that many countries react, as assumed in Fig. 3.9, the price-reducing effect on the domestic market would fizzle out completely and the domestic price would remain at the level of p_1World. Then only a pure welfare transfer from the importing to the exporting countries would take place, to a level which would be defined by the area p_1World G_1, G_2 and p_2World in Fig. 3.9. Secondly, alongside the level effect of the world market prices from p_1World to p_2World and also associated with the changed trade policies are the effects on the volatility of the world market prices because politically driven trade volumes, for example, reduce the elasticity of the export supply and the import demand, or because the import duties/export subsidies are variably adjusted with a sign reversal to the world market prices (see ANDERSON, 2012a, 2012b, 2012c). The effect on price volatilities is therefore quite similar to the influence of low stockholding quantities. Both phenomena reduce elasticities in the world market and lead to greater instability in the event of disruptions.

Model simulations show that great significance for the price increases of agricultural commodities in recent years can be attributed to ad hoc adjustments of trade policy instruments. MARTIN and ANDERSON (2011) thus estimate that 45% of the price increase for rice in the period 2005 to 2008 and 29% for wheat are attributable to ad hoc trade policy reactions.

3.2 Biofuels and speculation as scapegoats?

Alongside these classic explanatory factors for the market pricing of agricultural commodities, two new phenomena have been receiving increasing attention in recent years as potential causes of high and volatile world market prices. Here we are firstly looking at biofuels and their promotion and secondly at the speculation on commodity futures markets, in particular the increased involvement of index funds. Particularly in public and published opinion, both phenomena are attributed the bulk of the blame for the food price crises of 2007/08 and 2010/11, and therefore for hunger in the world.

Biofuels and their promotion

Here it is undisputed that an additional demand for agricultural commodities has on the one hand a price-driving effect in comparison with a situation without the existence of such fuels, all other things being equal. On the other hand, fixed mandates undeniably lead to lower demand elasticities and hence to higher price volatilities during all shocks. An influence on the price level and price fluctuations can therefore be assumed. We are thus left with the question of whether this influence is quantitatively significant, or perhaps insignificant, and how it behaves in relation to the other determinants. On this matter, a whole range of empirical results exists in the literature which derive one thing or another (see BECKMANN et al., 2012; BABCOCK, 2011; BABCOCK and FABIOSA, 2011; CHAKRAVORTY and HUBERT, 2012; CHEN and KHANA, 2012; GERASIMCHUK et al., 2012; HOCHMAN et al., 2012; ZILBERMAN et al., 2013; ABBOT, 2012 and the literature sources mentioned in Box 3.2 as extracts). These range from an estimated 66% and respectively 30% contribution to the price rise by MITCHELL (2009) and ROSEGRANT (2008) to the assertion of a value below 10% (by von WITZKE, 2011 and the EU COMMISSION, 2010) or hardly noticeable effects on the price level by GILBERT (2010a, 2010b) and BAFFES and HANIOTIS (2010). In between there are numerous publications based on partial and general equilibrium models which arrive at results between 10% and 30% for the price effect of biofuels. This is also the conclusion of TANGERMANN (2011) for the time period from 2006 to 2008, which however also states that the debate on this is not yet over and it is probably impossible to precisely determine the exact price effect in the context of all other influential factors.

The dispute about the true influence of biofuels on the prices of agricultural commodities also continues in the more recent literature. For example, de GORTER et al. (2013a, 2013b, 2013c and de GORTER, 2013) see the biofuel policies in the USA and the EU as being the main cause of previous price spikes, as they directly connect the oil market and the agricultural markets with each other through biofuels. This is derived theoretically based on simple market models without testing the statements empirically. Moreover, the authors apparently overlook the fact that energy prices can also have a direct effect on agricultural commodity prices without the detour via biofuels, in that additional input and transport costs are incurred. This explains, for example, the extreme rise in agricultural prices in many developing countries, even though their markets are to a large extent decoupled from the world market, as will be shown in Section 4.2.

Box 3.2: Quantitative impact analyses of biofuels on agricultural commodity prices*

Mitchell (2009):	**66% between 2002-2008**
Rosegrant (2008):	**30% between 2000-2007**
Wright (2009):	**substantial price effect of biofuels**
USDA (2008):	**13% till 18% between 2007-2008**
Taheripour (2008):	**9% till 16% between 2001-2006**
FAO (2008):	**7% till 15% between 2008-2018**
OECD (2008):	**5% till 16% between 2008-2018**
Banse (2008):	**7% till 12% between 2008-2020**
EU Commission:	**3% till 6% (only for grains) bis 2020**
von Witzke (2011):	**0.1% till 4.6% between 2007-2008**
Gilbert (2010):	**hardly any impact of biofuels**
Baffes/ Haniotis (2010):	**hardly any impact of biofuels**
Tangermann:	**10% till 30% between 2006-2008**

„…still a matter of debate and probably impossible to quantify the precise price effect."

*Percentage increase, over the period considered, initiated by biofuels only

Source: Own compilation from literature contributions

In contrast to de GORTER'S results, TIMILSINA et al. (2012) and BROCKMEIER et al. (2013), based on general equilibrium models, arrive at much lower influences of biofuels on the global agricultural commodity prices (see Tables 3.1 and 3.2). Even in the case of a doubling of the currently announced expansion targets, TIMILSINA et al. calculate price increases of under 4% for maize and oilseeds. A price increase of almost 12% results only in the case of sugar. For food as a whole, the values lie at only half of one percent. BROCKMEIER et al. arrive at somewhat higher values. Feed grain and oilseed prices rise by 12% and almost 14%, respectively, and the price increase for sugar lies at 21%.

Also interesting are the effects on supply and land use in developing countries identified by TIMILSINA et al. (see Tables 3.3 and 3.4). According to these calculations, the food supply in developing and emerging countries is receding only marginally, and also the worry about CO_2-emitting, indirect changes to land use through deforestation and the ploughing up of grassland seems to a large extent to be unfounded (see also NUNEZ et al., 2013). However, this situation will not be delved into further here. It is not the subject of this study. For this purpose, a comprehensive literature survey of existing empirical analyses on indirect changes to land use would be necessary.

Table 3.1: Change in world prices due to biofuel promotion till 2020 %*

Products	Announced targets	Doubling of the announced targets
Wheat	**1.1**	**2.4**
Maize	**1.1**	**3.7**
Oilseeds	**1.5**	**3.1**
Sugar	**9.2**	**11.6**
Rice	**0.8**	**1.6**
Food	**0.2**	**0.5**

*In comparison with continuation of the current biofuel promotion
Source: TIMILSINA, BEGHIN, van der MENSBRUGGHE and MEVEL (2012)

Table 3.2: Contribution of biofuels to the increase of world market prices of agricultural commodities 2004-2020

Agricultural products	Total price increase %	Of which biofuels %	Contribution of biofuels in price increase %
Wheat	**32.7**	**1.1**	**3.4**
Coarse grain	**52.0**	**6.3**	**12.1**
Oilseeds	**50.0**	**3.3**	**6.6**
Vegetable oils and fats	**10.3**	**1.4**	**13.6**
Sugar	**5.7**	**1.2**	**21.1**
Rice	**17.7**	**0.6**	**3.4**

Source: BROCKMEIER, YANG and ENGELBERT (2013) and own estimations

Table 3.3: Change in the regional food supply in 2020 (%)

Region	Announced targets	Doubling of the announced targets
China	-0.1	-0.2
India	-0.4	-0.3
Indonesia	-0.1	-0.1
Malaysia	-0.1	-0.3
Latin America and the Caribbean	-0.1	-0.3
Russia	-0.2	-0.6
Middle East and North Africa	-0.4	-1.0
Sub-Saharan Africa	-0.2	-0.5

Source: TIMILISINA et al. (2012), Journal of Agric. Economics, Vol.43, pp 315-332

Table 3.4: Change in regional land supply in 2020 relative to the baseline due to doubling of biofuels production (%))

Region	Arable area total	Forest	Grassland
France	+0.7	-5.1	-4.1
Germany	+0.8	-2.2	-1.5
Great Britain	+1.0	-3.1	-3.0
USA	+0.1	-0.3	-0.2
China	+0.3	-0.2	-0.3
India	+0.2	-0.6	-0.5
Indonesia	+0.1	-0.4	-0.4
Thailand	+0.1	-1.1	-1.2
Brazil	+0.3	-1.2	-1.4
Argentina	+0.2	-0.5	-0.6
Sub-Saharan Africa	+0.1	0.0	-0.2
World total	+0.2	-0.6	-0.5

Source: TIMILISINA et al. (2012)

Following the literature survey of the influence of biofuels on prices, it can be concluded that the results scatter widely.

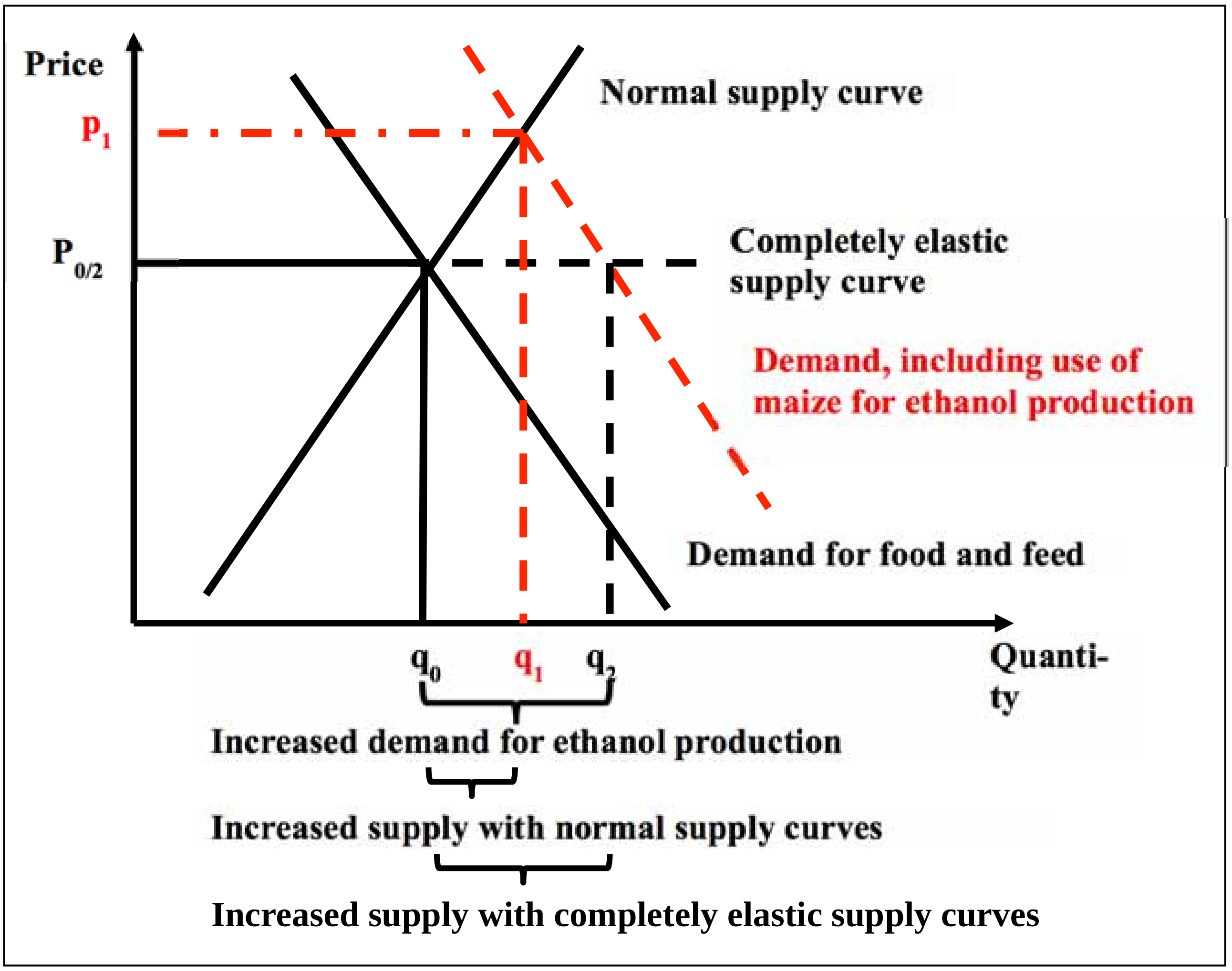
But how can we now explain such considerably different results? A more precise analysis of the relevant literature provides the following indications:

- The length of the period under review plays a crucial role. In the case of longer time periods, more elastic adaptation reactions by market participants are to be expected, and any supply and demand shocks will lead to more moderate price movements. In contrast to this, more inelastic reactions are to be expected in the case of short time periods, with the result that one-off or permanent supply and demand changes could in the short term lead to intense price reactions. Partial and general equilibrium models usually result from a long-term perspective, so that their simulations lead to lesser price effects (see BANSE et al., 2008). The significance of the supply elasticity for price rises on the world maize market as a result of an increased demand for maize for ethanol production is illustrated by Fig. 3.10. If the supply function takes a normal course, this would result in an increase in the maize price from P_0 to P_1 at equilibrium and a displacement effect for maize as a foodstuff and animal feed to the value of the difference between the increased demand for ethanol maize and the increased supply in total. In the case of a completely elastic supply, neither a price nor a displacement effect would result. The increased demand would then be fully covered by a corresponding increase in supply. Finally, it is conceivable that through special advances in cultivation as a result of more attractive prices the maize yield could increase further. This would shift the supply curve to the right and further curb any price rises, or in the extreme case even completely prevent them.

- As already outlined, price level and price volatility and their changes are the result of a complex bundle of influential factors that can change over the course of time. As a result, the causes behind the price spike of 2007/08 do not have to correspond to the causes behind the price spike of 2010/11 or of 2012, at least not in their order of precedence. Future explanatory factors do not have to correspond with past ones. Thus, the choice of observation period plays an important role for the result (see TROSTLE et al., 2011).

- It must be also distinguished whether the potential price influence on agricultural commodities is rather the result of market forces or mainly the consequence of the expansion of biofuel subsidies in numerous countries. Thus BABCOCK (2011) comes to the conclusion for the USA that ethanol subsidies only explain up to 5% of the price rise of wheat in the period from 2004 to 2009, while the market-driven expansion of ethanol, e.g. due to rising crude oil prices, accounts for a share of almost 30%. The almost 70% remaining can be traced back to all other factors. A political influence of only 13% at most is calculated for maize, while the pure market influence amounts to just under 50%. If this analysis is correct, which would have to be checked for other countries, the oil price rise would above all have been responsible for the price explosions, and less so the public biofuel promotion (see also BABCOCK and FABIOSA, 2011).

Fig. 3.10: Price and quantity effects on world maize market due to increased demand for commodities for biofuels production



Source: Own representation

- However, the main causes of the different empirical results regarding the price influence of biofuels is, without doubt, the economic models selected for the analysis and the necessary pre-selection of the essential determinants. Thus there has so far been no model that records all of the above influential factors at the same time and maps their potential interactions in terms of intensifying and weakening. If one leaves out important influential factors, this can lead to distorted results. For example, a short-term, strong growth in biofuel production can cause extreme or marginal upwards price movements, depending on whether or not stock-to-use ratios are accounted for in the model. The consideration or non-consideration of co-products in biofuel production as animal feedstuffs is also crucial for the price effect on agricultural commodities, as shown in the analysis by TAHERIPOUR et al. (2010) in **Table 3.5**. When taking co-products into account, the price influence of biofuels for cereals turns out to be a one third lower.

Table 3.5: US price effects due to biofuel production between 2006 – 2015

Commodities	Without by-product	With by-product
Coarse grains	**22.7 %**	**14.0 %**
Oilseeds	**18.2 %**	**14.5 %**
Sugar cane	**12.6 %**	**9.4 %**
Food	**0.5 %**	**0.4 %**

Source: TAHERIPOUR, HERTEL, TYNER, BECKMANN and BIRUR (2010)

- Finally, numerous models do not adequately map the actual price developments because they are not formulated stochastically and dynamically but are instead deterministic and comparative-static in orientation, or because they do not record the cross-price relations between the markets but are instead based on individual market analyses.

Speculation on commodity futures markets (CFM)

Speculation on commodity futures markets is also coming increasingly under the crossfire of critics. In this context, several campaigns are being run against the "speculation with food". Numerous civil society organisations have adopted the Masters hypothesis[1] as their own, according to which the increasing involvement of index traders is destabilising the futures markets, driving up the real prices for agricultural products and causing them to fluctuate even more, thereby further exacerbating the hunger situation in the world. Demands for sweeping regulations and prohibitions are logically derived from this. However, most of the arguments put forward do not stand up to scientific scrutiny, they confuse coincidental correlation with causality, thus coming to completely wrong conclusions and in some cases to counter-productive political recommendations. The reports and studies commissioned by some civil soci-

[1] The American Michael W. MASTERS is a hedge fund manager who vehemently and with public effect champions strict regulation of the financial markets.

ety organisations exhibit serious flaws, for example that of BASS (2011) commissioned by Welthungerhilfe, who with his regression calculation proposes a 15% influence of investors on the price increases between 2007 and 2009 without using a single variable in his estimation that reflects the futures market business of institutional investors. He interprets the unexplained remainder of his estimation loosely as “room for the possibility of the influence of financial market investments”.

Also to be very critically considered is the study of SCHUMANN (2011) commissioned by Foodwatch, which consists mainly of interviews with critics of speculation and refers to a colleague of MASTERS as his crown witness (see Frenk, 2010). The few articles from the literature quoted by SCHUMANN originate mainly from research and discussion papers from the grey literature or are statements from organisations. Only one source originates from a journal with a peer review. No empirical analyses of the author are carried out in the Foodwatch study. Simple correlations are presented as causalities over wide sections of the article. And analyses of the relevant literature take place only to a limited extent and selectively. Instead, the author polemicises against “textbook economists” without presenting empirically sustainable counterevidence. For example, the paper from BASS, with the deficiencies described above, is quoted approvingly.

These articles from Welthungerhilfe and Foodwatch, as well as a further 35 relevant studies from the scientific literature, have been closely examined by scientists from the Martin-Luther University of Halle-Wittenberg and the Leibnitz Institute for Agricultural Development in Central and Eastern Europe (IAMO) in Halle (see PIES et al., 2013; WILL et al., 2012; GLAUBEN and PIES, 2013; PREHN et al., 2013; PIES, 2012; PIES, 2013), who reach the conclusion that the Masters hypothesis is seen as untenable by the overwhelming majority of the empirical studies. In spite of the considerable growth in institutional investors (e.g. index and hedge funds) in the commodity futures markets (CFM), it is not possible to prove empirically a destabilising effect on future and spot prices of agricultural commodities just as little as an impairment to the traditional functions of commodity futures markets, namely risk hedging and price prediction (see also Filler et al., 2012; BMELV, 2013; IRWIN and SANDERS, 2011; BOHL and STEPHAN, 2012; BRUNETTI and BUYUKSAHIN, 2009; IRWIN and SANDERS, 2012 and BASTIANIN, 2012). In contrast, various empirical studies reveal that the involvement of institutional investors safeguards the necessary liquidity for short hedging of commercial participants and even stabilises forward prices. Even where contrary empirical results are derived, authors are very cautious in the interpretation, stressing the provisional nature of the analysis (see ROBLES et al. 2009).

The distinction between commodity future market participants into speculators and hedgers is also regarded as outdated. Hedgers also sometimes speculate, and speculators occasionally just hedge. Index funds, for example, go to the CFM for the purpose of diversification of their portfolios, as stock and commodities markets are to a large extent uncorrelated (for the index fund business model see also PREHN et al., 2013 and GLAUBEN and PIES, 2013). The increased share of index funds in commodity futures markets preceded the price boom of 2007/08 by the significant time frame of two and a half years, which means it cannot be the cause (see SANDERS and IRWIN, 2011). Moreover, price explosions also occurred in commodity futures and agricultural commodity markets in which tracker funds were not involved at all, for example for rice, and also in commodities markets, where no CFMs existed at all, such as for apples, onions and beans. And finally, the future and spot prices for animal products in the stated time period increased by only below-average amounts, although it was precisely here where the involvement of index traders was particularly intensive (see also SCHMITZ; 2011; SCHMITZ and MOLEVA, 2011).

The price explosion of 2007/08 and the renewed increases in spot prices in 2010/11 and 2012 can, according to these studies, be attributed to a large extent to fundamental factors relating to supply and demand on the agricultural markets themselves, to the ad hoc trade policy measures in numerous countries and to macro-economic influences. The significance of the individual components will be quantified more closely in Section 3.3. While spot prices are characterised mainly by current influential factors, futures prices depend on the characteristics of the influential factors that are expected in the future. Only when new information is available do the futures prices change, and not because index funds go "long". Every long transaction is accompanied by a corresponding short-hedge transaction. Index funds and speculators therefore ensure the necessary liquidity for safeguarding the price risks, which are then obviously estimated similarly by farmers, dealers and processors as well. It is therefore also incorrect to maintain that the futures markets contract volume of agricultural commodities extending far beyond the physical volume is responsible for the price instability. It simply mirrors the hedging requirement of the hedgers, which could not be realised without the speculators. Futures markets therefore function differently from goods markets, where an increased demand pushes the prices up, all other things being equal (see also TANGERMANN, 2011; IIF, 2011; SANDERS and IRWIN, 2010; Wiss. Beirat, 2011).

If speculation were at all to play a role, then it is the speculation on the real spot markets with physical goods by farmers themselves, by dealers and processors, and last but not least by private households. Spot prices will increase when goods are withheld. However, the officially known stock levels had been reduced in the periods mentioned and could therefore not have had a price-driving effect.

In closing it remains the case that not only the cause analysis of the increased price volatility and the renewed price highs are wrong, but there are apparent serious deficits in knowledge about the way commodity futures markets work and their useful functions in the national economy. Finally, the measures proposed, such as a financial transaction tax, position and price limits, minimum holding times for high-frequency traders, etc. are anything but constructive, and are sometimes even counter-constructive bearing in mind the goals of food security and market stabilisation. This will be proven in the following.

Against the backdrop of this literature survey and the limitations of method mentioned above, we advise caution before branding speculation and biofuels as scapegoats for excessive and more volatile prices and hence making them responsible for greater hunger and poverty in developing countries.

3.3 Own empirical results explaining the price situation

After discussing the most important determinants of pricing and their special influence on the level and volatility of prices, as well as giving an overview of the relevant empirical literature, the question of how the individual influential factors are to be evaluated in the overall context and what dynamics they will exhibit in combination over time will be dealt with in the following. Or to put it another way: What determinants are mainly responsible for the world market price development and which can be proven to have no significant influence? The most suitable instruments to establish this are econometric methods, but also scenario simulations using market models. Therefore in Section (a), the econometric estimation of the reduced form of a structural world market model for maize and soybeans will be put to use with a total of eight of the potential influential factors discussed (multiple regression), in Section (b) the estimation of a dynamic vector autoregressive time series model (VAR) for mapping the progress with time of the variables and their interaction as a result of shocks, and in Section (c) a partial multi-region, multi-product market simulation model (AGRISIM) for the analysis of two influential factors working concurrently, namely biofuels and ad hoc trade interventions.

a) Structural econometric model - multiple regression

The starting point for the following econometric estimation is a theoretical world market model for maize or soya beans with an aggregated export supply and import demand function, which together form the price and quantity equilibrium on the world market. Behind both of these functions are all countries participating in the world market. Using the example of maize, the following model therefore applies with the corresponding positive (+) or negative (-) influences on the individual dependent variable:

Export supply function

$$q_S = f(\underset{(+)}{P}, \underset{(-)}{P_{Oil}}, \underset{(+)}{w}, \underset{(+)}{W}, \underset{(-)}{X}, \underset{(-)}{S}) \quad (1)$$

Import demand function

$$q_D = g(\underset{(-)}{P}, \underset{(+)}{Y}, \underset{(+)}{E}, \underset{(+)}{L}, \underset{(-)}{w}, \underset{(-)}{S}) \quad (2)$$

World market equilibrium

$$q_S = q_D \quad (3)$$

The reduced form of the world market price is obtained by applying equations (1) and (2) in (3).

$$P = f(\underset{(+)}{P_{Oil}}, \underset{(+)}{E}, \underset{(-)}{w}, \underset{(-)}{W}, \underset{(+)}{X}, \underset{(+)}{Y}, \underset{(-)}{L}, \underset{(+)}{S}) \quad (4)$$

With

q_S	Maize export supply on the world market
q_D	Maize import demand on the world market
P	Maize world market price
P_{Oil}	Oil price
E	World ethanol production

w	Dollar exchange rate (indirect quotation) against the currencies of the most important trading nations
W	Weather-related maize production fluctuations world-wide
X	Export restrictions adopted ad hoc
Y	Global economic activity as a proxy variable for world-wide real income fluctuations
L	Stock levels in relation to consumption
S	Number of contracts of speculators adjusted for the short positions of traders (net long)

If one evaluates this reduced form of the price equation, supplemented by an error term based on monthly data (Jan. 2000 to Dec. 2012) with the help of the OLS approach, after autocorrelation has been switched off and homoscedasticity and normal allocation of the residues have been secured[2], then the following statements can be derived for maize (see Tables 3.6 and 3.7 for the results overview for maize and soybeans):

The maize price over the stated period depends significantly on:

➔ the dollar exchange rate (significance level: 97%)
A 1% devaluation of the dollar increases the maize price by 2.97%.
➔ weather-related production loss (significance level: 88%)
A 1% fall in production increases the maize price by 0.24%.
➔ the stock level/consumption ratio (significance level: 99.8%)
A 1% reduction of the ratio increases the maize price by 0.22%.
➔ the oil price (significance level: 89%)
A 1% increase in oil price increases the maize price by 0.10%.

[2] The avoidance of autocorrelation and heteroscedasticity and the assumption of a normal distribution are necessary to obtain an undistorted estimate of the parameters.

Table 3.6: Results of the multiple regression analysis for maize price

Dependent variable: Price for maize

Least squares method

Independent Variable	Coefficients	Standard deviation	t-statistic	Probability
Crude oil	0.10	0.06	1.59	0.112
Ethanol	-0.08	0.08	-1.00	0.318
Exports	0.03	0.03	1.09	0.277
Speculation	-0.0006	0.006	-0.10	0.916
Weather/production	-0.24	0.15	-1.55	0.123
Exchange rate	-2.97	1.40	-2.11	0.036
Stock ratio	-0.22	0.07	-3.06	0.002
C	0.02	0.09	0.18	0.855
AR(1)	0.10	0.09	1.13	0.258

R-squared	0.199870	Mean dependent var	0.007641
Adjusted R-squared	0.155725	S.D. dependent var	0.064512
S.E. of regression	0.059277	Akaike info criterion	-2.756531
Sum squared resid	0.509493	Schwarz criterion	-2.579047
Log likelihood	221.2529	Hannan-Quinn criter.	-2.684437
F-statistic	4.527579	Durbin-Watson stat	1.995337
Prob. (F-statistic)	0.000062		

Source: Own estimations

The influence of speculation and export restrictions hovers at around zero over the entire period and is not significant. Also the influence of ethanol production is not significant and even has a negative sign. Finally, the world-wide changes in real income were even taken out of the estimation, as they would have reduced the overall quality of the estimate. As the entire model was estimated in the form of the differences of the logarithmised values on a monthly basis, the results can also be interpreted as an explanation for the price spikes according to VON BRAUN and TARDESSE (2012) who, alongside the speculation variable, included only two further explanation factors in their estimate, namely the oil price and a variable for production shocks.

The following statements result for the soybean price: The soybean price over the stated period depends significantly on (see Table 3.7):

➔ the stock level/consumption ratio (significance level: 99.2%)
A 1% reduction in the ratio increases the soybean price by almost 0.08%.

➔ the extent of the net-long position on commodity futures markets, however only with an extremely small influence (significance level: 99.2%)

A 1% increase in the net-long position increases the soybean price by 0.018%.

➔ the oil price (significance level 98.8%)

A 1% increase in oil price increases the soybean price by 0.15%.

➔ the dollar exchange rate (significance level 98.7%)

A 1% devaluation of the dollar increases the soybean price by 3.57%.

➔ the extent of ad hoc export restrictions (significance level: 83%)

A tightening of export restrictions increases the soybean price by 0.35%.

Table 3.7: Results of the multiple regression analysis for the soybeans price

Dependent variable: Price for soybeans

Least squares method

Independent variable:	Coefficients	Standard deviation	t-statistic	Probability
Stock ratio	-0.08	0.03	-2.65	0.008
Exchange rate	-3.57	1.43	-2.49	0.013
Weather/production	-0.18	0.21	-0.88	0.377
BIP/GEA	0.42	0.37	1.15	0.252
Speculation	0.018	0.006	2.69	0.008
Exports	0.35	0.26	1.36	0.174
Crude oil	0.15	0.06	2.55	0.012
Biodiesel	-0.0007	0.06	-0.01	0.989
C	-0.22	0.08	-2.65	0.008
AR(1)	0.31	0.08	3.65	0.000

R-squared	0.311992	Mean dependent var	0.006629
Adjusted R-squared	0.267122	S.D. dependent var	0.067971
S.E. of regression	0.058189	Akaike info criterion	-2.785071
Sum squared resid	0.467259	Schwarz criterion	-2.582557
Log likelihood	216.0953	Hannan-Quinn criter.	-2.702790
F-statistic	6.953217	Durbin-Watson stat	1.901744
Prob. (F-statistic)	0.000000		

Source: Own estimations

Changes in real income are only slightly positive, but insignificant for the prices. Equally weak and insignificant is the negative price influence of weather-related production shocks. Finally, the influence of biodiesel production is not only insignificant, but it even shows a slightly negative sign, i.e. with an increase in biodiesel manufacture, the soybeanprice falls marginally. However, no causality can be derived from this, as the probability of error for this value is almost 100%.

If both estimates are combined, the following picture results:

- Exchange rates, stock levels and oil prices appear in both estimates as significant influential factors. A dollar devaluation or revaluation has the greatest effect on price fluctuations.
- In the case of maize, it is the weather-related production fluctuations which play a central role, and for soybeans the ad hoc export restrictions in numerous exporting countries.
- Biofuels play no role in price fluctuations on both markets and even exhibit marginally price-reducing effects, however at an insignificant level.
- There is no evidence at all of an influence of speculation on the maize market, it is significantly present on the soybean market but with a weakly positive effect tending towards zero.

Therefore, according to these results, responsible for the pricing situation on international agricultural commodities markets are, firstly, the macro-economic framework conditions, including the oil price which, with its effect in terms of supply and demand on the agricultural commodity prices, seems to take on a base price function (see Section 3.1), secondly, the known fundamental factors of the markets (e.g. weather shocks and stock levels) and, thirdly, unpredictable ad hoc trade interventions.

One elementary assumption of the estimations carried out so far is, however, that all explanation factors listed in the price equation (4) are exogenous or independent, and therefore causally define the maize price as a dependent variable. The ability of the maize price itself and its fluctuations to influence the other factors is excluded with this procedure (multiple regression). For example, an effect of the maize price on stock level decisions, on commodity futures market activities, on export restrictions and on biofuel production is conceivable. An approach which dispenses with an a priori defining of variables as exogenous and endogenous and takes into account the mutual dependencies of all variables among themselves is the vector autoregressive econometric time series model (VAR). It maps the time dynamics of the model variables and their reaction to shocks, dispensing however with clear statements of causality.

b) Vector autoregressive time series model (VAR)

The VAR approach treats the central impact factors as endogenous and is dependent in each case on its own time-delayed values, the time-delayed values of all other endogenous variables and – if available – on any determinants identified as exogenous. Expressed in a simplified way, this means that it is not necessary to define in advance which variable is influenced by which other variable, but rather the model calculates the reciprocal dependencies, as well as the course of events and the links with time (see also AHMED et al., 2010; KUHL and SCHMITZ, 1998; HARRI et al., 2009). The mathematical form is:

$$Y_t = A_1 \; Y_{t-1} + \cdots + \; A_p \, Y_{t-p} \; + \; BX_t + \; E_t \tag{5}$$

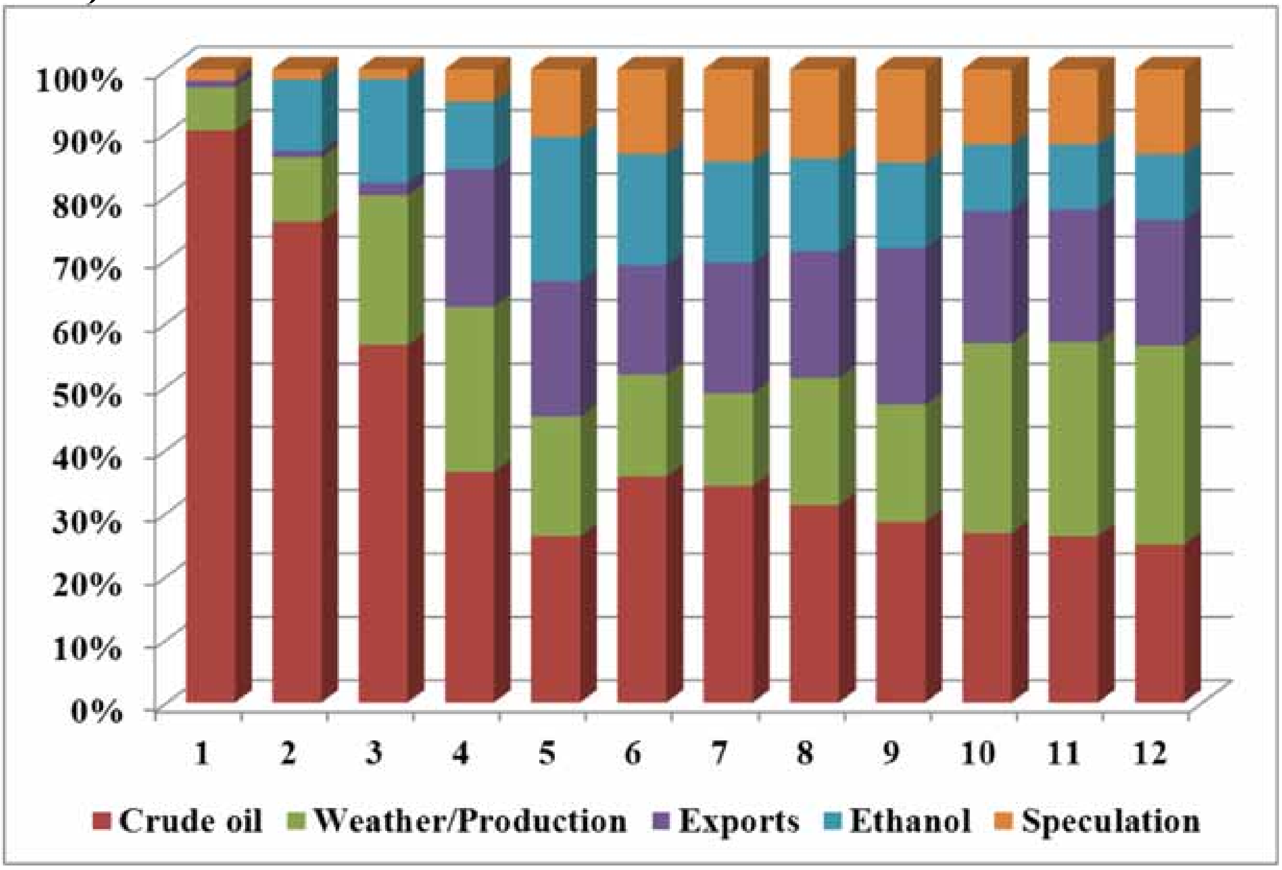
With

Y_t	Vector of the endogenous variables
X_t	Vector of the remaining exogenous variables
A_1 ... A_p and B	Vectors of the coefficients to be estimated
E_t	Vector of confounding factors

The application of the multivariate non-restrained VAR model consists of five steps. The first step is to ensure that all nine time series are stationary and are integrated with the same order of zero. For this purpose, the augmented Dickey-Fuller (ADF) test is used. In the second step, the remaining exogenous determinants are identified using the block exogeneity test. Then in the third step the VAR model is estimated and the statistical significance, as well as the lag structures between the variables are shown. This entails testing the lags from one to nine months with the help of the Lag Order Selection Criteria. In the fourth step, the impulse response functions are shown which represent the reaction of individual variables to one-off shocks from the other variables over the course of time. The fifth and final step involves a variance decomposition of the maize and soybean prices into individual components of causes of fluctuation. The results from these five steps are documented completely in Appendix B. From the estimates as well as the impulse response functions and the variance decompositions, the following statements can be made.

The dollar exchange rate and the stock levels prove once again to be significant exogenous components in the development of maize prices over time. In contrast to the multiple regression, the world-wide economic situation is added as a further important exogenous component. Finally, the remaining endogenous variables control the movements in the maize price over time, above all the oil price (see also McPHAIL et al., 2012), the weather-related production fluctuations and the ad hoc export restrictions. The contributions of ethanol production and speculation on the futures markets are not significant and tend towards zero (see Fig. 3.11 and the impulse response functions in Appendix B).

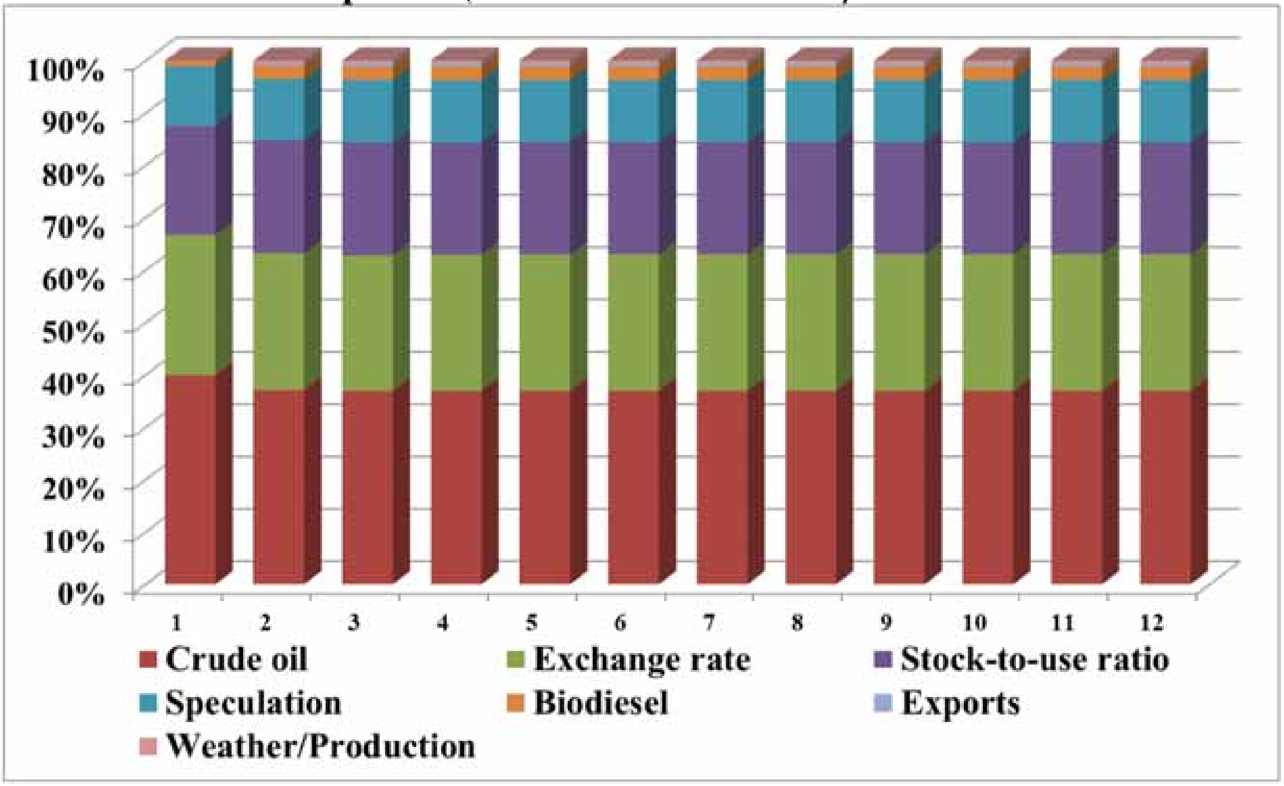
Fig. 3.11: Variance decomposition of price for maize (only endogenous components)



Source: Own estimations with VAR model between January 2000 and December 2012

Weather-related production fluctuations and the dollar exchange rate prove to be exogenous for the soybean price, but are insignificant influential factors over the entire period, whereby the influence of the weather is marginal and there is a heavy influence of the dollar rate. Biodiesel production is just as little involved in the variance decomposition of the soybean price as are ad hoc export restrictions and speculation, and their influence is also insignificant. Significantly involved, however, are the crude oil price and the stock levels, with a maximum of 27% after one year (see Fig. 3.12 and the impulse response functions in Appendix B).

Fig. 3.12: Variance decomposition of price for soybeans (endogenous and exogenous components, without GEA-variable)



Source: Own estimations with VAR model between January 2000 and December 2012

The maize and soybean prices are furthermore characterised to a high degree by their own values in the previous period, however to a decreasing extent, e.g. still at 50% after one year and even almost 80% to 90% after one month. This is indicative of the large influence of the fundamental factors immanent in the market and of the high sluggishness of price adjustments.

The links estimated with the VAR method are essentially identical to the results from the multiple regression. In particular for the question of interest here, it is the case that biofuels exert, if at all, only a limited influence on the maize and soybean prices which, according to the variance decomposition for maize, reaches a maximum of only 7% in the first year and for soybeans remains at below 2%. This is also confirmed by the hardly measurable influence of futures market speculation on the maize and soybean prices, which is insignificant and contributes a maximum of 6% and 3.5%, respectively, to the price variance (see Figs. B5 and B10 in Appendix B).

c) A partial multi-region-multi-commodity simulation model (AGRISIM)

To supplement the current literature on the price effects of biofuels in connection with ad hoc political interventions in foreign trade, the market simulation model

AGRISIM available at the Institute for Agricultural Policy and Market Research is to be used in the following. AGRISIM is a numerical, computer-assisted, partial equilibrium model, which in the version used here works with nine different agricultural products and 16 countries or regions. It is of a comparative static nature and is based on isoelastic supply and demand functions with constant supply and demand elasticities. The trade between individual countries is designated as net trade (difference between supply and demand). The model is able to quantify the effects on production, demand, net trade, producer income, consumer income, national budget and overall welfare of individual countries as a result of changes in exogenous variables such as income, population, technological progress, yield changes, other shift factors of supply and demand as well as policy changes.

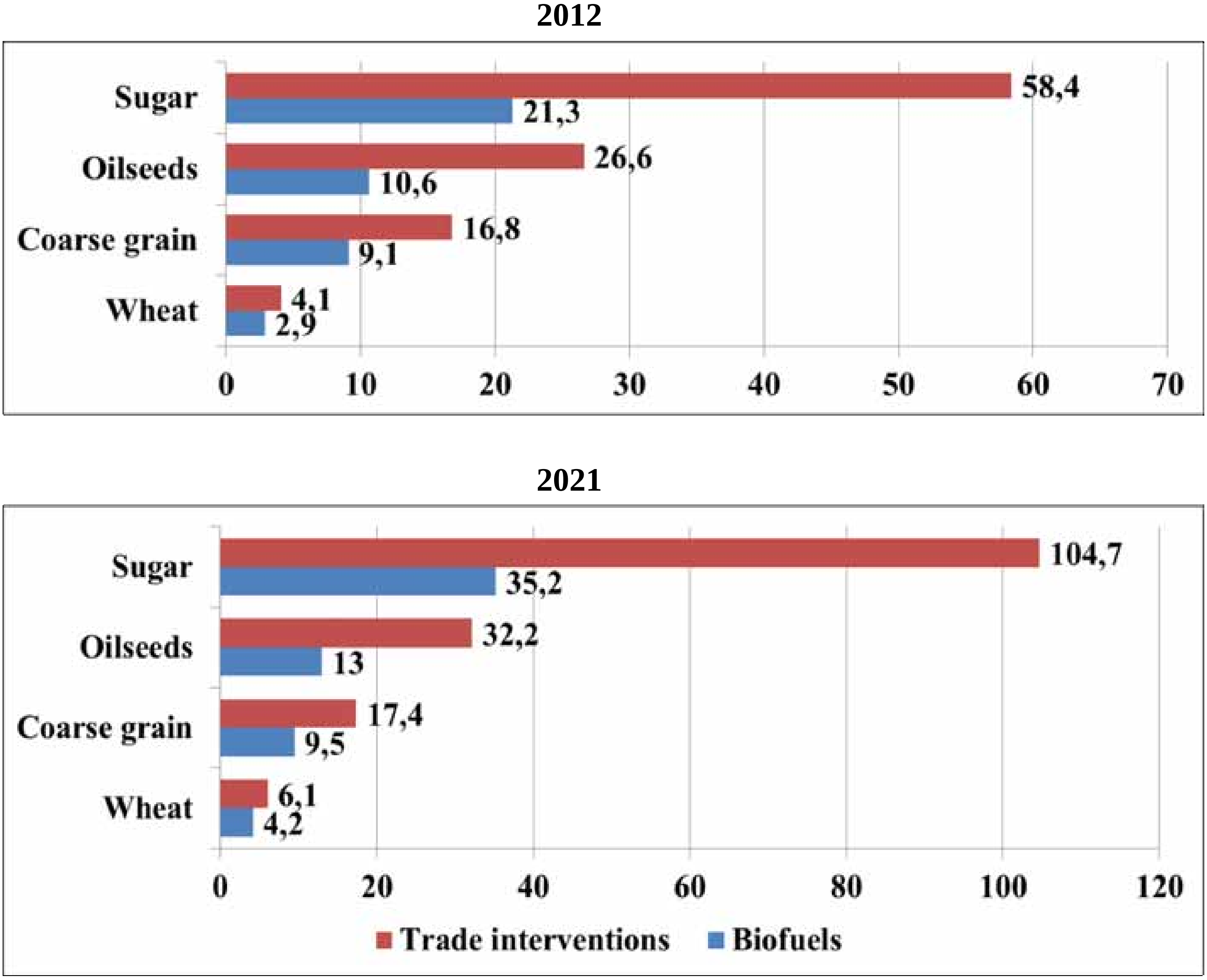
For the following simulations, the figures from the OECD/FAO (2012) for 2012 and 2021 quoted in Section 2.2 (see Table 2.1) were used: in 2012, 13.4% of coarse grain (2021: 13.6%), 19.2% of the global raw sugar (2021: 31.2%), 13.5% of vegetable oils (2021: 16.1%) and finally 1.2% of wheat (2021: 2.1%) go into biofuel production. Based on these percentages, the amount by which the demand for agricultural commodities has risen or will rise as a result of biofuel production alone can be readily calculated. This additional demand is entered into the simulation model as an exogenous shock and the effects on various variables resulting from this are quantified. In the foreground in this instance are the price effects, for which it is initially assumed that all countries, with a given protection level, permit a full price transmission (price transmission elasticity = 1) from the world market to the domestic markets (see Table 3.8 and Fig. 3.13). This results, as expected, in positive price effects, above all for the main raw materials for biofuel production, with sugar leading at +21.3% followed by oilseeds (10.6%) and coarse grain (9.1%). Rice as a raw material is not involved at all, and wheat only to a minor extent, hence the price effects are negligibly small. Even a slight price reduction is shown for animal products, which must be caused by the additional supply of animal feeds. If one assumes the OECD/FAO forecasts for biofuel production in 2021 to be correct, this results, with one exception, in similar price effects, only these lie at a somewhat higher level. Only in the case of sugar does the price effect increase considerably from 21% to 35% (see Table 3.8 and Fig. 3.13). The main reason for this is that a large share of the sugar cane production goes, as expected, into ethanol production. These results, calculated using AGRISIM, agree to a large extent with the price effects recently simulated by BROCKMEIER et al. (2013) with the GTAP model (see also Section 3.2). Measured on the actual price increases in 2007/08 and 2010/11, apparently only a relatively small contribution is attributable to biofuels, as the econometric analyses have already shown.

Table 3.8: World market price effects due to biofuels production and ad-hoc trade policy interventions (%)

Agricultural commodities	Due to increased demand for commodities for biofuels production		Due to ad-hoc trade policy interventions	
	2012	2021	2.012	2.021
Wheat	2.9	4.2	4.1	6.1
Coarse grain	9.1	9.5	16.8	17.4
Rice	0	0	-1.4	-1.8
Oilseeds	10.6	13.0	26.6	32.2
Sugar	21.3	35.2	58.4	104.7
Dairy products	-0.3	-0.4	-0.6	-0.8
Beef	-1.9	-2.5	-4.5	-5.9
Pork	-1.4	-1.8	-2.6	-3.6
Poultry	-1.1	-1.5	-2.2	-3.0

Source: Own estimations with simulation model AGRISIM

Fig. 3.13: World market price increases due to biofuels with and without ad-hoc export restrictions (%)



Source: Own estimations with simulation model AGRISIM

Of interest now is how the result from the model changes if a second price-driving determinant is effective. For this purpose it is assumed in AGRISIM that, when faced with increasing prices on the world market, the developing and emerging countries isolate their markets so as not to allow price impulses from the world market to pass into their domestic markets, i.e. they exhibit a price transmission elasticity of zero. The prices for agricultural crop commodities increase considerably above the level which results only on the basis of the increased demand for biofuel manufacture. The price increase for sugar almost triples, a two-and-a-half times increase results for oilseeds and the grain price increases turn out at a further 40% to 85%. Ad hoc political interventions in foreign trade therefore have a distinct effect of driving up prices, sometimes with a considerably higher contribution than would be caused by biofuels alone. If one were to introduce further price-driving determinants into the model, such as weather shocks or low stock levels, similar amplifier effects would be expected, putting the contribution of biofuels clearly into perspective. The results of the model simulations made with the equilibrium model AGRISIM used here therefore confirm our own results obtained with the econometric approaches, as well as the results from the relevant literature (MARTIN and ANDERSON, 2011; ANDERSON, 2012a, 2012b, 2012c and HEADEY, 2011), according to which ad hoc export restrictions drive up and destabilise the world market prices.

3.4 Interim results – actual versus perceived causes

In view of our own empirically verified results and the majority of results from the relevant literature on this subject, one must first ask how, from the point of view of non-governmental organisations, the media, churches, development agencies and the public, it is particularly biofuels and speculation that could come so much to the fore as the assumed main causes of high and volatile prices. Secondly, it is not understandable how an exacerbation of the hunger situation can be derived from this without more exact knowledge of the transmission mechanisms of prices from the world market to the domestic markets of the developing countries. Even if one were to assume a large influence of biofuels and speculation on the world market events, this would have no significance for the price and food security situation in poor countries considering the low level of integration of the markets of developing countries in the world markets. The degree of integration and the extent of decoupling is the subject of the calculations in Chapter 4 that follows. And even if one observes exploding and volatile agricultural commodity and food prices in developing countries as on the world market, this does not automatically mean that they were transferred from the world market. It is, for example, conceivable that the same influential factors are effective on unconnected markets, e.g. an oil price increase or changes in exchange rates. Or exclusively domestic determinants are effective, such as extreme local weather conditions, distorted price policies or state market power in the value added chain, which work in the same direction as on the world market. Then, although there would be synchronous price movements on the world and the domestic markets with a high positive correlation, the latter would not be the causal result of the world market pricing situation.

In spite of this clear evidence concerning the main causes of high and volatile prices and the many questions regarding the transmission of world market prices to the markets of the developing countries and the food security situation, the myth of the negative consequences of biofuels and speculation persists. The perceived causes of the current price and food security situation displace the actual causes in the perception of the citizens. Science therefore has an obligation to explain.

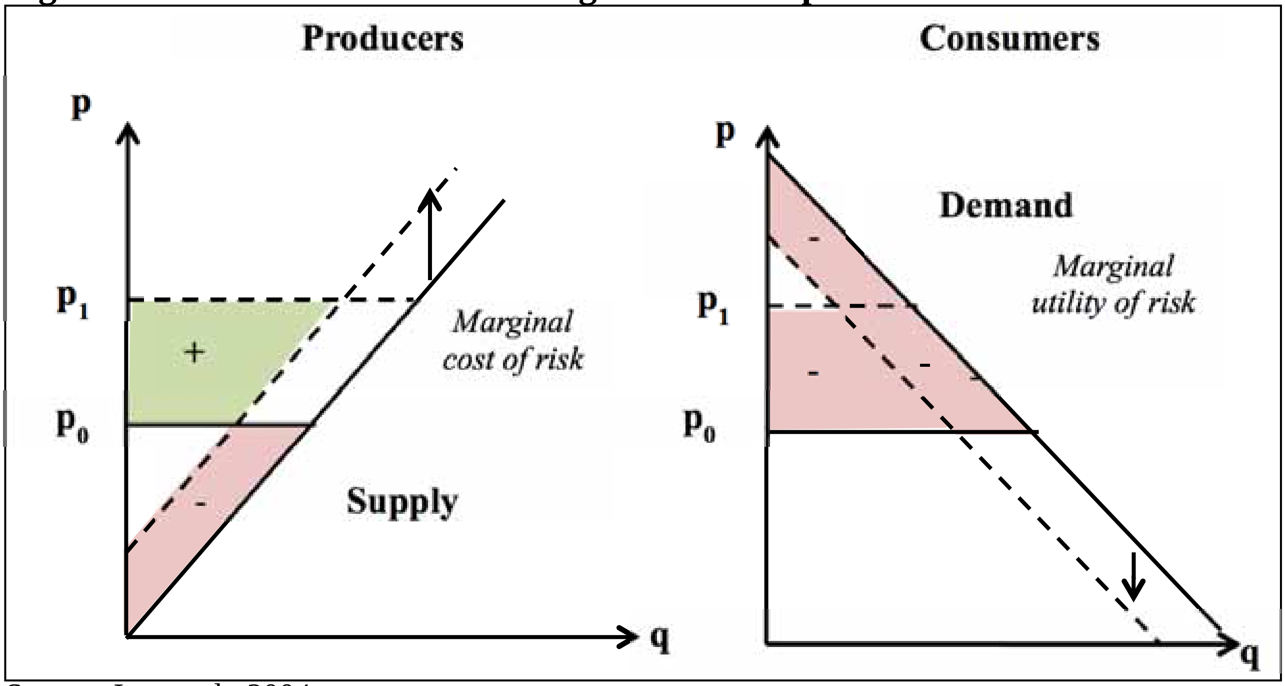
4 Transmission of the world market prices on domestic prices and consequences for hunger and poverty

4.1 Literature survey on price transmission

If one assumes initially that the pricing on the world agricultural markets is transmitted 1:1 to the domestic markets of developing countries in terms of level and volatility, quite different results arise for producers and consumers (see Fig. 4.1): Producers benefit from higher prices and show an increase in producer surplus, while consumers are affected negatively and lose consumer income (see also ANDRIQUEZ et al., 2013). Both market participants are negatively affected by price volatility, which is expressed in Fig. 4.1 through a risk addition on the marginal costs curve and a risk deduction from the marginal benefits curve, for which it has been shown from empirical experience that the welfare effects of price level changes turn out to be many times greater than of those of changes in price fluctuations. (see THOMPSON et al., 2004). To evaluate a change in the price situation it is therefore generally sufficient to look at the price level. The result depends on whether the households are net buyers or net sellers of food. With a high share of food in the shopping basket, the urban population will most likely be among the losers, which was probably the reason behind the numerous hunger revolts in the years with price spikes. Smallholding farmers in the country, however, basically profit from higher prices, as do also the landless farm workers in the form of higher real wage rates. In the case of other rural households, the question of whether food is a net purchase or not remains open. In its report (2011), the FAO assumes that also the poor people in rural areas are net food buyers. In this connection, IVANIC and MARTIN (2008) calculate an increase in extreme poverty of around 105 million people for 2005 to 2008. On a wider database for 28 developing countries and 38 agricultural products in the period 2010/11, the same authors (2012) deduce an increase in poverty of 44 million people, where 24 million persons leave the poverty situation and 68 million are newly added to it. This corresponds with a growth in poverty of only 1.1% in the poorest countries. However, some important aspects have not even been considered. On the one hand, the authors imply that with the given technology, the price increases do not trigger supply responses, nor investment plans or any other productivity-improving measures. On the other hand, the numbers stated are valid only on the assumption of constant wages. Although the authors show the changed poverty indices under consideration of the wage increases for individual countries, they dispense with an aggregation for all 28 countries. Here it must be assumed that the total numbers will sink further. Incidentally, in the article it is not completely clear how the price increases have materialised: as a result of world market prices or domestic influential factors. This will be clarified in the following.

One must first of all record the fact that the simple formula: “high and volatile agricultural prices are causal and decisive for hunger and malnutrition” is not tenable. With increasing world agricultural prices, net exporting developing countries, for example, have higher export earnings and foreign exchange revenues available which can contribute to the improvement of living standards. Incidentally, higher prices stimulate investments in agriculture and therefore contribute to an improvement in the food situation (FAO, 2011), particularly as 80% of hunger and poverty is found in rural areas, and the great majority of the rural population is employed in agriculture.

Fig. 4.1: Welfare effects of increasing and volatile prices

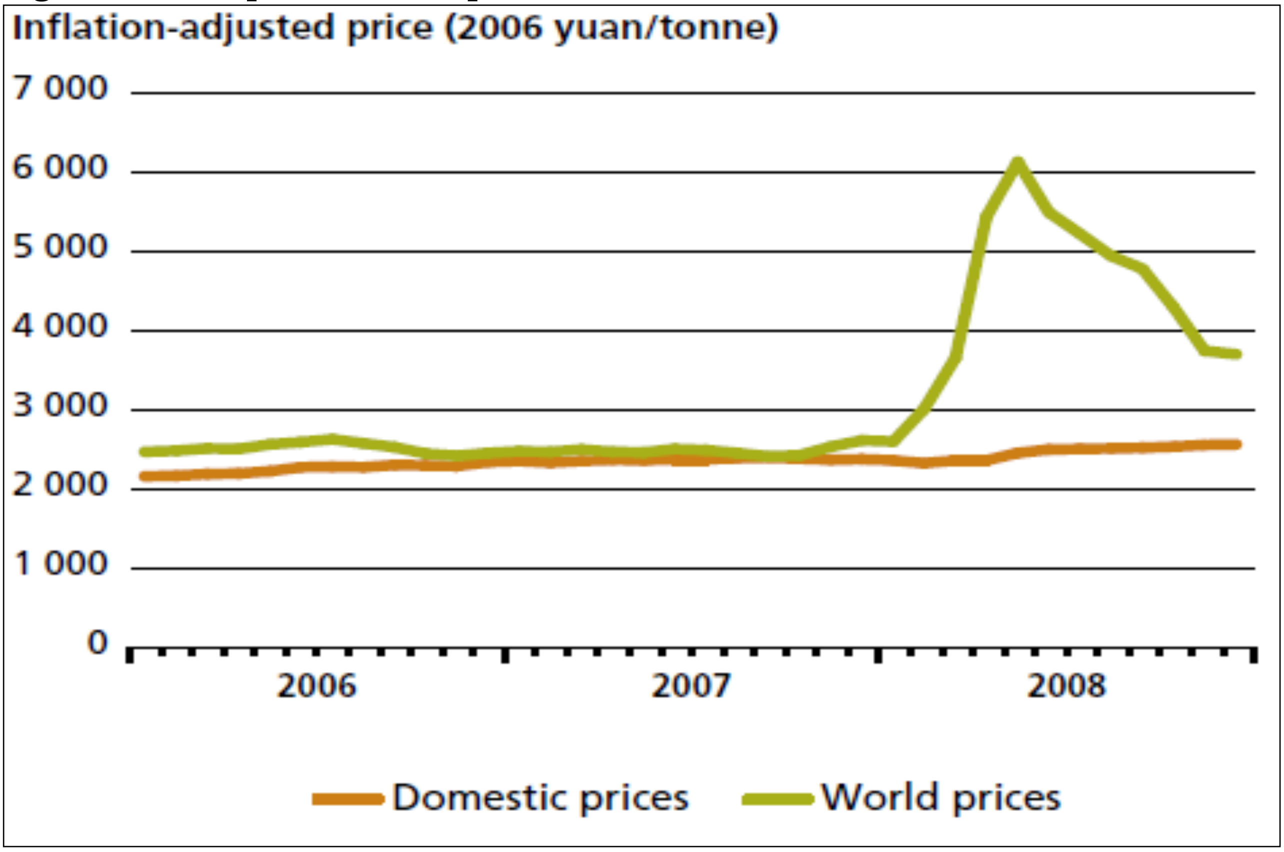


Source: Just et al., 2004

However, price level changes and price volatilities are generally not – as was previously assumed – passed on 1:1 to the domestic prices of developing countries, as governments often operate their own trade, price, exchange rate and tax policies because high transport costs with lacking infrastructure can prevent to a large extent, or even completely, connection of the domestic market to the world market, or because price changes are not passed on, or not passed on symmetrically, by powerful market players in the food chain. State interventions in pricing in particular lead to a reduction in producer prices and are at the expense of the smallholder. This happens with export taxes and import subsidies, and equally with production taxes. In addition, over-valued currencies lower the prices of tradable agricultural goods. And last but not least, duties on industrial products increase the costs to agriculture for raw materials and operating equipment. The price transmission elasticity (domestic price change in % due to a 1% price change for the same product on the world market) is frequently less than one and occasionally even zero for remote rural areas in developing countries (see also MINOT, 2011; GILBERT, 2011a and RAPSOMANIKIS and MUGERA, 2011). Figs. 4.2 and 4.3 illustrate this situation for rice in Asian countries.

In the event that people in poor countries do not receive any nourishment from internationally tradable commodities, but instead have to rely on local foods not tradable nationally, they would also not be affected by events on the world market. Also in these cases world market developments cannot be held responsible for hunger and poverty. In this context it is interesting that the prices occasionally fluctuate more significantly for local non-tradable commodities, e.g. cassava, sorghum and millet, than for internationally tradable goods (see Fig. 4.4). This is due to the fact that domestic production fluctuations are often more intense than fluctuations in world production on aggregate, and in isolated markets no buffers exist as compensation which, in the case of price spikes, trigger import inflows and, in the case of price troughs, export outflows. An opening up to world markets and a stronger market integration would therefore even have a stabilising effect for the households budgets in developing countries. On this point, Appendix D contains our own calculations of the volatilities for selected countries and products between 2000 and 2012.

Fig. 4.2: Development of rice price on world and Chinese market 2006 - 2008



Source: FAO 2011

The result of the low volatility of goods traded internationally compared with goods traded more regionally/locally is also confirmed by MINOT (2012) with the example of Africa. Furthermore, his article contains further interesting results, e.g. that

- the price volatility has significantly increased in only 7 of 67 investigated African price-time series in the period 2003 to 2010.
- in 17 out of 67 cases, the price volatility even fell and
- in the remaining 43 cases, no significant change in the price volatility took place.

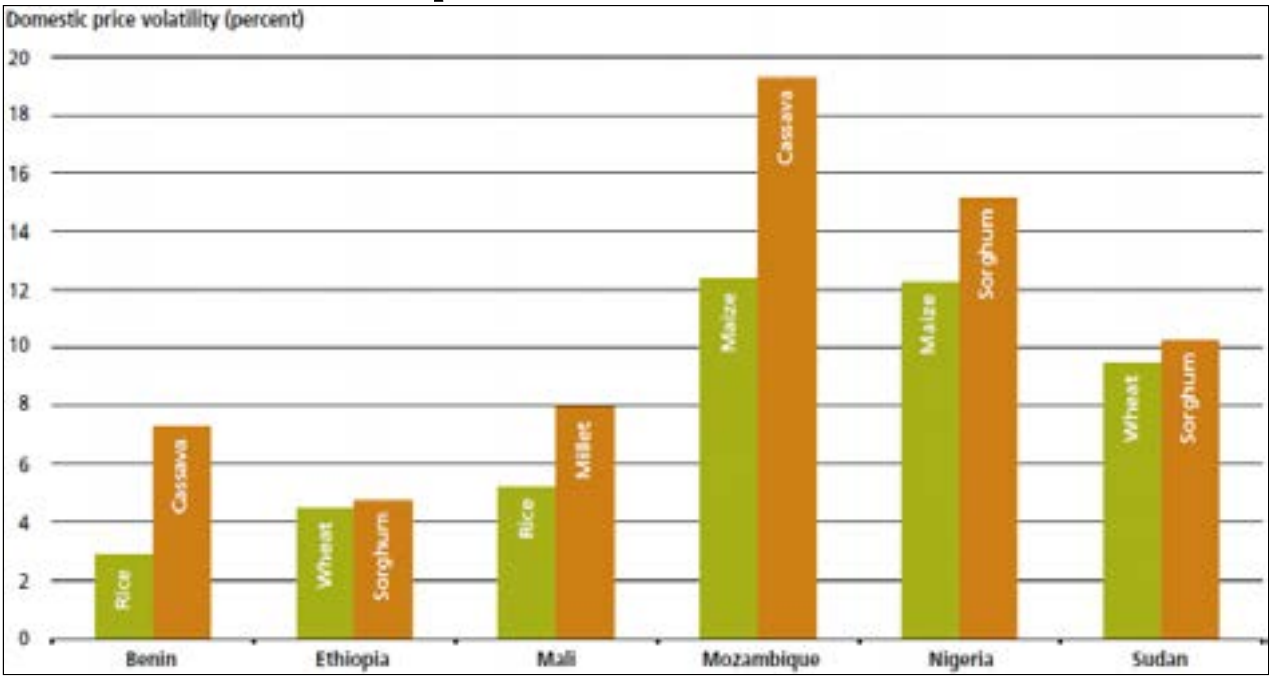
This contradicts the widespread opinion that the volatility in poor countries has risen since the food price crisis of 2007/08.

Fig. 4.3: Price transmission elasticity in developing countries 2007 – 2008

Source: DELGADO 2011

The same author provided a further article in 2011 that is highly relevant to the present question (MINOT, 2011). He looked very intensely at the question of how to estimate the price transmission elasticity. MINOT shows that misleading results can be obtained when calculating price transmission elasticities if one only compares the percentage increase in prices on the domestic market and the world market with each other over a certain time period or, more precisely, divides one by the other, without testing the causality between the two. Causality is namely a prerequisite for elasticity calculations, for example in the case of price elasticities of supply and demand, where a causal influence of the price on quantities is assumed. Using this simple procedure for 12 African countries and 83 time series pairs between June 2007 and June 2008, MINOT arrives at an average price transmission elasticity of 0.71. This means 71% of the relevant world market price increase is transmitted to the domestic price. These results are also somewhat scattered, depending on the country and type of product. The price transmission elasticities in Western Africa are therefore considerably lower than in Southern and Eastern Africa, and for maize and wheat they are higher than for goods which are not, or hardly, traded internationally.

Fig. 4.4: Domestic prices for rice, wheat and maize were less volatile than those for traditional staples in Africa between 2005 and 2010



Source: FAO 2011

However, on investigation and consideration of causality with the help of an error correction model, MINOT (2011) arrives at completely different results. After application of the Johansen test for co-integration, only 13 of 62 price-time series (= 21%) exhibit a long-term causal relationship between world market price and domestic price. And only 6 of 62 (= 9.7%) are statistically significant. On average, the price transmission elasticity of the selected countries falls to 0.21, with rice now exhibiting the highest value of 0.47. Maize is at only 0.1, and with wheat there is no connection to the world market at all.

On reviewing the figures for 2007/08, one comes to the conclusion that African markets are to a large degree decoupled from the world market prices and are apparently subject to their own regularities with regard to pricing. MINOT therefore concludes that local factors and political reactions, e.g. if neighbouring countries restrict their exports, must play an important role for pricing in developing countries. This statement will be further pursued in the following, as it certainly puts the chain of arguments of biofuel and speculation critics into question. For this purpose, the analysis of MINOT (2011) will be extended in the next chapter by a longer and more recent time period and by a larger number of countries from three continents.

4.2 Own empirical results using an econometric Vector Error Correction model (VEC)

The Vector Error Correction Model (VECM) is used in this study in order to investigate the relationship between world food prices and domestic food prices in African, Asian and Latin American countries. Here we are dealing with an econometric time series analysis which tests whether the prices of a product on two spatially separate markets influence each other, either mutually, unilaterally or not at all. Each estimated model consists of a domestic price for a commodity on a domestic market and the world market price for the same commodity. The VECM can be used if two conditions are met (the technical description of the method that follows has been formulated closely based on MINOT 2011):

- Each variable is non-stationary and integrated from degree 1, written as I(1).
- The variables are co-integrated, which means that the linear combination of the variables is stationary.

For each pair of domestic and world market prices, the analysis consists of three steps:

1. Checking the individual price series in order to see whether they are integrated from degree 1. Used for this check are the augmented Dickey-Fuller test, the Phillips-Perron and the Kwiatkowski test.
2. The Johansen test analysis is used to check whether the two price series are co-integrated. This means that a test is performed to determine whether the price pairs have a long-term relationship.
3. If the Johansen test indicates a long-term relationship, then the VEC model is estimated.

The model has the following general form:

$$\Delta p_t = \alpha + \Pi p_{t-1} + \sum_{k=1}^{q} \Gamma_k \Delta p_{t-k} + \varepsilon_t \qquad (6)$$

With

p_t being an *n x 1* vector of *n* price variables;

Δ being the difference, where $\Delta p_t = p_t - p_{t-1}$

ε_t being an *n x 1* vector of the error term;

α being an *n x 1* vector of estimated parameter which describe the trend;

Π being an *n x n* matrix of estimated parameters which describe the long-term relationship and the error correction adjustment;

Γ_k being a series of *n x n* matrices of estimated parameters which describe a short-term relationship between prices.

In the following estimation, a two-variable VEC model will be used: The effect of world market price on domestic prices and the effect of domestic prices on world market prices. As most countries can be considered to be "small countries", domestic prices presumably have no effect of on world prices:

$$\Delta p_t^d = \alpha + \theta \left(p_{t-1}^d - \beta p_{t-1}^w\right) + \delta \Delta p_{t-1}^w + \rho \Delta p_{t-1}^d + \varepsilon_t \qquad (7)$$

For which the following applies:

p_t^d	is the logarithmised domestic market price in US dollars;
p_t^w	is the logarithmised world market price in US dollars;
Δ	is the difference, where $\Delta p_t = p_t - p_{t-1}$
$\alpha\ \theta\ \beta\ \delta, \rho$	are the coefficients
ε_t	is the error term

The coefficients can be interpreted as follows:

1. As the prices are expressed as logarithms, the co-integration coefficient β is the long-term price transmission elasticity between the world market and domestic market price.
2. The error correction-coefficient θ mirrors the speed of adjustment to the new equilibrium. The larger the θ coefficient as an absolute value, the faster the domestic prices will reach a new equilibrium.
3. The coefficient δ represents the short-term price transmission elasticity between the world market and the domestic price..
4. The coefficient ρ is an autoregressive term and demonstrates the effect of each change in the domestic price as a result of the price change in the previous period (based on MINOT, 2011; ENDERS, 1995)

For quantifying the price transmission from the world market to the domestic markets in the developing countries, 77 price-time series pairs for 23 countries of Africa, Asia and Latin America and five products (maize, wheat, sorghum, rice and sugar) were investigated, with the aid of the econometric vector error correction model described above (see Appendix C). The data on national prices and world market prices used as a basis was obtained from FAO statistics for different periods per product between January 1990 and September 2012, depending on data availability. The selection of the poorest countries was oriented on two FAO indices (Multi-Dimensional Poverty Index and Human Development Index).

Table 4.1: Transmission of world market price situation of agricultural commodities on domestic markets in developing countries

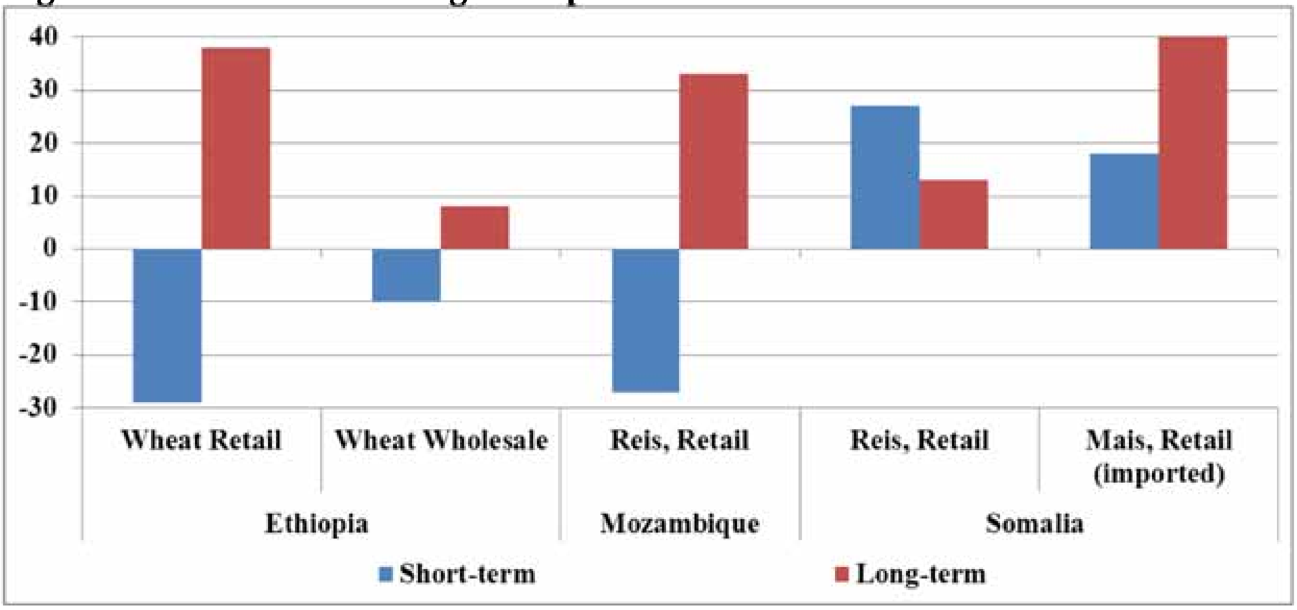
Indicator	Africa	Asia	Latin Amerika	Developing countries
Number of poorest surveyed countries	9	7	7	23
Number of pairwise time-series comparison	33	16	28	77
Share of cointegrated time-series	33%	44%	36%	36%
Number of time-series with significant price transmission elasticity				
Long-term (total time period)	15%	13%	25%	**18%**
Short-term (after one month)	6%	0%	11%	**6%**

Only 28 of the 77 time series pairs (= 36%) show any long-term connection (co-integration) between world market and domestic market (see Table 4.1). Conversely this means that about two thirds of the pricing on the world market is not transmitted at all to the developing countries and a large share of the domestic price movements are apparently home-made.

Significant values for the long-term price elasticity can be calculated for only 14 of the 77 data pairs (= 18%). It indicates the share of the world market price change that arrives in the domestic markets of the developing countries. In 5 of 14 cases this is a transmission of only 10% and less, in two further four cases between 10% and 20% and between 30% and 50%, respectively. In the case of one outlier, the transmission is a multiple (290%) of the world market price change (see also Figs. 4.5 to 4.7). The short-term price reaction on the domestic markets frequently turns out to be negative, this means that price increases on the world market are followed within the first month by a price reduction on the domestic market, which then dissipates again over time and converts to moving with the world market price in the same direction.

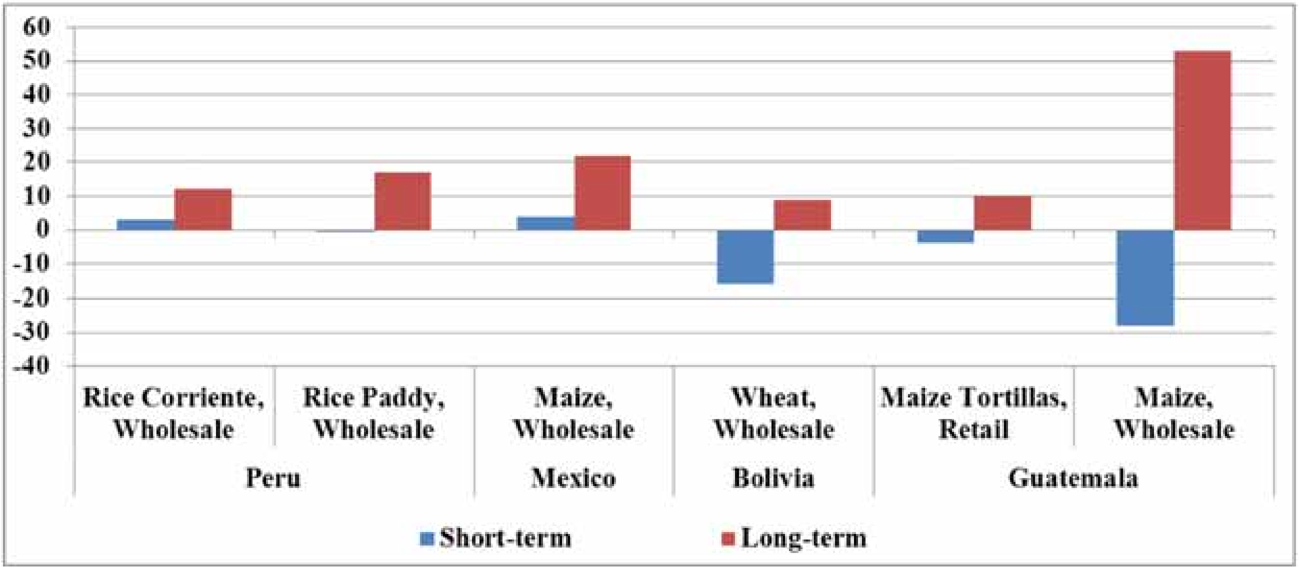
The interpretation of the results of these analyses suggests the conclusion that pricing in developing countries takes place to a large extent independently of the world market, and price impulses are either not passed on to the domestic markets, or are passed on only in relatively small amounts. Accordingly, pricing in developing countries is above all the result of domestic determinants.

Fig. 4.5: Short-term and long-term price transmission in African countries %*



* Short-term price transmission refers to the first month of price changes on the domestic market and long term transmission refers to the total period of the estimate.
Source: Own estimation with vector error correction model

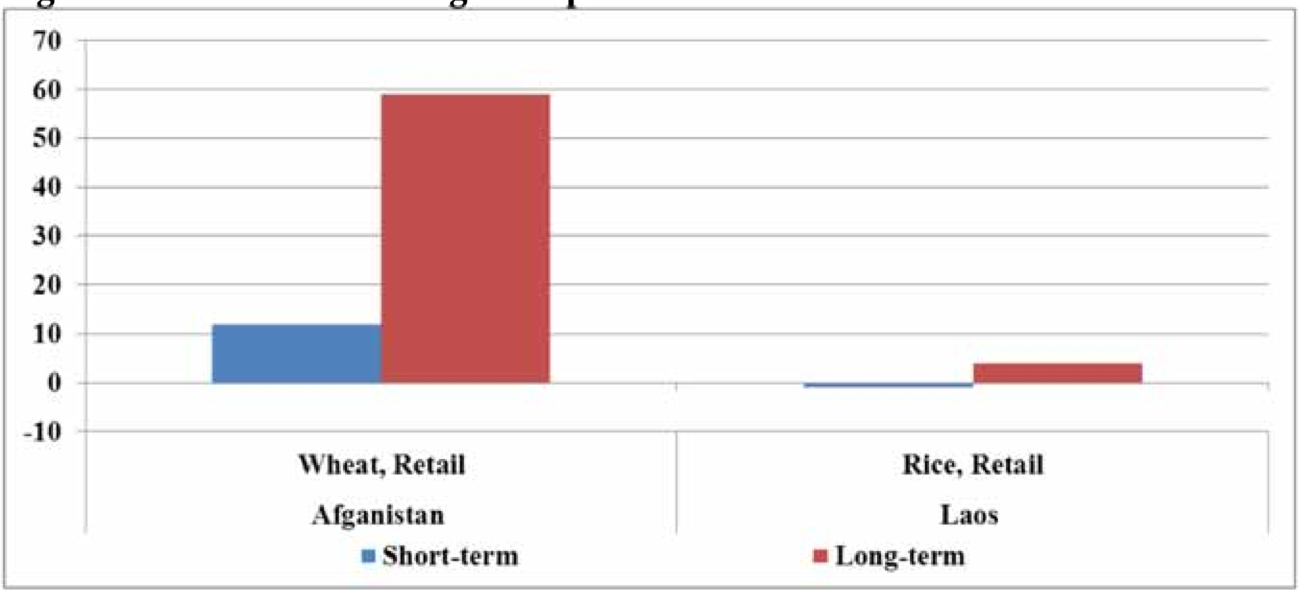
Fig. 4.6: Short-term and long-term price transmission in Latin American countries %*



* Short-term price transmission refers to the first month of price changes on the domestic market and long term transmission refers to the total period of the estimate. The outlier value of Nicaragua is excluded from the figure.

Source: Own estimation with vector error correction model

Fig. 4.7: Short-term and long-term price transmission in Asian countries %*



* Short-term price transmission refers to the first month of price changes on the domestic market and long term transmission refers to the total period of the estimate.

Source: Own estimation with vector error correction model

4.3 Home-made causes of hunger and poverty in developing countries

Against the background of these results, a critical view must be taken of a whole range of articles on the nutritional situation which assume excessively high price transmission elasticities or which ignore corresponding adjustment reactions in rural areas (expansion of supply and wage increases) or the spill-over effects of higher export earnings. This applies to numerous partial and general equilibrium models (e.g. KLÜMPER and QAIM, 2013) which attribute a hunger-exacerbating effect to biofuels. KLÜMPER and QAIM quantify this, for example, with 81 million additional people going hungry as a result of biofuel production in rich countries.

In order to ultimately understand better what the main influential factors for undernourishment in developing countries are, an econometric analysis is certainly the more suitable tool. One such analysis from ABDULAI and DITHMER (2013) has quite recently become available as a dynamic panel model which covers a comprehensive sample of 158 developing countries in the period 1980 to 2007 and investigates the nutritional energy supply per head as the variable to be clarified. The authors arrive at the following results:

- The nutritional energy supply changes in the course of time only very slowly, i.e. once a hunger situation has developed, it is very difficult to correct;
- Open trade, i.e. integration into foreign markets, has a significantly positive effect on the nutritional situation;
- Equally, a growth in real income leads, as expected, to an improvement in the nutritional situation;
- Violent conflicts and natural catastrophes have a significantly negative effect on nutrition;
- Equally significantly negative are the effects of population growth and inflation.

In an extension to the basic model, the development of the infrastructure, capital stocks in the agricultural sector, good governance and the macro-economic stability have proven to be additional, significantly positive determinants.

The main causes of hunger and poverty in developing countries thus lie above all in the developing countries themselves. To be mentioned here are isolated markets, poor governance, corruption, inefficient administrations, civil wars, weather extremes, natural catastrophes and, not least, the discrimination of agriculture as a result of export taxes, industry protection at the expense of agriculture and overvalued currencies, with the result that farmers receive only a fraction of the world market price for their products. Consumers, on the other hand, frequently pay excessive prices because powerful state and private market players in the food chain (processors and dealers) expand the margins to their advantage. For the large part, the wholesale and retail prices in poor countries are even considerably higher than the world market prices (see the figures in Appendix E). This is particularly noticeable for maize in Mexico, Peru, Nicaragua and Niger. In the case of Mexico, this will be revisited in Section 5.1.

Alongside the home-made market deficiencies and politics-related market distortions through the country's own government and through neighbouring countries, the oil prices can also have a direct effect on the pricing in developing countries by making the use of energy for transport, for processing and for the manufacture of agricultural operating equipment more expensive. Even this when considered causally would have nothing to do with the pricing of agricultural commodities on the world market, but would, when separated from this, lead to synchronous price developments on the domestic markets, all other things being equal. The eruptions as a result of this shock could even be greater in the developing countries, as supply and demand elasticities that are present there tend to be lower.

Summarised this means that artificially depressed producer prices and excessively high consumer prices coupled with a self-made higher price volatility considerably exacerbate the hunger situation in developing countries. World market prices are not causally responsible for this. At best, common influential factors such as oil prices, exchange rates and ad hoc export restrictions, work separately from one another and lead to synchronous pricing developments. If hunger and undernourishment are to be fort against the actual causes need to be tackled and not the perceived ones. The key to this lies above all in the developing countries themselves, which does not rule out help from the industrialised countries. However in the following, and before commenting in Chapter 6 on some implications for policy-making, some myths surrounding the discussion on biofuels will firstly be done away with.

5 Criticizing of biofuels – two case studies

NGOs continually use striking case examples from developing countries in order to present apparent causalities as facts. Two examples will be critically commented upon in the following.

5.1 Tortilla crisis in Mexico

The opinion is widespread that the increasing use of US maize for the production of ethanol was mainly responsible for the extreme rise in price of Mexican tortillas by 25% at the end of 2006 and by a further 69% by 2011 (Action Aid International, 2012a, 2012b). WISE (2012) attempts to prove this using the following chain of arguments (see also ACTION AID INTERNATIONAL; 2012):

- 40% of US maize is used for the production of ethanol, which is about 15% of the world's maize production.
- A study by the National Academy of Sciences is then quoted, according to which 20% to 40% of the price increase between 2007/08 was due to biofuels. Dramatic effects for consumers and food-importing countries are derived from this.
- For Mexico it has been established that, after considerable growths in imports, it now imports one third of its maize from the USA.
- The import volumes between 2006 and 2011 are then multiplied by the mark-up for maize as a result of ethanol production in order to calculate an additional expenditure for import of 1.5 billion US dollars.
- This is interpreted as a conservative estimate, indicating that it could even be easily double.
- Finally, from the fact that maize makes up about 40% of the production costs of tortillas, it is concluded that the price explosion for tortillas was attributable to the ethanol production in the USA.

Only as a note in the margin does WISE (2012) mention that there are winners in the maize price increase in Mexico, namely the maize producers. However, no offset is made. Just as no further causes, which no doubt exist, were sought for the tortilla price increase. In his analysis of the price increases of 2006, NAVARRO (2007) names three of these as examples: On the one hand, he holds the monopolistic position of just a few processors and sellers in the maize-tortilla food chain responsible for the high prices, as they control not only the domestic market, but also to a large extent the foreign trade. On the other hand, he justifiably points out that the price increases for diesel, petrol and electricity that make up a 30% share of the tortilla production costs have also contributed considerably to the price increase of tortillas. Finally, more and more yellow maize is used in Mexico as a feedstuff in animal production, which on Mexican farms possibly partially displaces the white maize used for tortilla production (see also MEJIA and PEEL, 2009).

Unfortunately there are as yet no empirically reliable, quantitative analyses for these additionally mentioned determinants (monopolies, energy price increases, maize as an animal feed). These would need to refer back to monthly data since 2006 and cover the price development in the entire food chain from the raw materials to the final consumer price of the tortilla. There is also no summary presentation of a more recent date on the price development of tortillas. For this reason it is possible that the wrong ideas about the influence of US biofuels on the tortilla price in Mexico persist.

In spite of these limitations, the analysis of WISE (2012) can be attacked at two points and leads to wrong results. Firstly, the increase in the price of maize on the world market due to biofuels is considerably overestimated. Instead of 20% to 40%, more likely 4% to 12% can be assumed, based on the literature and our own calculations. And secondly, only a fraction of the world market price increase is transmitted to the Mexican domestic market. For example, for Mexico City, Xalapa and Guadalajara in the period January 2000 to July 2013, our own calculations using the error correction model in Section 4.2 give price transmission elasticities of only 16%. Even if a 40% increase in the world market price is assumed, only 6.4% of this price increase would then arrive on the Mexican domestic market. This means that the price increases for tortillas are hardly influenced by the US market or the world market. The reasons for the price increase must therefore be sought within Mexico itself. Important arguments have already been stated.

Incidentally, it must not necessarily be bad or harmful to welfare for a country – as is wrongly suggested by various articles – if spending on imports increases. After all, in exchange one obtains valuable merchandise which can obviously be produced cheaper abroad than by using domestic resources. These in turn can instead be used in those goods for which the country has comparative advantages. For Mexico, that would be, for example, fruit and vegetables, which are now successfully marketed as an export product. The consumers and produces therefore profit in the course of this international division of labor.

Analysis of the tortilla crisis suggests the conclusion that the predominant part of the domestic food price explosion in developing countries comes about firstly through home-made market inadequacies (market power of private suppliers) and politics-related distortions of the market, and secondly, through macroeconomic influences (energy price increases), the effect of which also unfolds on domestic markets that to a large extent are disconnected from the world market.

5.2 Land grabbing in Africa and Asia

Large-scale land acquisitions in Africa and Asia, intended for growing agricultural commodities for the production of biofuels, are being increasingly suspected of displacing food production, driving up the prices of food and land and thus exacerbating the hunger situation. At the same time, it is being criticised that the traditional users of the land areas that are sold or leased are frequently driven away; they find no alternative work elsewhere and therefore fall prey to poverty. The public image of land investment has a very one-sided, negative characteristic; the necessary analysis of the true causes of the undesirable development is in most cases missing.

A whole range of scientific publications meanwhile exists which deal concretely and in detail with the problem (see COTULA and VERMEULEN, 2009; VON BRAUN and MEINZEN-DICK, 2009; HALL, 2011; COTULA et al., 2011; SCHONEVELD et al., 2011; MABISO, 2012; VERMEULEN and COTULA, 2010; OBIDINSKI et al., 2012; RIST et al., 2010; MSANGI and EVANS, 2013; FEINTRENIE et al., 2010; ZEN et al., 2006). The result of these studies is that, apart from the negative examples, there are numerous advantages in connection with large-scale land acquisition. But before these are explained, three important comments need to be made in advance. Firstly, the data analysis for generalisations is still in need of improvement, particularly for analyses supported by empirical data. Secondly, in the agricultural sector of many developing countries, an exorbitant investment gap prevails that could be closed by land investments. And thirdly, foreign direct investments are fundamentally met with mistrust, also in Western countries.

Mainly the following aspects are regarded as advantages of the large-scale acquisition of land:

- The production of agricultural commodities for the manufacture of biofuels, either domestically or abroad, can be interpreted by farmers as an additional production activity in terms of a cash crop with which additional income and jobs can be generated.
- The investment gap, which has formed over decades in the agricultural sector of developing countries, could be closed with this additional income.

- From the point of view of the developing country, the expenditure for importing fossil energy could on the whole be considerably reduced by the production of biofuels for their own use.
- Finally, worth mentioning is the fact that with the investment in land, other investors could be drawn in at the same time and improvements in the infrastructure could be made, financed by foreign investors directly or indirectly through the country's increased tax income.

On the matter of available data, the current Land Matrix Newsletter of the Land Matrix Global Observatory dated June 2013 (LAND MATRIX NEWSLETTER, 2013) offers interesting corrections and details. The newsletter is sponsored by various development organisations. The analysis thus differentiates between concluded, planned and failed agreements. Accordingly, 755 agreements, covering over 32.6 million hectares of land, have been concluded since the year 2000, a further 145 agreements concerning a planned almost 11 million hectares are still under negotiation and a not insignificant number of 50 agreements concerning almost 5 million hectares have failed.

The main target areas for large-scale land acquisitions are Sub-Saharan Africa and South-East Asia. The top ten in decreasing order include South Sudan, Papua New Guinea, Indonesia, Democratic Republic of Congo, Mozambique, Sudan, Ethiopia, Sierra Leone, Liberia and Madagascar. Large investors are the governments of China and India, countries in the Gulf region and Europe as well as investment funds. Also of interest are the uses of the acquired land stated in the Land Matrix Newsletter. The largest portion of about 9 million hectares is used for food and animal feed production. This is followed by the land areas used for biofuel production at a little over 6 million hectares. Only slightly behind is the land requirement for timber and natural fibres at almost 6 million hectares. For tourism, an area of at least about 3 million hectares is also needed. If one considers all other purposes for the use of the concluded land acquisition contracts in addition, biofuels contribute world-wide (only) one fifth (= 20%): In a recent study of four African countries, LOCKE and HENLEY (2013) arrive at even smaller shares of land area for biofuel. They prove that a serious discrepancy exists between the announced and actually realised biofuel projects in connection with large-scale land acquisitions. Accordingly, the share in Mozambique is around 2.9%, in Ethiopia 2.6% and in Zambia and Tasmania less than 1%. This puts the contribution of commodity farming for biofuels within the context of land acquisition considerably into perspective.

Unfortunately there are as yet no comprehensive studies in the scientific literature on the economic cost-benefit ratio of large-scale land acquisitions, and certainly not for the share occupied by biofuels. However, individual case studies give grounds for a positive view. Using Ethiopia as an example, NEGASH and SWINNEN (2013) show that the nutritional situation of the 476 smallholders questioned considerably improves if they take part in the programme for the production of raw materials for biodiesel manufacture and use 15% of their land area for this. The food supply is expanded because the improved access to fertilisers and advise increases the yield of food crops by an average of 20% and thereby more than compensates for the loss of land area. In addition, income and liquidity are increased and the soil quality is improved by the changed crop rotation. The article therefore comes to a clear, positive view about investments in biofuel production. Foregoing these direct investments seems not to make sense, in view of the principally advantageous economic effects. Instead of this, potential problems in the form of breaches of contract, expulsions, threats to existence and environmental pollution in the target country itself must be solved by clarifying ownership rights, enforcing the sanctity of contracts, involving and if necessary compensating the parties affected and internalising environmental pollution.

6 Policy Implications

6.1 How to cope with high and volatile prices?

As long as one can be certain that high prices on the world markets for agricultural commodities are not the result of manipulative market powers, they should be accepted as indicators of scarcity on the markets. With the high numbers of current and potential participants, it can be taken as a fact that the international agricultural commodity markets function to a large extent competitively. Price levels in this case indicate not only the scarcity condition and its developments, but at the same time also provide signals for adjustment measures. Producers will want to offer more when prices are high and consumers will want to demand less. When prices are low, the suppliers will hold back, and consumers will be encouraged to demand more. Therefore with their adjustment measures, suppliers and demanders contribute to stabilisation of the market prices. If market powers are nevertheless in operation, the cartel authorities are called upon to restore functionality to the markets.

However, price volatilities in the case of short-term inelastic market reactions cannot be ruled out in principle, but their consequences affecting allocation can be cushioned. In the long-term, more open borders, free trade and greater market transparency, in particular, contribute to a stabilisation of the agricultural commodity prices (FAO, 2011). This applies in particular to developing countries, and if as part of a South-South trade, i.e. an exchange between neighbouring countries or regions (see also the World Bank study “Africa can help feed Africa”, 2012). A considerable contribution to removing price instabilities on the world agricultural commodity markets can also be made by a further substantial reduction of agricultural protection in industrialised countries.

It can be established on the whole that the international agricultural price system is certainly able to efficiently fulfil its coordination function in the face of competing demands on biomass and to send corresponding signals for the market participants to adapt (see also PINGAL et al., 2008). Direct state interventions in pricing are therefore not only unnecessary, but would even be damaging, as the expected intentions regarding allocation policies would destroy the control function of the markets.

6.2 Fighting against hunger and poverty in developing countries

An extensive range of scientific literature exists on the causes of hunger and poverty. Development organisations have a profound experience in combatting hunger. What has been recognised is the fact that hunger and poverty can have numerous causes, are to an overwhelming extent home-made and that accordingly a wide range of combatting measures is not only needed, but these must also be individually formulated for each country. Agriculture plays a central role in this. For a long time this has been underestimated by the international development organisations. The national governments in developing countries have discriminated massively against agriculture for many decades, using the most varied measures. These include export and production taxes as well as the taxation of imported industrial goods used as input for the agricultural industry, and overvalued currencies which burden tradable goods over non-tradable goods. For this reason, investments in agricultural production and the market infrastructure (transport, warehousing and communication) are urgently needed in order to combat hunger and poverty primarily in rural areas (WISS. BEIRAT, 2012; GILBERT, 2011b). Finally, for those who do not make a living from agriculture, but are affected by high and volatile prices, a social safety net must be provided. Those in government in developing countries must be enabled through information and analyses to react in good time and comprehensively to changed circumstances and looming food crises (see Benson et al., 2013). The international community could help in this respect. The contribution of rich countries could consist of opening up their own markets and completely refraining from of export subsidies.

6.3 Consequences of policy failures and corner-stones of a balanced bio-fuel and futures markets policy

As politics in its public statements presently gears itself rather to perceived causes than to the actual causes of the pricing and nutrition situation, serious mistakes are being made. In the best case these are without effect, but generally they are even counter-productive in that they make prices unstable and even exacerbate the hunger situation. Some of the measures currently discussed in connection with regulation of the commodity futures markets are likely to restrict their ability to function. Hedging is made difficult, liquidity is restricted and price predictions are made impossible. As no negative effects evidently result from such stock-exchange futures markets, there is no requirement for action. However, one could demand more transparency in over-the-counter (OTC) trading, being off-market trading. Incidentally, it is not possible, either empirically or analytically, to differentiate between normal and excessive speculation in order to derive from this a need for action. Every increase in speculation on commodity futures markets must always be opposed by an increased opposite transaction by hedgers, arbitrageurs and/or other speculators.

In the case of biofuel policies, it is mainly a matter of creating reliable political framework conditions. The idea of in the long term finally replacing fossil raw materials for the manufacture of fuels successively with alternatives is in principle to be welcomed. And the fact that biofuels in particular play a prominent role in this is also undisputed. Important is the setting of clear goals which are not the result of discussions in daily politics and changed without empirically verified analyses, and which should be pursued as far as possible uniformly within the EU.
The consequences of the currently discussed iLUC regulations, which would mean a reduction and perhaps the end of the biofuels introduced in the EU market, could be fatal, not only for the biofuel industry, which, trusting in political statements, has invested in physical and human capital and is now seeing these investments devalued. Serious disadvantages could also result for numerous developing and emerging countries for which biofuels and/or raw materials for their manufacture represent a welcome source of additional export income and a saving on import costs for fossil ener-

gy. One contribution to stabilising agricultural commodity prices could also lie in making biofuel quotas more flexible in order to make the demand for raw materials more elastic with varying agricultural and oil prices.

The EU directive on the promotion of biofuels 2009/28/EC provides all member states with the mandatory target of achieving a minimum quota of 10 percent renewable energy in the transport sector by 2020. For this purpose, the member states were required to present national action plans (see Table 2.3 in Section 2.2) which demonstrated the requirements for the biofuels that are under criticism, and therefore for the raw materials. By way of national implementation, the member states have introduced regulations regarding penalties in order to put the necessary fulfilment pressure on reaching the targets. In Germany, the penalty for non-fulfilment of the overall quota and for non-fulfilment of the quota for Diesel fuel is 19 euros per gigajoule, and 43 euros per gigajoule for non-fulfilment of the quota for petrol fuel.

Naturally the question arises as to whether those obliged to meet the quotas, that is to say the companies in the mineral oil industry, upwards of a certain biofuel price level, prefer to simply pay the penalty rather than use biofuels. The penalty would then become a possible fulfilment option for the mineral oil companies when the difference between the price for fossil fuel and for biofuel rises considerably, i.e. biodiesel becomes disproportionately more expensive. This would then also indicate disproportionately increasing raw material costs which would not have been induced through increased costs of fossil energy production alone. With that it would be possible to attribute the price increase particularly to an actual scarcity of raw materials, which would then also have considerable effects on food market. Thus the payment of a penalty does not have the effect of curbing agricultural commodity prices directly, but it does make it possible to react flexibly to increasing raw material prices.

Through the possibility of a double counting for biofuels from waste or residues towards fulfilment of the quota, as well as the possibility to carry quotas over into the following year, the effect of the penalty is tendentially weakened. The flexibility in fulfilling the legal requirements therefore makes it possible for those obliged to meet the quotas to react to high raw material prices, particularly in real scarcity situations.

The following fulfilment options are available to those obliged to meet the quotas:

- Admixture of biodiesel/bioethanol,
- Sale of pure fuels (B100, vegetable oil fuels, E85),
- Admixture of hydrated vegetable oils (HVO),
- Admixture of biomethane to natural gas fuel,

- Carry-over of quotas into the following year,
- Transfer of the quota obligation to a third party (quota trading),
- Payment of the penalty.

In this way, the rigid demand is moderated in reality by biofuel quotas established in law and the price effects of the raw materials used can be taken into account.

7 Summary and conclusion

Since the 2007/08 price explosion in agricultural commodities and the subsequent massive price fluctuations, world food security has come increasingly into the public view once again. It seemed reasonable to quickly conclude that a still unsatisfactory hunger and poverty situation and the simultaneous protest movements in numerous developing countries had to do mainly with the price developments on the world markets for agricultural commodities. High and volatile prices have since then been regarded as the main source of hunger and poverty in the world. In the search for the causes of this new price situation, these were also quickly discovered. In the public perception, biofuels and speculation are the main drivers of high and volatile world market prices, and therefore of the unsatisfactory world food situation. In particular NGOs, the media, churches, some development organisations and even large food companies have in the meantime been following the zeitgeist by increasingly homing in on industry, banks and speculators as the main groups responsible for hunger, poverty and misery in the world. In its justified effort of wanting to make a contribution to improving the world food situation, even politics seems to be increasingly adopting this diagnosis by questioning the promotion of biofuels and wishing to regulate more closely the activities on the commodity futures markets. This was the starting point of the present study, the aim of which was to investigate whether this chain of causality for the causes of hunger is logical, and whether the political measures introduced based on a conceivable misdiagnosis are not only inefficient, but possibly even counter-productive, i.e. can have the effect of exacerbating hunger. The investigation was carried out based on a comprehensive literature survey and our own additional empirical analyses performed with the help of econometric methods and market simulations. There are serious doubts about the above-mentioned chain of causality for the causes of hunger, as there are completely different, much more effective factors both for high and volatile prices on the one hand, and for hunger and poverty on the other.

The large price movements in the past six years do not constitute an exception in the long-term view since 1960. In this way, no significant upwards trend in the volatilities as a result of biofuel promotion and speculation can be recognised, at least not for the EU domestic markets, hitherto protected by market regulations. But lower volatilities than previously are not to be expected in the future. Clever risk management therefore remains a central task for companies in the agricultural and food industry. The price level for agricultural commodities and biofuels will tendentially rise until 2021, according to current forecasts, and will remain closely linked to the oil price. If the WTO talks fail and ad hoc interventions in foreign trade persist, this could at the same time cause a small increase in the volatilities, as these correlate with the price level to a small positive degree of significance.

As far as the biofuel markets are concerned, it remains to be stated that despite some uncertainties in biofuel policies, macroeconomic framework conditions and crude oil prices, a further significant growth in ethanol and biodiesel production must be anticipated. Here too, strong impulses seem to emanate from the oil price and from politics. The latter is currently under reconstruction in the EU and the USA, but with regard to the first-generation market volume will probably be over-compensated by the advancing expansion of conventional biofuel manufacture in numerous emerging and developing countries. The dynamics on the biofuel markets will therefore continue also in the future, and with that perpetuate the fuels-versus-food discussion. In the process, the world food situation has considerably improved since 1990. With a few exceptions, the number of undernourished has fallen considerably, and there has also been a clear reduction in poverty and child mortality. In spite of this, with 868 million people still undernourished, the global community cannot lean back in contentment and must continue to search for the true causes of hunger and poverty. However, it is not possible from the pure numerical data to deduce a clear link between the increase in biofuel production and the number of institutional investors on commodity futures markets on the one hand, and the world food situation on the other. But even that is not proof if one does not account for all explanatory factors in context and, above all, their possible interactions. In the present study, the simultaneous influence of eight different variables on the level and volatility of the maize price and soybean price were investigated econometrically. Individually these are:

- The oil price,
- Global ethanol production / global biodiesel production,
- The dollar exchange rate,

- Weather-related production fluctuations,
- Export restrictions adopted ad hoc,
- Fluctuations in the global economy,
- Stock level to consumption ratio and
- Number of net-long contracts of speculators.

According to these estimates carried out on a monthly basis, exchange rates, stock levels and oil prices have a significant influence on both of these prices. Above all, a dollar devaluation or revaluation has the greatest effect on prices. In the case of maize, it is the weather-related production fluctuations which play a central role, and for soybeans the export restrictions adopted ad hoc. Biofuels play no role in price fluctuations on both markets and even exhibit marginally price-reducing effects, however at an insignificant level. There is no evidence at all for an influence of speculation on the maize market, and on the soybean market it has an effect tending towards zero. Accordingly, responsible for the price developments on international agricultural commodities markets are firstly the macro-economic framework conditions, including the oil price, which seems to take on a base price function, secondly, the known fundamental factors of the markets (e.g. weather shocks and stock levels), and thirdly, unpredictable ad hoc trade interventions.

The results obtained with the vector autoregressive estimation method are essentially identical to the results from the multiple regression. Particularly for the question of interest here, it is the case that biofuels exert, if at all, only a limited influence on the maize and soybean prices, which, according to the variance decomposition for maize, reaches a maximum of only 7% in the first year and for soybean remains at below 2%. This is confirmed also by the hardly measurable influence of futures market speculation on the maize and soya bean prices, which contributes a maximum of 6% and 3.5%, respectively, to the price variance.

Alongside the econometric approaches to investigating the influence of biofuels, simulations with partial and general equilibrium models can also be found above all in the literature. The results of the market simulation model AGRISIM used here show contributions towards the price increase through biofuels for 2012 of about 10% for coarse rice and oilseed and about 20% for raw sugar. This largely corresponds with the results from the most recent relevant literature. Also the strong price effect of ad hoc interventions in trade policies (e.g. export bans), which exceeds the price level effects caused by biofuels many times over, can be confirmed.

Summarising all results from the most recent literature and our own empirical work, it can be established that

- biofuels trigger a price-increasing effect through the increased demand for agricultural commodities;
- this effect can be intensified in the short-term by further market-based and macroeconomic price drivers working simultaneously;
- the single influence of biofuels compared with other determinants for pricing is, however, small, particularly if corresponding mid- and long-term adjustment reactions by the market participants are taken into account;
- with that, the price influence of biofuels in the public perception is much overestimated, while the true causes for high and volatile prices are hardly heeded;
- also the claimed negative influence of speculation does not stand up to empirical testing.

A further doubt about the chain of causality for the causes of hunger applies to the implied assumption that world market prices are transmitted to a large extent unfiltered to the domestic markets of developing countries. In the relevant literature on this subject, question marks have already been formulated around the example of Africa. Our own econometric analyses using vector error correction models for the poorest countries of Africa, Asia and Latin America based on current numbers confirm this doubt. Significant relationships can be demonstrated for only 18% of the 77 time-series pairs of world market and domestic prices for agricultural commodities investigated. Conversely, 82% of the markets in developing countries are not integrated into the world market pricing, but follow their own regularities. Domestic price and trade policies, transport costs, state distribution systems, powerful market players, exchange rates as well as inadequate infrastructure and market connections play a significant role in this. Also ad hoc political restrictions of the immediately neighbouring countries can develop a considerable effect on the domestic pricing. In the final result, an extreme gap between producer and consumer prices can often be observed as a result of all of these influential factors. Thus, through poorly functioning markets and market distortions by the state, producer prices are artificially reduced and consumer prices increased, at times considerably above the world market price. And corrupt government representatives and administration officials also have no interest in changing anything about this situation, as this would threaten their acquired rights. Furthermore, it is conspicuous that not only the price levels are distorted, but also the price volatilities on the domestic markets of the developing countries are considerably higher than on the world market. This, too, is an indication for the fact that the domestic markets are to a large extent decoupled from international agricultural market pricing and are subject rather to home-made influences, or that macroeconomic shocks or oil price changes affect the price situation in poor countries directly, and not via the global agricultural markets.

These countries are thus missing the price-stabilising buffer volumes of regional or international trade activities, which on the whole places a burden on the domestic producers and consumers. Furthermore, artificially lowered producer prices and excessive consumer prices essentially contribute to the loss of real income and exacerbate the poverty and nutritional problems in rural and urban regions. As 70% to 80% of poverty and hunger is located in rural areas, it would be an important first step to allow farmers to participate in the benefits of increasing prices and to make it possible for them to access markets on a cross-region basis. In closing it should be noted that, firstly, biofuels and speculation do not have the claimed influence on pricing on the world markets, secondly, that the world market pricing is transmitted to the domestic markets of poor countries only to a small extent and, thirdly, hunger and poverty in developing countries are attributed almost exclusively to the decoupled price situation in the developing countries themselves and are the consequence of poor governance, corruption, civil wars, extreme weather conditions, bloated state marketing organisations and the discrimination of agriculture.

This explains the hunger revolts in numerous developing countries and also the tortilla crisis in Mexico. In all cases, domestic conditions were the main causes. And finally, the allegation that biofuel production leads to land-grabbing and therefore to the displacement and destruction of the means of existence of the local population must be rebuffed. It is a fact that the volume of large-scale land purchases by foreigners has considerably increased, and there have doubtlessly also been breaches of contract, displacement and threats to existence. However, these dislocations, seized on mainly by the media, stand in opposition to far more advantages of such direct investments in land and agriculture. These include higher incomes, more employment, expansion of the infrastructure and know-how transfer, to name only a few. And the dislocations are not avoided by banning land acquisition by foreigners, but through improving the internal regulations for co-determination and participation and for creating transparency.

On the subject of dealing with high and volatile prices, the comment must basically be made that the price level is indicated above all by the scarcities, and should not be placed in the service of reallocation wishes. And price volatilities cannot in principle be excluded in the case of short-term inelastic market reactions with only their consequences being able to be cushioned. Long-term, more open borders, free trade and greater market transparency in particular contribute to a stabilisation of the agricultural commodity prices. This also applies to developing countries and should be within the framework of a south-south trade, i.e. an exchange of neighbouring countries or regions. Hunger and poverty are best combatted by investments in agricultural production and in the market infrastructure, as well as by establishing a social safety net for the very poorest.
In particular, agriculture in developing countries should be freed of its burdens under agricultural, trade and currency policies, so as to initiate corresponding production impetuses and lift smallholders from subsistence and integrate them into the local markets. The contribution by industrialised countries could involve opening their markets to exporting developing countries more than previously, dispensing with their own trade-distorting export subsidies and hence generating a greater price-stabilising buffer volume for market shocks at the same time.

A political system which, in spite of these evidence-based findings, does not concentrate on the actual causes of unstable markets and undernourishment, but instead adopts an approach based on “perceived” causes and symptoms is not only in danger of being ineffective, but also of exacerbating price risks, hunger and poverty even further. Biofuels and/or raw materials for the manufacture of biofuels, for example, are for many developing and emerging countries a welcome source of additional export earnings and a saving of import expenditures for fossil energy. In this way, these new forms of cash crops can contribute considerably to increases in real income in developing countries. And even food crops can then profit from this development, in that important operating equipment is additionally available. Wrong decisions can also cause damage in the area of financial market policies, in that the functionality of commodity futures markets is compromised through strict regulation, liquidity is removed and price hedging for farmers and their market partners is made difficult. Price volatility would then increase, and not decrease.

After all, the significance of biofuel policies should above all be geared to contributing to climate protection. This has in the meantime already happened with regard to the indirect land use changes (iLUC), and has led to the first political reactions, however on a questionable basis, which it would be advisable to investigate. A sensible and targeted climate protection policy should, incidentally, not draw on individual phenomena, but rather cover all factors that lead to direct and indirect land use changes, meaning as well as plant and animal production, also the use of forests and green areas for other agricultural purposes (e.g. timber industry, demands for firewood, settlement areas, oleochemistry). After all, in the whole discussion the fact is ignored that a large share of the increased demand for agricultural commodities will not be satisfied by the additional use of land area, but rather through increases in intensity and yield.

Biofuel policies must not only be embedded into a wide political framework which also covers other aspects relevant to the climate, but must also be agreed on a supranational and international basis. National unilateral actions fizzle out in their climate effect at the expense of market shares and the national welfare of the country.

A further demand on the EU biofuel policies is to flexibilise biofuel quotas in order to increase the price elasticity of the demand for substrates, and thereby lower the instability of agricultural commodity prices. Such flexibilisation is conceivable in individual cases, but even now it already exists. Instead of fulfilling quotas, mineral oil companies are able to pay a penalty or have the possibility of taking advantage of carrying over quotas from one year to the next. The wish for more flexibility should therefore align itself more with the biofuel policies of the USA, as there they do not work with percentages, but with fixed overall quotas and partial quotas, and therefore the demand for agricultural commodities for the manufacture of biofuels is relatively inelastic and therefore price-destabilising. Incidentally, during the reconstruction or, better, further development of biofuel policies, a certain amount of attention should be given to protection of trust. Investments have been made in physical and human capital for the protection of natural capital. These investments should not be devalued too quickly, above all not on the basis of faulty and incomplete analysis results. Apart from that, it must be clear that a branch of industry cannot be permanently fed and promoted by the state for its own sake. Added value for society must be clearly recognisable.

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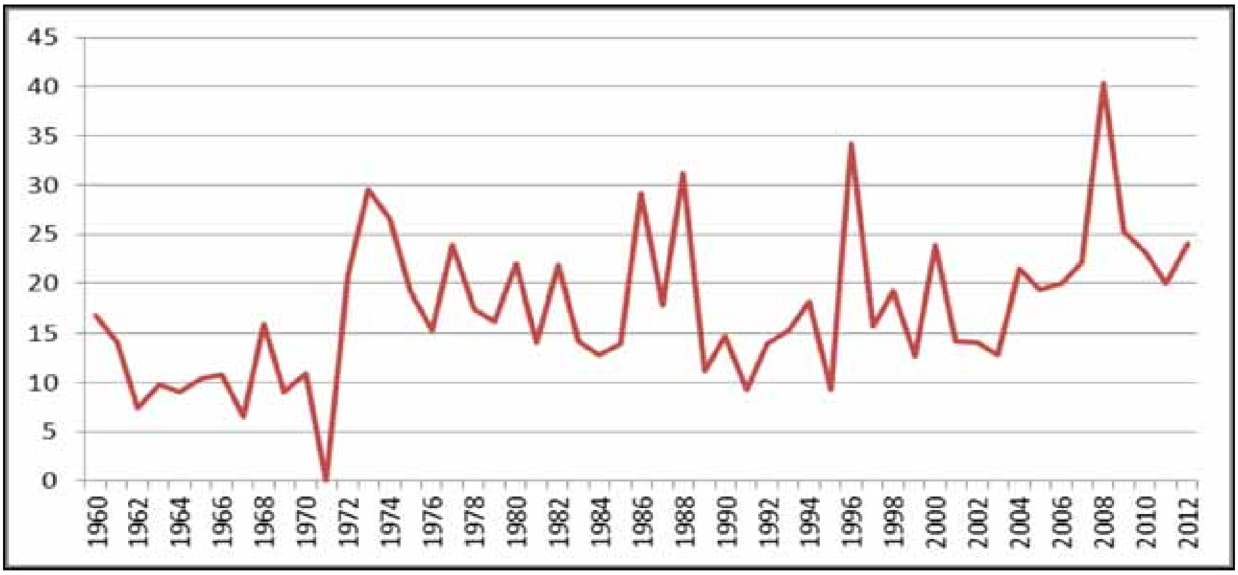
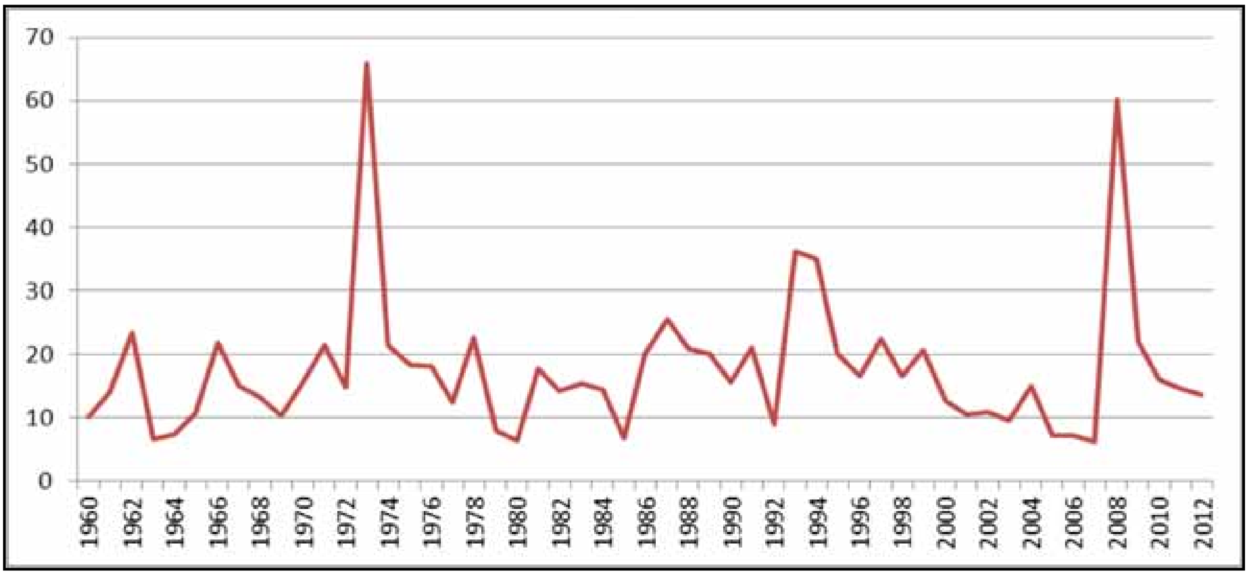
APPENDIX A
Price volatilities for selected agricultural commodities

A1: Price volatility on the world maize market 1960-2012



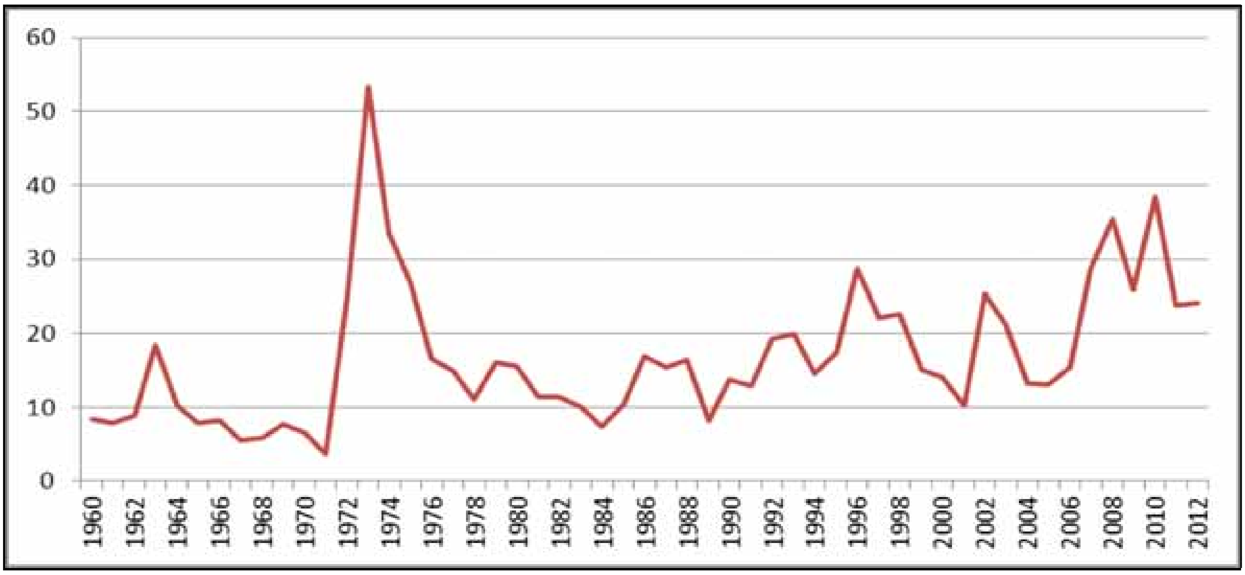
Source: Own calculation (database: WORLD BANK)

A2: Price volatility on the world rice market 1960-2012



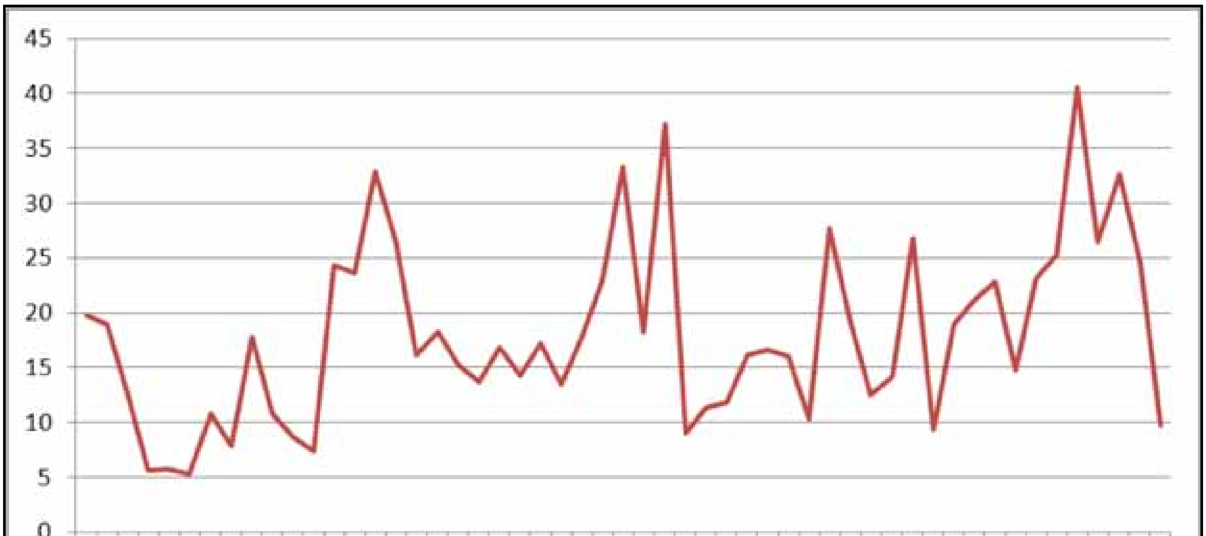
Source: Own calculation (database: WORLD BANK)

A3: Price volatility on the world wheat market 1960-2012



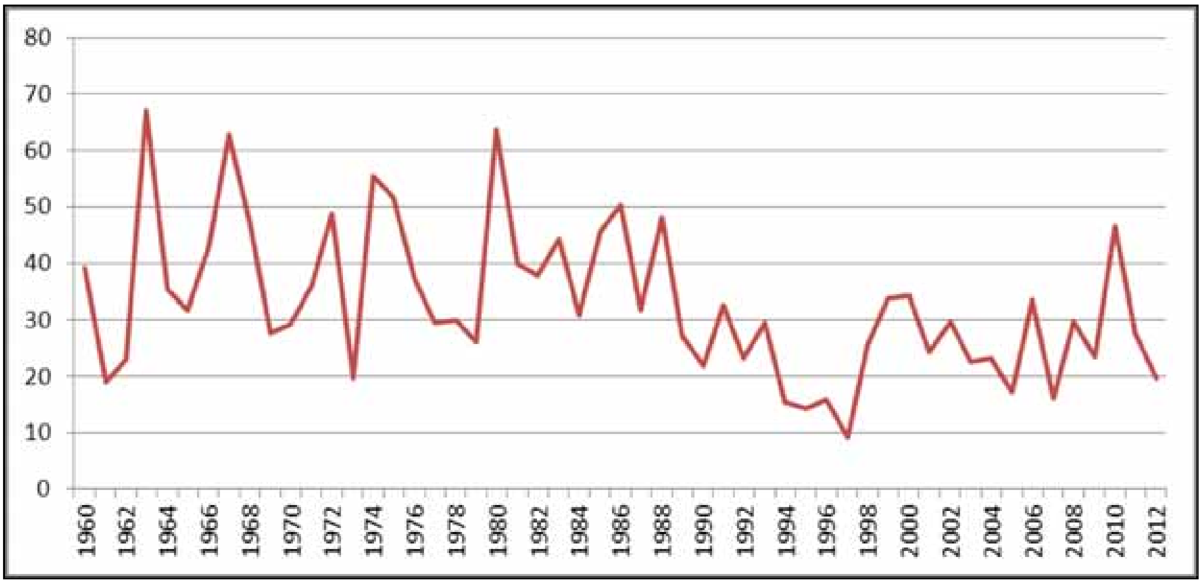
Source: Own calculation (database: WORLD BANK)

A4: Price volatility on the world sorghum market 1960-2012



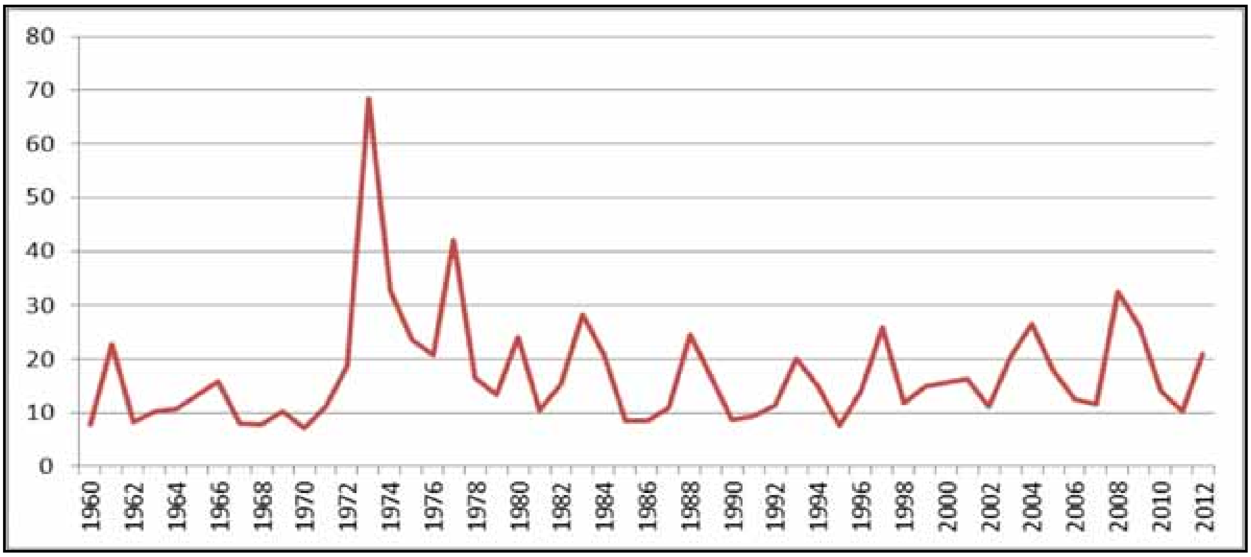
Source: Own calculation (database: WORLD BANK)

A5: Price volatility on the world sugar market 1960-2012



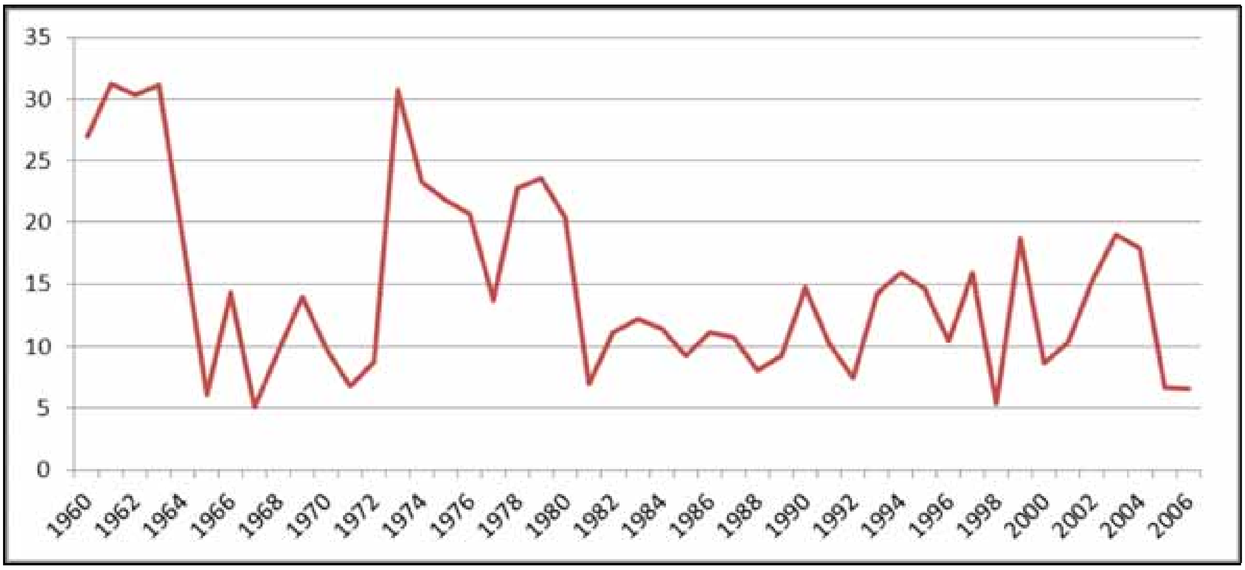
Source: Own calculation (database: WORLD BANK)

A6: Price volatility on the world soybeans market 1960-2012



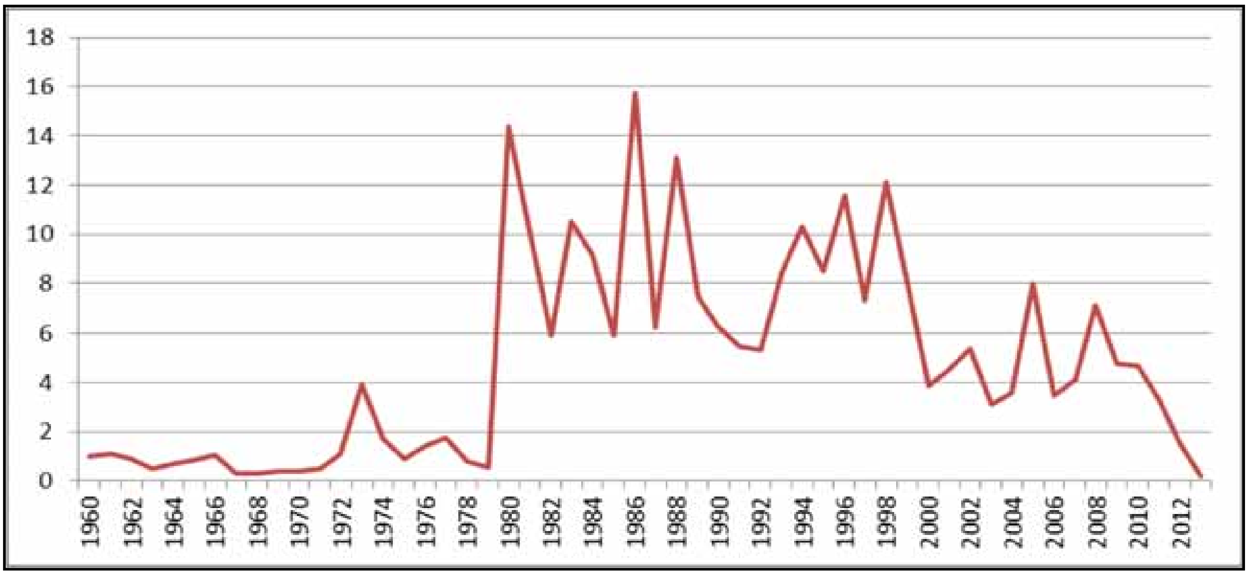
Source: Own calculation (database: WORLD BANK)

A7: Price volatility on the world beef market 1960-2012



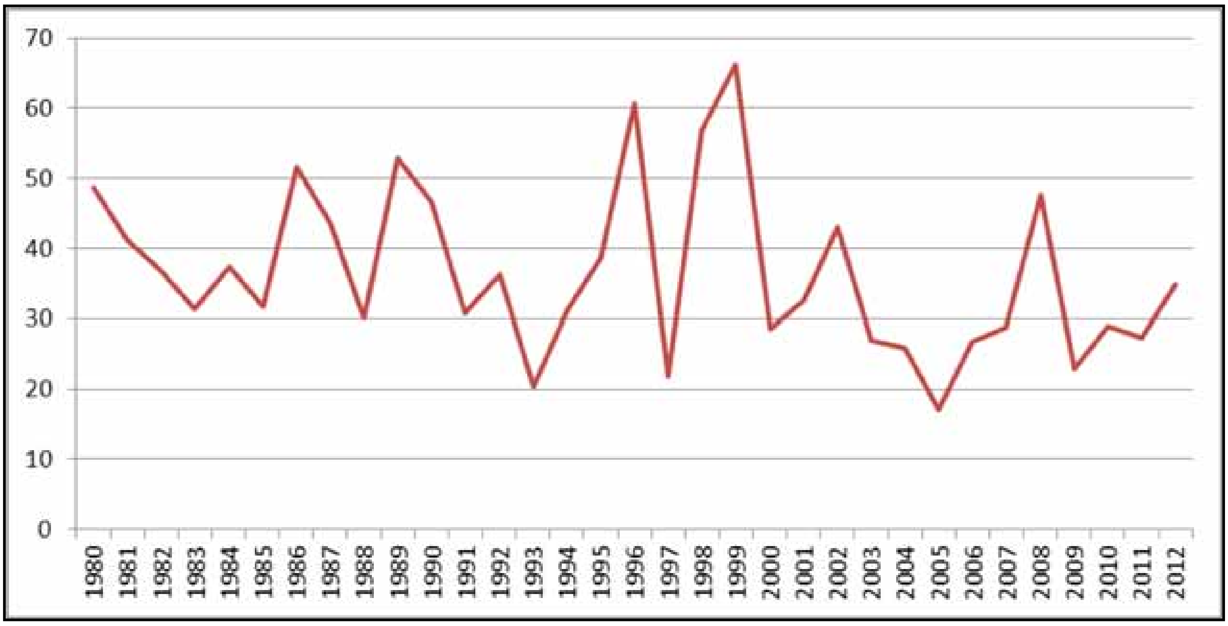
Source: Own calculation (database: WORLD BANK)

A8: Price volatility on the world poultry meat market 1960-2012



Source: Own calculation (database: WORLD BANK)

A9: Price volatility on the world pork market 1980-2012



Source: Own calculation (database: WORLD BANK)

Appendix B

Data base for the econometric estimations

B1: Data used for the regression and vector autoregression analysis (I)

	Designation	Description	Source	Data units
1	Maize price	U.S. No. 2 Yellow, FOB Gulf of Mexico	WORLD BANK	US Dollars per metric ton
2	Exports	Global Maize Exports	F.O. Licht	Thousand tons
3	Stock-to-use ratio	Stock-to-use ratio=Ending stock/total domestic use	USDA-WASDE	Percentage
4	Weather	Monthly Global Production	USDA-WASDE	Million metric tons
5	Ethanol	US Ethanol Production, Monthly Energy Review	EIA (U.S. Energy Information Administration)	Thousand barrels
6	Speculation	Non-Commercial Short and Long Contracts/Futures Only, Net long=Long-Short	CFTC (US Commodity Futures Trading Commission, CBOT Exchange)	Number of contracts
7	GEA	Global Indicator of Economic Activity Index SA	BANK OF MEXICO	Index, 2003=100
8	Crude oil	Crude Oil, avg., spot, $/bbl	WORLD BANK	US Dollar per metric ton
9	Exchange rate	Real Effective Exchange Rate (the nominal effective exchange rate divided by a price deflator or index of costs)	WORLD BANK	Index

Source: Own representation

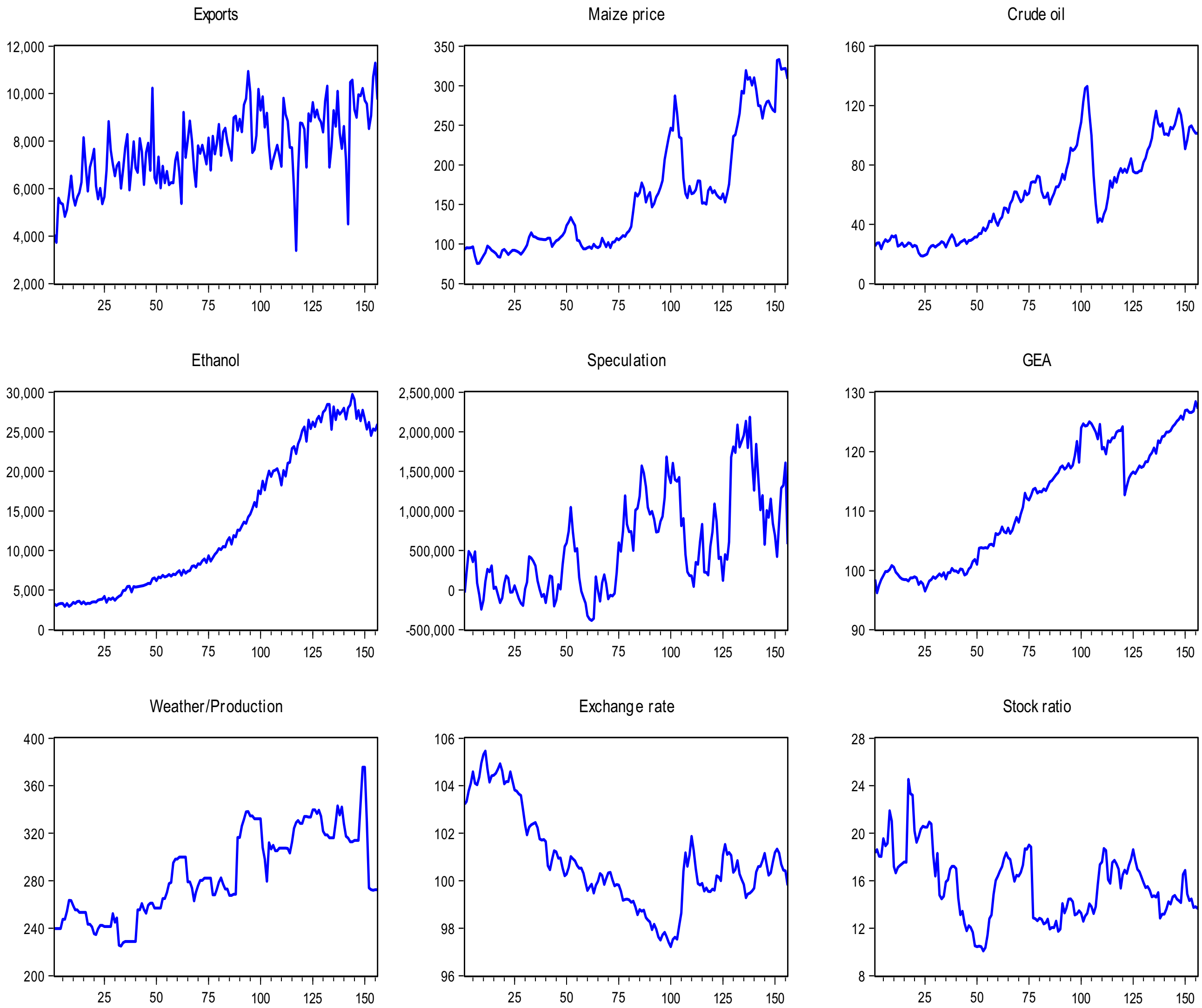
B2: ADF test results for maize price VAR model

Variable	Augmented Dickey Fuller test statistics (without trend)
Maize price	-10.62047
Exchange rate	-6.303439
GEA	-15.96648
Exports	-6.013427
Ethanol	-8.701106
Stock-to-use ratio	-11.84827
Weather	-9.802296
Speculation	-12.65155
Crude oil	-7.835608

Critical values: 1%=-3.473672, 5%= -2.880463, 10%=-2.576939

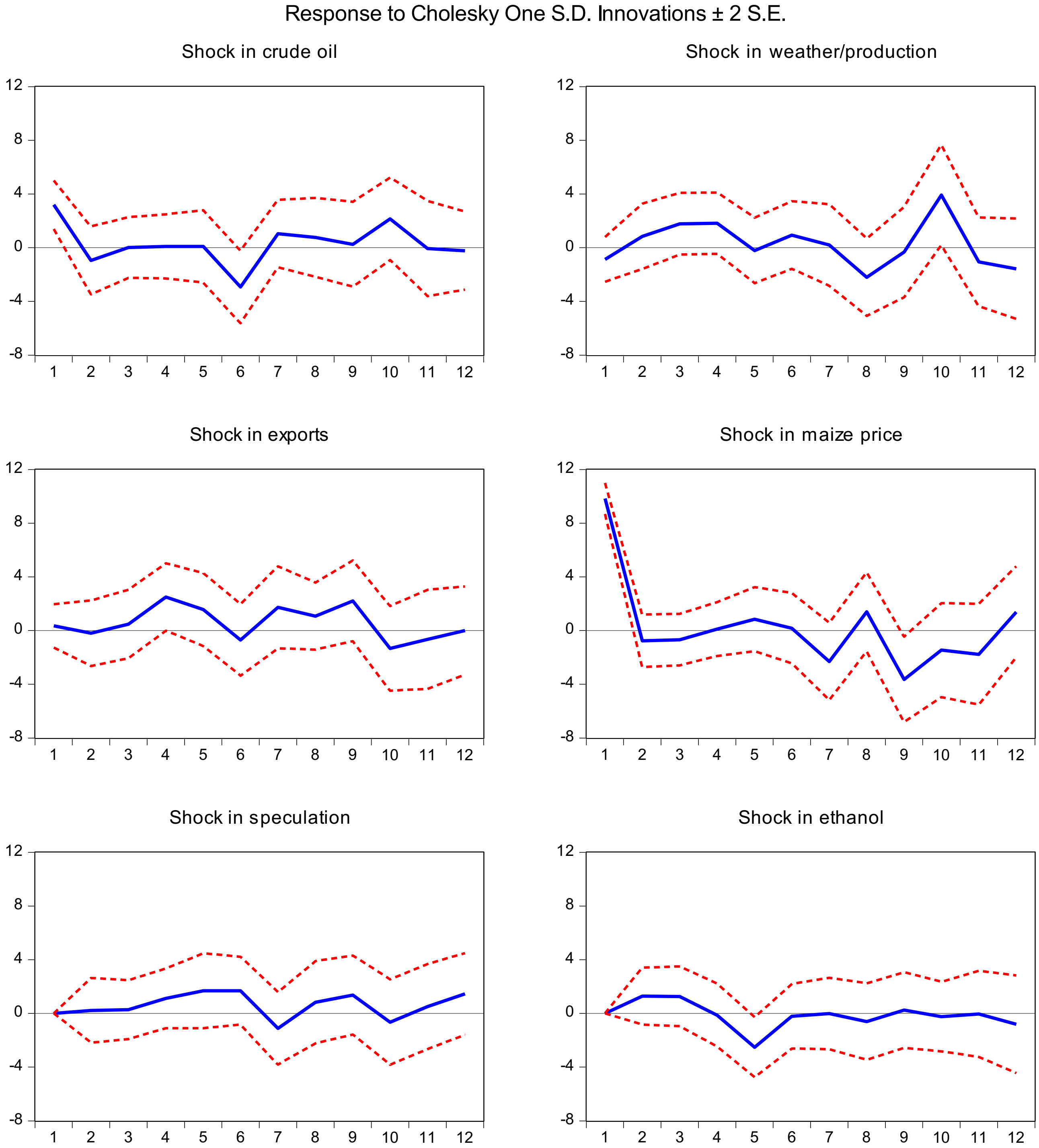
Source: Own calculations

B3: Time series presentation of used variables (I)
January 2000 - December 2012



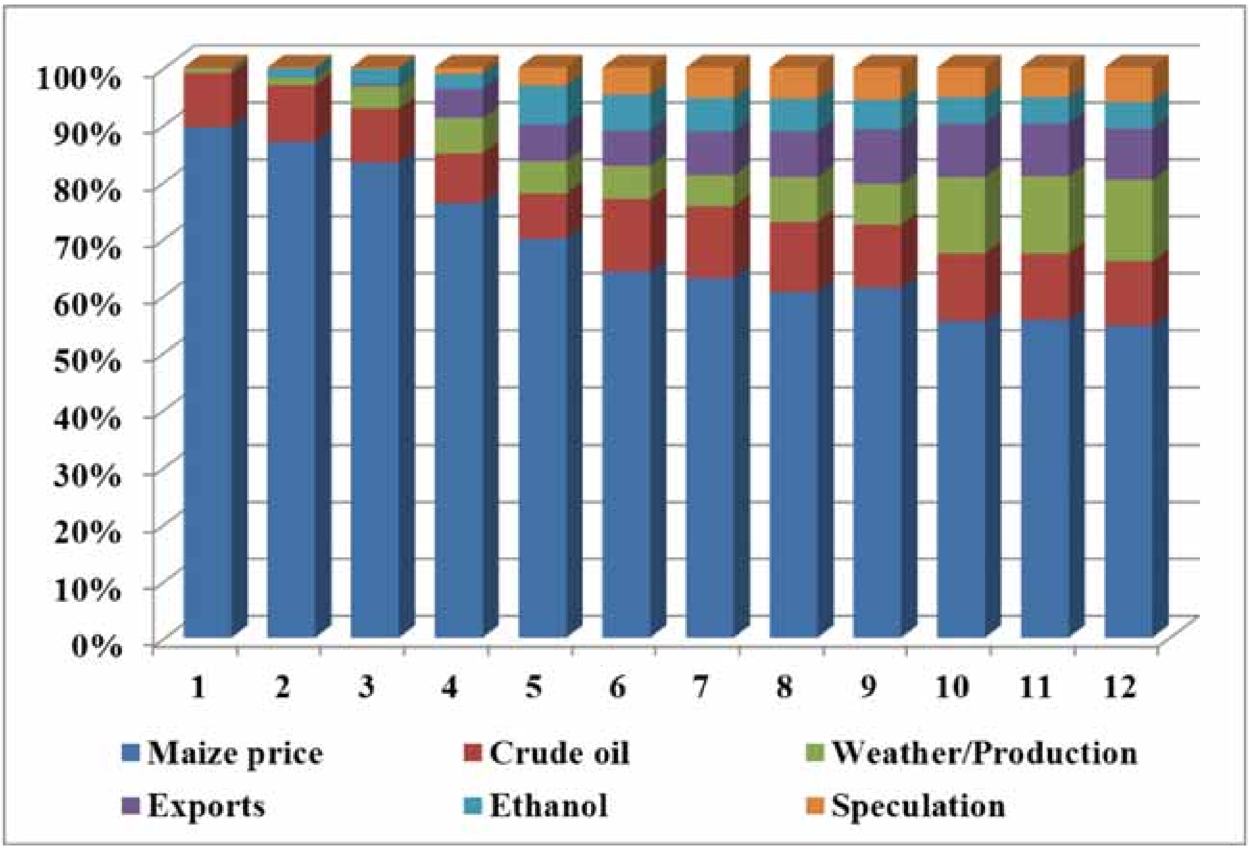
Source: Own representation

B4: Impulse-response-function with confidence intervals of ± 2 standard deviations (Change of maize price during 12 months)



Source: Own calculations

B5: Variance decomposition of maize price (Jan. 2000 – Dec. 2012)



Source: Own calculations

B6: Database for the regression and vector autoregression analysis (II)

	Designation	Description	Source	Data units
1	Soybeans price	Soya beans, in bulk, United States, n° 2 yellow, CIF Rotterdam	IMF (International Monetary Fund)	US Dollars per metric ton
2	Exports	Global soya bean exports	USDA-WASDE	Million metric tons
3	Stock-to-use ratio	Soya bean stock-to-use ratio = Ending stock/total domestic use	USDA-WASDE	Percentage
4	Weather	Monthly global soya bean production	USDA-WASDE	Million metric tons
5	Biodiesel	Global biodiesel production	F.O. Licht	Thousand tons
6	Speculation	Soya bean non-commercial short and long contracts/futures only, Net long=Long-Short	CFTC (US Commodity Futures Trading Commission, CBOT Exchange)	Number of contracts
7	GEA	Global Indicator of Economic Activity Index SA	BANK OF MEXICO	Index, 2003=100
8	Crude oil	Crude oil, avg., spot	WORLD BANK	US dollars per barrel
9	Exchange rate	Real Effective Exchange Rate (the nominal effective exchange rate divided by a price deflator or index of costs)	WORLD BANK	Index

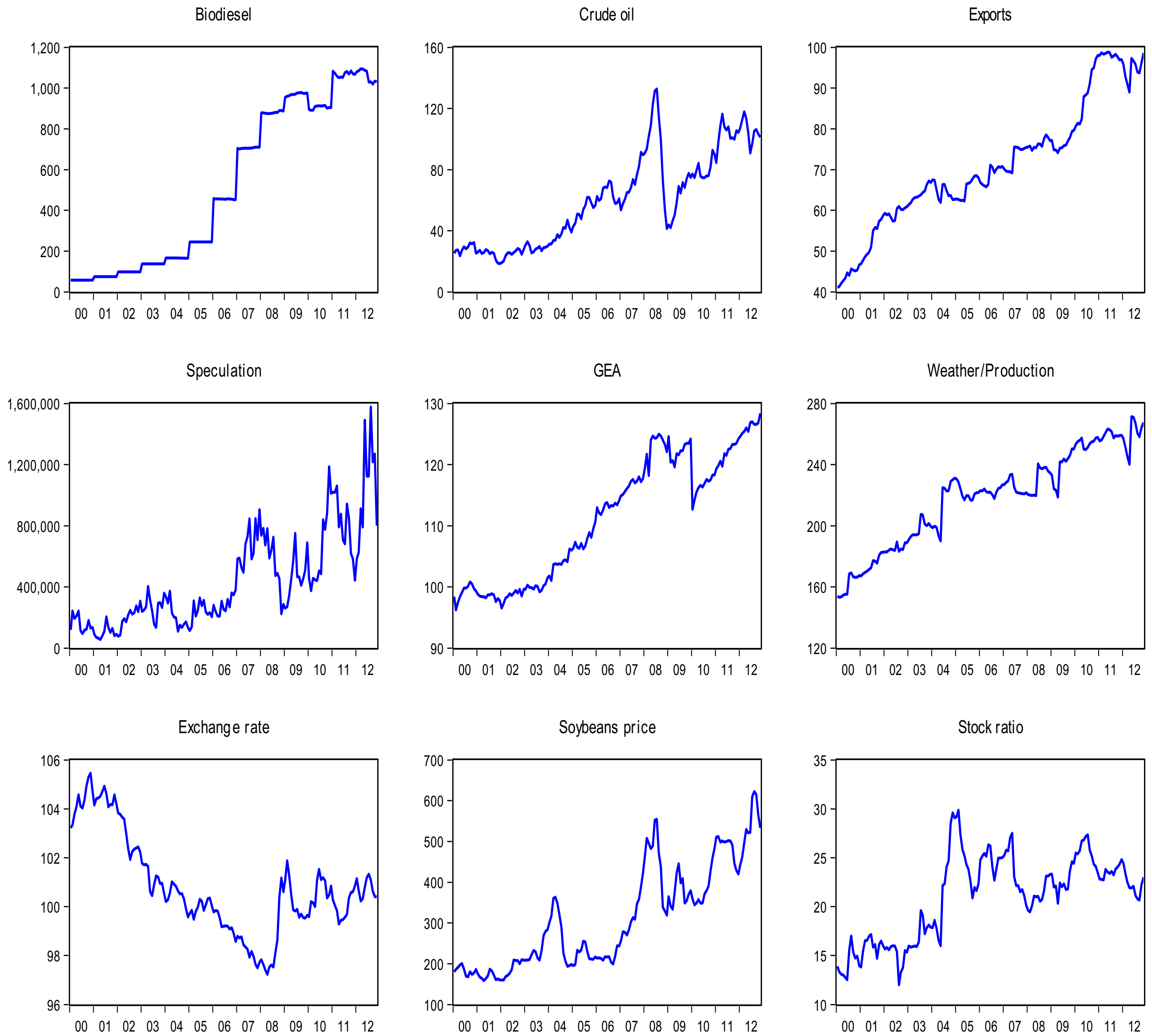
Source: Own representation

B7: ADF test results for soybeans price in VAR model

Variable	**Augmented Dickey Fuller test statistics (without trend)**
Soybean price	-3.557149
Exchange rate	-6.303439
GEA	-15.96648
Exports	-11.28760
Biodiesel	-12.88091
Stock-to-use ratio	-3.219377
Weather	-13.07517
Speculation	-17.21844
Crude oil	-7.835608

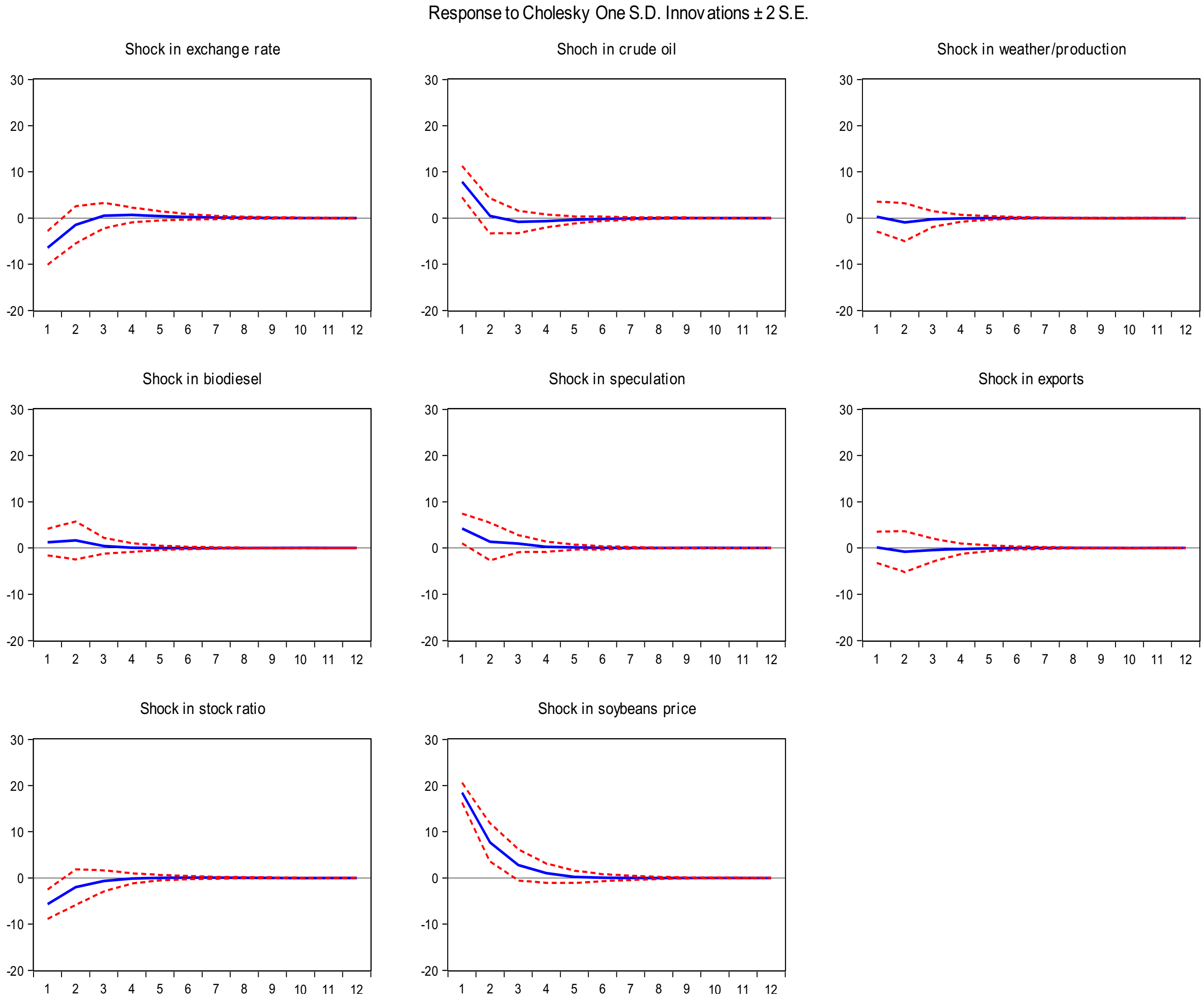
Critical values: 1%=-3.473672, 5%= -2.880463, 10%=-2.576939
Source: Own calculation

B8: Time series representation of used variables (II)
January 2000- December 2012



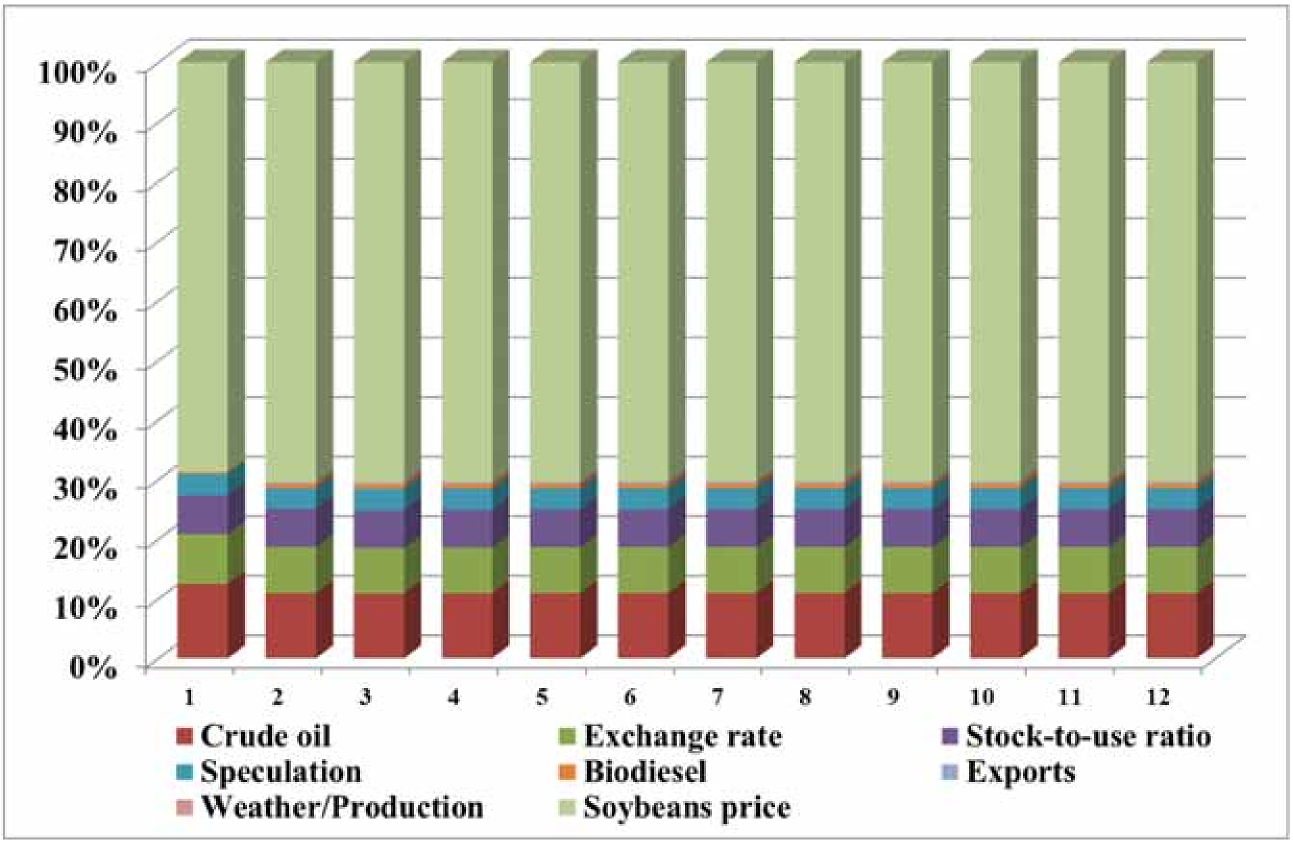
Source: Own calculation

B9: Impulse-response-function with confidence intervals of ± 2 standard deviations (Change of maize price during 12 months)



Source: Own calculation

B10: Variance decomposition of soybeans price (Jan. 2000 – Dec. 2012)



Source: Own calculation

Appendix C
Price transmission analysis in Africa, Asia and Latin America

1: Unit root test for domestic markets in African countries

Market	Augmented Dicky-Fuller		Phillips-Perron	
	P_t	dP_t	P_t	dP_t
Ethiopia – Addis Ababa – Maize – Wholesale	-1.637675	-8.543098 ***	-1.536165	-8.608952 ***
Ethiopia – Addis Ababa – Maize (white) – Retail	-2.101048	-5.005560 ***	-2.210121	-5.208777 ***
Ethiopia – Addis Ababa – Sorghum (red) – Retail	-1.945161	-10.03277 ***	-1.878077	-9.997888 ***
Ethiopia – Addis Ababa – Sorghum (red) – Wholesale	-1.697584	-9.041196 ***	-1.616081	-8.978345 ***
Ethiopia – Addis Ababa – Sorghum (white) – Whole-sale	-1.500406	-8.271756 ***	-1.428465	-8.253249 ***
Ethiopia – Addis Ababa – Sorghum (white) – Retail	-1.650487	-7.333115 ***	-1.803341	-7.449294 ***
Ethiopia – Addis Ababa – Sorghum (yellow) – Retail	-1.844544	-8.284977 ***	-1.946857	-8.321296 ***
Ethiopia – Addis Ababa – Wheat (white) – Retail	-1.395403	-7.419633 ***	-1.694895	-7.485420 ***
Ethiopia – Addis Ababa – Wheat (white) – Wholesale	-1.317049	-8.922791 ***	-1.288840	-8.904832 ***
Burkina Faso – Ouagadou-gou – Rice (imported) – Wholesale	-1.831309	-9.312776 ***	-1.876997	-9.309796 ***
Burkina Faso – Ouagadou-gou – Sorghum (local) – Wholesale	-1.726457	-9.913952 ***	-1.612055	-10.53397 ***
Burundi – Bujumbura – Maize – Retail	-2.029236	-10.94673 ***	-1.876261	-10.96486 ***
Burundi – Bujumbura – Rice – Retail	-1.620323	-8.761097 ***	-1.601579	-8.874806 ***
Burundi – Bujumbura – Wheat – Retail	-0.281404	-8.396067 ***	-0.282175	-8.396251 ***
Chad – N'Djamena – Maize – Retail	-2.947762 *	-8.952928 ***	-2.359363 *	-8.890462 ***
Chad – N'Djamena – Rice (imported) – Retail	-3.964934 ***	-14.45246 ***	-3.773817 ***	-20.18877 ***
Chad – N'Djamena – Rice (local) – Retail	-2.790352 *	-13.34387 ***	-2.586426	-13.62618 ***
Chad – N'Djamena – Sor-ghum – Retail	-2.287316	-10.90808 ***	-2.287316	-10.90047 ***
Democratic Republic of the Congo – Kinshasa – Rice (imported) – Retail	-2.747467 *	-10.29002 ***	-2.747467 *	-10.14590 ***
Mali – Bamako – Rice (im-ported) – Wholesale	-2.451151	-10.00562 ***	-2.391588	-10.05522 ***
Mali – Bamako – Rice (lo-	-2.818528 *	-11.09714 ***	-2.699942 *	-11.12158 ***

cal) – Wholesale				
Mali – Bamako – Sorghum (local) – Wholesale	-1.978969	-6.941334 ***	-1.960562	-8.626324 ***
Mozambique – Nampula – Maize (white) – Retail	-3.796428 ***	-10.46293 ***	-3.291001 **	-9.944052 ***
Mozambique – Nampula – Maize (white) – Wholesale	-3.762479 ***	-9.093024 ***	-2.727624 *	-8.801485 ***
Mozambique - Nampula - Rice - Retail	-1.008100	-11.64727 ***	-1.193870	-13.36106 ***
Niger - Niamey - Maize - Retail	-1.897938	-9.869084 ***	-1.938280	-9.778268 ***
Niger - Niamey - Rice (imported) - Retail	-1.048351	-13.28327 ***	-0.957536	-13.38140 ***
Niger - Niamey - Rice (imported) - Wholesale	-1.873124	-9.582937 ***	-1.848937	-9.582922 ***
Niger - Niamey - Sorghum - Retail	-1.894882	-10.29072 ***	-1.973146	-10.29072 ***
Niger - Niamey - Sorghum (local) - Wholesale	-1.567744	-10.64282 ***	-1.373363	-10.73977 ***
Somalia - Baidoa - Maize (white) - Retail	-2.395068	-11.21275 ***	-2.352695	-11.21264 ***
Somalia - Baidoa - Rice (imported) - Retail	-2.305782	-13.88117 ***	-2.032582	-14.55311 ***
Somalia - Baidoa - Sorghum (red) - Retail	-2.014983	-10.94683 ***	-2.050648	-10.94683 ***

Critical values:
1% = -3.473672 ***
5% = -2.880463 **
10% = -2.576939 *

C2: Price transmission of world market price on domestic market price of selected products in African countries

Country	Location	Product	Long-term Relationship	Error correction model (elasticities)		
			Johansen test	Adjustment speed	Short-run	Long-run
Ethiopia	Addis Ababa	Maize - Wholesale	No			
Ethiopia	Addis Ababa	Maize (white) - Retail	Yes	-0.060150 [-1.01043]	0.283376 [1.49177]	0.6722
Ethiopia	Addis Ababa	Sorghum (red) - Retail	No			
Ethiopia	Addis Ababa	Sorghum (red) – Wholesale	No			
Ethiopia	Addis Ababa	Sorghum (white) – Wholesale	No			
Ethiopia	Addis Ababa	Sorghum (white) - Retail	No			
Ethiopia	Addis Ababa	Sorghum (yellow) - Retail	Yes	-0.081723 [-.64610]	0.123152 [0.82491]	0.7642
Ethiopia	Addis Ababa	Wheat (white) – Retail	Yes	**-0.242580 *** [-5.03546]**	**-0.291566 ** [-2.35289]**	**0.37504 *** **
Ethiopia	Addis Ababa	Wheat (white) - Wholesale	Yes	**-0.092855 *** [-4.23793]**	**-0.096825 * [-1.18194]**	**0.07845 *** **
Burkina Faso	Ouagadougou	Rice (imported) – Wholesale	No			
Burkina Faso	Ouagadougou	Sorghum (local) - Wholesale	No			
Burundi	Bujumbura	Maize - Retail	No			
Burundi	Bujumbura	Rice - Retail	No			
Burundi	Bujumbura	Wheat - Retail	No			
Chad	N'Djamena	Maize – Retail	No			
Chad	N'Djamena	Rice (imported) - Retail	Stationary			
Chad	N'Djamena	Rice (local) - Re-	Yes	-2.605999 [-1.16031]	-8.867666 [-0.36025]	0.38995

		tail				
Chad	N'Djamena	Sorghum - Retail	No			
Democratic Republic of the Congo	Kinshasa	Rice (imported) - Retail	Stationary			
Mali	Bamako	Rice (imported) - Wholesale	No			
Mali	Bamako	Rice (local) - Wholesale	Stationary			
Mali	Bamako	Sorghum (local) - Wholesale	No			
Mozambique	Nampula	Maize (white) - Retail	Stationary			
Mozambique	Nampula	Maize (white) – Wholesale	Stationary			
Mozambique	Nampula	Rice - Retail	Yes	**-0.284864 *** [-5.06162]**	**-0.272899 *** [-1.61399]**	**0.32663 *** **
Niger	Niamey	Maize - Retail	No			
Niger	Niamey	Rice (imported) - Retail	Yes	**-0.119924 *** [-2.97228]**	**0.041042 *** [0.54700]**	**0.171502 *** **
Niger	Niamey	Rice (imported) - Wholesale	No			
Niger	Niamey	Sorghum - Retail	No			
Niger	Niamey	Sorghum (local) - Wholesale	No			
Somalia	Baidoa	Maize (white) - Retail	Yes	**-0.194995 [-2.98956]**	**0.273845 [0.68487]**	**0.133460**
Somalia	Baidoa	Rice (imported) - Retail	Yes	**-0.255435 [-3.79909]**	**0.178300 [0.93805]**	**0.40926**
Somalia	Baidoa	Sorghum (red) - Retail	No			

Critical values:
1% - ***
5% - ***
10% - ***

C3: Unit-root-test for domestic markets in Asian countries

Market	Augmented Dicky Fuller		Phillips-Perron	
	P_t	dP_t	P_t	dP_t
Afghanistan - Kabul - Wheat - Retail (USD/ton)	-1.153821	-10.60048 ***	-1.165064	-11.66510 ***
Bangladesh - National Average - Rice (coarse) - Retail (USD/ton)	-1.431851	-5.486589 ***	-1.532435	-5.604260 ***
Bangladesh - National Average - Rice (coarse) - Wholesale (USD/ton)	-1.569264	-10.11331 ***	-1.652373	-10.07329 ***
Bangladesh - National Average - Wheat - Retail (USD/ton)	-1.884603	-4.563651 ***	-1.783455	-4.510678 ***
Bangladesh - National Average - Wheat - Wholesale (USD/ton)	-1.404300	-9.012657 ***	-1.497961	-9.222664 ***
India - Delhi - Rice - Retail (USD/ton)	-0.136283	-10.84193 ***	-0.206754	-10.84411 ***
India - Delhi - Rice - Wholesale (USD/ton)	-0.247050	-10.65099 ***	-0.522132	-10.85952 ***
India - Delhi - Sugar - Retail (USD/ton)	-0.249004	-10.17853 ***	-0.442428	-10.18723 ***
India - Delhi - Sugar - Wholesale (USD/ton)	1.167938	-7.224295 ***	1.582218	-7.223487 ***
India - Delhi - Wheat - Retail (USD/ton)	-0.729590	-9.296461 ***	-0.358147	-8.796124 ***
India - Delhi - Wheat - Wholesale (USD/ton)	-0.870976	-8.796363 ***	-0.634612	-8.122955 ***
Lao People's Democratic Republic - National Average - Rice (Ordinary) - Retail (USD/ton)	-1.300672	-9.055448 ***	-1.036087	-13.83361 ***
Myanmar - National Average - Rice - Retail (USD/ton)	-1.653715	-6.059959 ***	-1.510725	-6.199044 ***
Nepal - Kathmandu - Rice (coarse) - Retail (USD/ton)	-2.314746	-8.613863 ***	-2.283487	-6.042162 ***
Pakistan - Lahore - Rice (basmati) - Retail (USD/ton)	-1.659436	-6.804388 ***	-1.586421	-6.856430 ***
Pakistan - Lahore - Wheat - Retail (USD/ton)	-1.702967	-6.864466 ***	-1.446394	-6.823304 ***

Critical values:
1% = -3.473672 ***
5% = -2.880463 **
10% = -2.576939 *

C4: Price transmission of world market price on domestic market price of selected products in Asian countries

Country	Location	Product	Long-term relationship	Error correction model (elasticities)		
			Johansen test	Adjustment speed	Short-run	Long-run
Afghanistan	Kabul	Wheat - Retail	Yes	**-0.082164 *** [-3.10730]**	0.121518 [1.10842]	**0.058906 *****
Bangladesh	National Average	Rice (coarse) - Retail	Yes	-0.064331 [-1.12843]	0.055959 [0.61387]	0.078331
Bangladesh	National Average	Rice (coarse) - Wholesale	No			
Bangladesh	National Average	Wheat - Retail	No			
Bangladesh	National Average	Wheat - Wholesale	No			
India	Delhi	Rice - Retail	Yes	-0.034589 [-1.60422]	-0.041984 [-0.95726]	0.057386
India	Delhi	Rice - Wholesale	Yes	-0.043356 [-1.75410]	-0.019881 [-0.37427]	0.230422
India	Delhi	Sugar - Retail	Yes	-0.001404 [-0.04153]	0.009052 [0.16478]	0.002034
India	Delhi	Sugar - Wholesale	Yes	-0.053229 [-0.84109]	0.216327 [1.52973]	0.041072
India	Delhi	Wheat - Retail	No			
India	Delhi	Wheat - Wholesale	No			
Lao People's Democratic Republic	National Average	Rice (Ordinary) Retail	Yes	**-0.041724 ** [-2.54341]**	-0.017317 [-0.26614]	**0.045308 *****
Myanmar	National Average	Rice - Retail	No			
Nepal	Kathmandu	Rice (coarse) - Retail	No			
Pakistan	Lahore	Rice (basmati) - Retail	No			
Pakistan	Lahore	Wheat - Retail	No			

Critical values:
1% - ***
5% - ***
10% - ***

C5: Unit-root-test for domestic markets in Latin American countries

Market	Augmented Dicky Fuller		Phillips-Perron	
	P_t	dP_t	P_t	dP_t
Bolivia - Santa Cruz - Maize (hard yellow cubano) – Wholesale	-1.586211	-8.205525 ***	-1.733648	-8.796316 ***
Bolivia - Santa Cruz - Rice (estaquilla) - Wholesale	-1.897011	-8.267551 ***	-1.679490	-8.287485 ***
Bolivia - Santa Cruz - Rice (grano de oro) - Wholesale	-1.009409	-8.704006 ***	-1.094986	-8.763212 ***
Bolivia - Santa Cruz - Wheat (pelado) – Wholesale	-0.996468	-10.19381 ***	-1.027733	-10.19397 ***
Guatemala - National Average - Maize (tortillas) – Retail	0.688912	-15.51331 ***	0.408919	-15.18705 ***
Guatemala - National Average - Maize (white) – Wholesale	-2.554516	-12.87700 ***	-2.363844	-16.76585 ***
Guatemala - National Average - Rice (second quality) – Retail	-0.747788	-4.382203 ***	-0.440858	-12.26866 ***
Haiti - Port-au-Prince - Maize (local) - Retail	-2.107463	-8.001204 ***	-1.926966	-7.882305 ***
Haiti - Port-au-Prince - Maize (imported) – Retail	-1.224121	-10.14495 ***	-1.153579	-10.14051 ***
Haiti - Port-au-Prince - Rice (imported) - Retail	-3.035695 **	-8.599372 ***	-3.170863 **	-8.555501 ***
Haiti - Port-au-Prince - Rice (local) – Retail	-4.538690 ***	-9.232949 ***	-4.633220 ***	-22.24586 ***
Haiti - Port-au-Prince - Sorghum – Retail	-2.299937	-8.851028 ***	-2.341213	-9.175894 ***
Honduras - Tegucigalpa - Maize (white) – Wholesale	-3.355019 **	-5.412909 ***	-2.662419 *	-5.384969 ***
Honduras - Tegucigalpa - Rice (second quality) – Wholesale	-2.013317	-5.418782 ***	-1.966230	-5.580874 ***
Mexico - Mexico City - Rice (Morelos) - Wholesale	-0.934233	-8.418084 ***	-1.166421	-8.861803 ***
Mexico - Mexico City - Rice (Sinaloa) - Wholesale	-1.129970	-7.851029 ***	-1.073233	-7.998530 ***
Mexico - Mexico City - Maize (tortillas) - Retail	-0.240139	-11.12082 ***	-0.474418	-11.18811 ***
Mexico - Mexico City - Maize (white) - Wholesale	-2.002399	-5.327156 ***	-1.685635	-5.286980 ***
Nicaragua - National Average - Maize (tortillas) – Retail	-2.172375	-6.881130 ***	-2.292836	-6.901342 ***
Nicaragua - National Average - Maize (white) – Wholesale	-3.552275 ***	-6.507738 ***	-2.814623 *	-6.921816 ***

Nicaragua - National Average - Maize (white) - Retail	-3.142224 **	-5.139032 ***	-2.370405	-4.308271 ***
Nicaragua - National Average - Rice (first quality) - Wholesale	-1.723098	-7.029709 ***	-1.984095	-7.100200 ***
Nicaragua - National Average - Rice (first quality) - Retail	-1.342467	-8.639011 ***	-1.404945	-8.844193 ***
Nicaragua - National Average - Rice (second quality) – Wholesale	-2.110338	-6.601450 ***	-2.425910	-6.755388 ***
Nicaragua - National Average - Rice (second quality) - Retail	-1.695381	-12.42297 I(2) ***	-1.372545	-8.983850 ***
Peru - National Average - Maize (yellow) - Wholesale	0.389543	-13.58354 ***	0.395015	-13.48447 ***
Peru - National Average - Rice (corriente) – Wholesale	-1.750080	-5.855468 ***	-1.331803	-6.099243 ***
Peru - National Average - Rice (paddy) - Wholesale	-1.431871	-8.038033 ***	-1.483268	-8.355018 ***

Critical values:
1% = -3.473672 ***
5% = -2.880463 **
10% = -2.576939 *

C6: Price transmission of world market price on domestic market price of selected products in Latin American countries

Country	Location	Product	Long-term Relationship	Error correction model (elasticities)		
			Johansen test	Adjustment speed	Short-run	Long-run
Bolivia	Santa Cruz	Maize (hard yellow cubano) - Wholesale	No			
Bolivia	Santa Cruz	Rice (estaquilla) - Wholesale	No			
Bolivia	Santa Cruz	Rice (grano de oro) - Wholesale	No			
Bolivia	Santa Cruz	Wheat (pelado) - Wholesale	Yes	**-0.089602 *** [-4.16301]**	**-0.163841 ** [-2.14827]**	**0.089142 ****
Guatemala	National Average	Maize (tortillas) - Retail	Yes	**-0.086736 *** [-3.33836]**	-0.041111 [-0.79131]	**0.101855 ****
Guatemala	National Average	Maize (white) - Wholesale	Yes	**-0.333309 *** [-5.30962]**	**-0.289405 * [-2.10133]**	**0.530254 *****
Guatemala	National Average	Rice (second quality) - Retail	Yes	0.001581 [0.09878]	**0.179332 * [2.20258]**	2.492270
Haiti	Port-au-Prince	Maize (local) - Retail	No			
Haiti	Port-au-Prince	Maize (imported) - Retail	No			
Haiti	Port-au-Prince	Rice (imported) - Retail	Stationary			
Haiti	Port-au-Prince	Rice (local) - Retail	Stationary			
Haiti	Port-au-Prince	Sorghum - Retail	No			
Honduras	Tegucigalpa	Maize (white) - Wholesale	Stationary			
Honduras	Tegucigalpa	Rice (second quality) - Wholesale	No			

Mexico	Mexico City	Rice (Morelos) - Wholesale	No			
Mexico	Mexico City	Rice (Sinaloa) - Wholesale	No			
Mexico	Mexico City	Maize (tortillas) - Retail	No			
Mexico	Mexico City	Maize (white) - Wholesale	Yes	**-0.149639 *** [-3.81122]**	0.045796 [0.75715]	**0.22134 *****
Nicaragua	National Average	Maize (tortillas) - Retail	Yes	**-0.306480 *** [-3.26238]**	**-0.153259 * [-2.14007]**	**2.90971 *****
Nicaragua	National Average	Maize (white) - Wholesale	No			
Nicaragua	National Average	Maize (white) - Retail	No			
Nicaragua	National Average	Rice (first quality) - Wholesale	Yes	0.020652 [0.44966]	-0.019450 [-0.26888]	0.03870
Nicaragua	National Average	Rice (first quality) - Retail	No			
Nicaragua	National Average	Rice (second quality) - Wholesale	Yes	0.031394 [0.60790]	0.016326 [0.29925]	0.08465
Nicaragua	National Average	Rice (second quality) - Retail	No			
Peru	National Average	Maize (yellow) - Wholesale	No			
Peru	National Average	Rice (corriente) - Wholesale	Yes	**-0.065803 *** [-3.17694]**	0.025728 [0.63120]	**0.120137 *****
Peru	National Average	Rice (paddy) - Wholesale	Yes	**-0.088273 *** [-3.25163]**	-0.006560 [-0.10233]	**0.175563 *****

Critical values:
1% - ***
5% - ***
10% - ***

C7: Technical details for the international price time series

Products	Details	Source
Rice	White Broken Rice, Thai A1 Super, f.o.b. Bangkok (Wednesday) USD/t	FAOSTAT
Maize	US No.2, Yellow, U.S. Gulf (Friday) USD/t	FAOSTAT
Sorghum	US No.2, Yellow, U.S. Gulf (Friday) USD/t	FAOSTAT
Wheat	US No.2, Hard Red Winter ord. Prot, US Fob Gulf (Tues-day) USD/t	FAOSTAT
Sugar	I.S.A. daily price, Average of week USD/t	FAOSTAT

Source: Own representation

C8: Technical details for price time series in African countries

Country	Market	Products	Time series
Ethiopia	Addis Ababa	Maize - Wholesale	Jan 2000-Sep 2012
Ethiopia	Addis Ababa	Maize (white) - Retail	Sep 2007-Dec 2011
Ethiopia	Addis Ababa	Sorghum (red) - Retail	Jan 2006-Sep 2012
Ethiopia	Addis Ababa	Sorghum (red) – Wholesale	Mar 2001-Dec 2011
Ethiopia	Addis Ababa	Sorghum (white) – Whole-sale	Jan 2000-Sep 2012
Ethiopia	Addis Ababa	Sorghum (white) - Retail	Jan 2006-Dec 2011
Ethiopia	Addis Ababa	Sorghum (yellow) - Retail	Jan 2006-Sep 2012
Ethiopia	Addis Ababa	Wheat (white) – Retail	Jan 2006-Dec 2011
Ethiopia	Addis Ababa	Wheat (white) - Wholesale	Jan 2000-Sep 2012
Burkina Faso	Ouagadougou	Rice (imported) – Wholesale	Jan 2006-Sep 2012
Burkina Faso	Ouagadougou	Sorghum (local) - Wholesale	Jan 2006-Sep 2012
Burundi	Bujumbura	Maize - Retail	Jan 2006-Aug 2012
Burundi	Bujumbura	Rice - Retail	Jan 2006-Aug 2012
Burundi	Bujumbura	Wheat - Retail	Jan 2006-Feb 2012
Chad	N'Djamena	Maize – Retail	Oct 2003-Jul 2012
Chad	N'Djamena	Rice (imported) - Retail	Oct 2003-Jul 2012
Chad	N'Djamena	Rice (local) - Retail	Oct 2003-Jul 2012
Chad	N'Djamena	Sorghum - Retail	Oct 2003-Jul 2012
Democratic Re-public of the Congo	Kinshasa	Rice (imported) - Retail	Jan 2007-Aug 2012
Mali	Bamako	Rice (imported) - Wholesale	Jan 2006-Sep 2012
Mali	Bamako	Rice (local) - Wholesale	Jan 2006-Sep 2012
Mali	Bamako	Sorghum (local) - Whole-sale	Jan 2006-Sep 2012
Mozambique	Nampula	Maize (white) - Retail	Jan 1994-Sep 2011
Mozambique	Nampula	Maize (white) – Wholesale	Oct 1998-Aug 2012
Mozambique	Nampula	Rice – Retail	Jan 2000-Aug 2012
Niger	Niamey	Maize - Retail	Jan 2000-Apr 2012
Niger	Niamey	Rice (imported) - Retail	Jan 2000-Apr 2012
Niger	Niamey	Rice (imported) - Wholesale	Jan 2006-Sep 2012
Niger	Niamey	Sorghum - Retail	Jan 2000-Apr 2012
Niger	Niamey	Sorghum (local) - Wholesale	Jan 2006-Sep 2012
Somalia	Baidoa	Maize (white) - Retail	Jan 2001-Jul 2012
Somalia	Baidoa	Rice (imported) - Retail	Jan 2001-Jul 2012
Somalia	Baidoa	Sorghum (red) - Retail	Jan 2001-Jul 2012

C9: Technical details of price time series in Asian countries

Country	Market	Agricultural commodities	Time series
Afghanistan	Kabul	Wheat - Retail (USD/ton)	Jan 2000-Sep 2012
Bangladesh	National Average	Rice (coarse) - Retail (USD/ton)	Jul 1998-Jun 2011
Bangladesh	National Average	Rice (coarse) - Wholesale (USD/ton)	Jul 2005-Mar 2012
Bangladesh	National Average	Wheat - Retail (USD/ton)	Jul 2005-Jun 2011
Bangladesh	National Average	Wheat - Wholesale (USD/ton)	Jul 1998-Mar 2012
India	Delhi	Rice - Retail (USD/ton)	Jan 2000-Sep 2012
India	Delhi	Rice - Wholesale (USD/ton)	Jan 2000-Sep 2012
India	Delhi	Sugar - Retail (USD/ton)	Jan 2000-Aug 2012
India	Delhi	Sugar - Wholesale (USD/ton)	Jan 2006-Sep 2012
India	Delhi	Wheat - Retail (USD/ton)	Jan 2000-Sep 2012
India	Delhi	Wheat - Wholesale (USD/ton)	Jan 2000-Sep 2012
Lao People's Democratic Republic	National Average	Rice (Ordinary) - Retail (USD/ton)	Jan 1990-Jul 2012
Myanmar	National Average	Rice - Retail (USD/ton)	Feb 2007-Jan 2012
Nepal	Kathmandu	Rice (coarse) - Retail (USD/ton)	Jan 2005_Jun 2012
Pakistan	Lahore	Rice (basmati) - Retail (USD/ton)	Jan 2006-Sep 2012
Pakistan	Lahore	Wheat - Retail (USD/ton)	Jan 2006-Sep 2012

C10: Technical details of price time series in Latin American countries

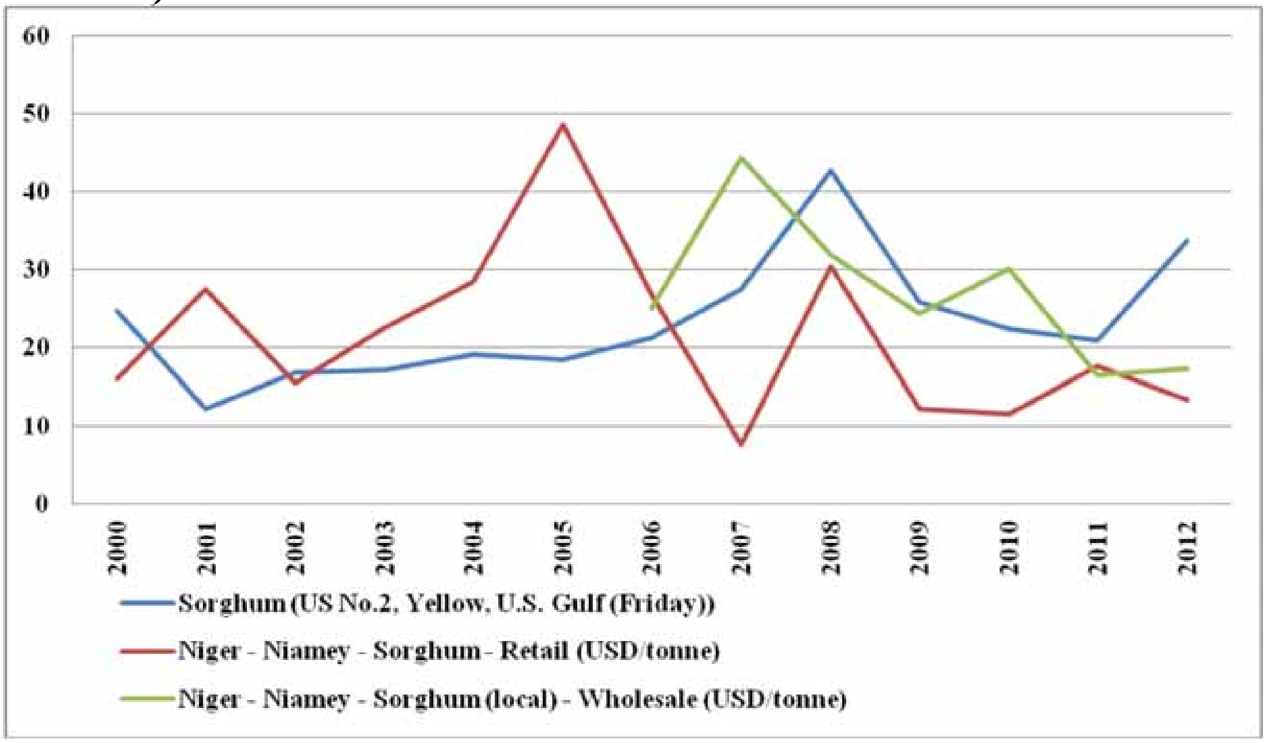
Country	Market	Commoditiy	Time series
Bolivia	Santa Cruz	Maize (hard yellow cubano) - Wholesale (USD/ton)	Jan 2003-Sep 2012
Bolivia	Santa Cruz	Rice (estaquilla) - Wholesale (USD/ton)	Jan 2003-Sep 2012
Bolivia	Santa Cruz	Rice (grano de oro) - Wholesale (USD/ton)	Jan 2003-Sep 2012
Bolivia	Santa Cruz	Wheat (pelado) - Wholesale (USD/ton)	Jan 2003-Sep 2012
Guatemala	National Average	Maize (tortillas) - Retail (USD/ton)	Jan 2001-Jul 2012
Guatemala	National Average	Maize (white) - Wholesale (USD/ton)	Jan 2000-Aug 2012
Guatemala	National Average	Rice (second quality) - Retail (USD/ton)	Jan 2000-Sep 2012
Haiti	Port-au-Prince	Maize (local) - Retail (USD/ton)	Jan 2005-Sep 2012
Haiti	Port-au-Prince	Maize (imported) - Retail	Jan 2005-Sep 2012

		(USD/ton)	
Haiti	Port-au-Prince	Rice (imported) - Retail (USD/ton)	Jan 2005-Sep 2012
Haiti	Port-au-Prince	Rice (local) - Retail (USD/ton)	Jul 2008-Sep 2012
Haiti	Port-au-Prince	Sorghum - Retail (USD/ton)	Jan 2005-Sep 2012
Honduras	Tegucigalpa	Maize (white) - Wholesale (USD/ton)	Feb 2007-Sep 2012
Honduras	Tegucigalpa	Rice (second quality) - Wholesale (USD/ton)	Feb 2007-Sep 2012
Mexico	Mexico City	Rice (Morelos) - Wholesale (USD/ton)	Jan 2000- Sep 2012
Mexico	Mexico City	Rice (Sinaloa) - Wholesale (USD/ton)	Jan 2000- Sep 2012
Mexico	Mexico City	Maize (tortillas) - Retail (USD/ton)	Jan 2007- Sep 2012
Mexico	Mexico City	Maize (white) - Wholesale (USD/ton)	Jan 2000- Sep 2012
Nicaragua	National Average	Maize (tortillas) - Retail (USD/ton)	Sep 2007-Jul 2012
Nicaragua	National Average	Maize (white) - Wholesale (USD/ton)	Jan 2007- Sep 2012
Nicaragua	National Average	Maize (white) - Retail (USD/ton)	Jan 2009- Sep 2012
Nicaragua	National Average	Rice (first quality) - Wholesale (USD/ton)	Jan 2008- Sep 2012
Nicaragua	National Average	Rice (first quality) - Retail (USD/ton)	Jan 2005- Sep 2012
Nicaragua	National Average	Rice (second quality) - Wholesale (USD/ton)	Jan 2008- Sep 2012
Nicaragua	National Average	Rice (second quality) - Retail (USD/ton)	Jan 2005- Sep 2012
Peru	National Average	Maize (yellow) - Wholesale (USD/ton)	Jan 1999-Aug 2012
Peru	National Average	Rice (corriente) - Wholesale (USD/ton)	Jan 2000- Aug 2012
Peru	National Average	Rice (paddy) - Wholesale (USD/ton)	Jan 2000- Aug 2012

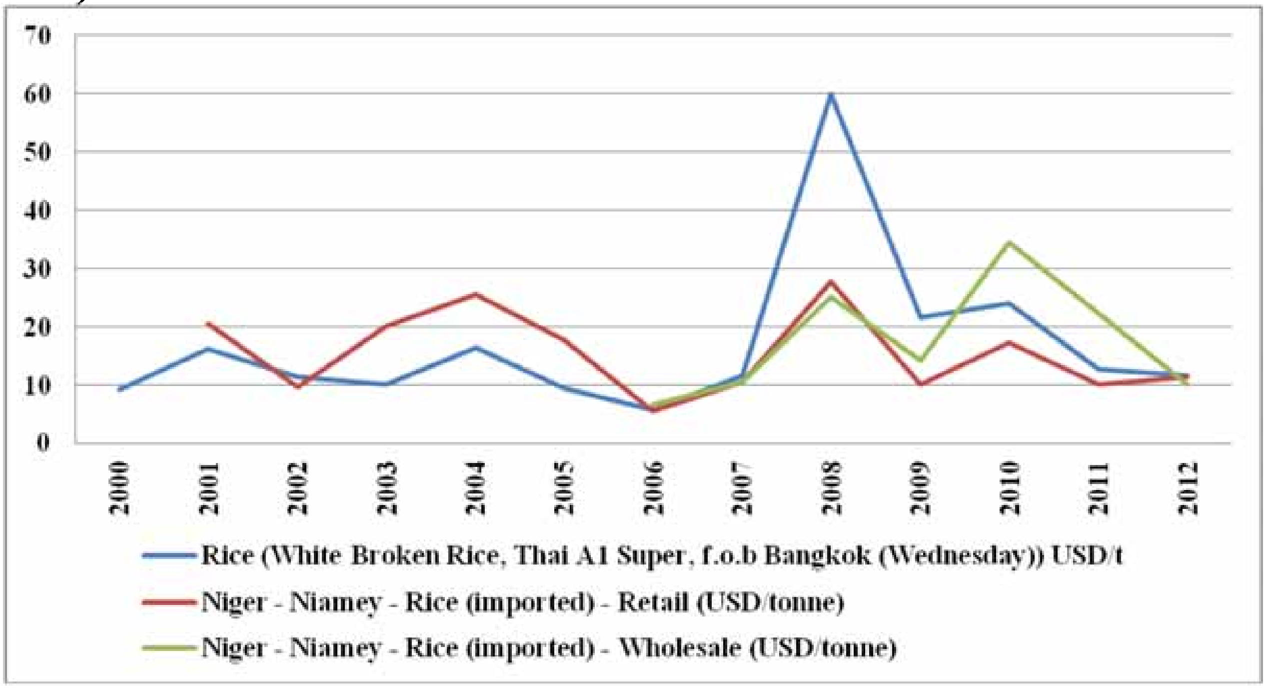
Appendix D

Comparing price volatilities on world and domestic markets for selected diveloping counties

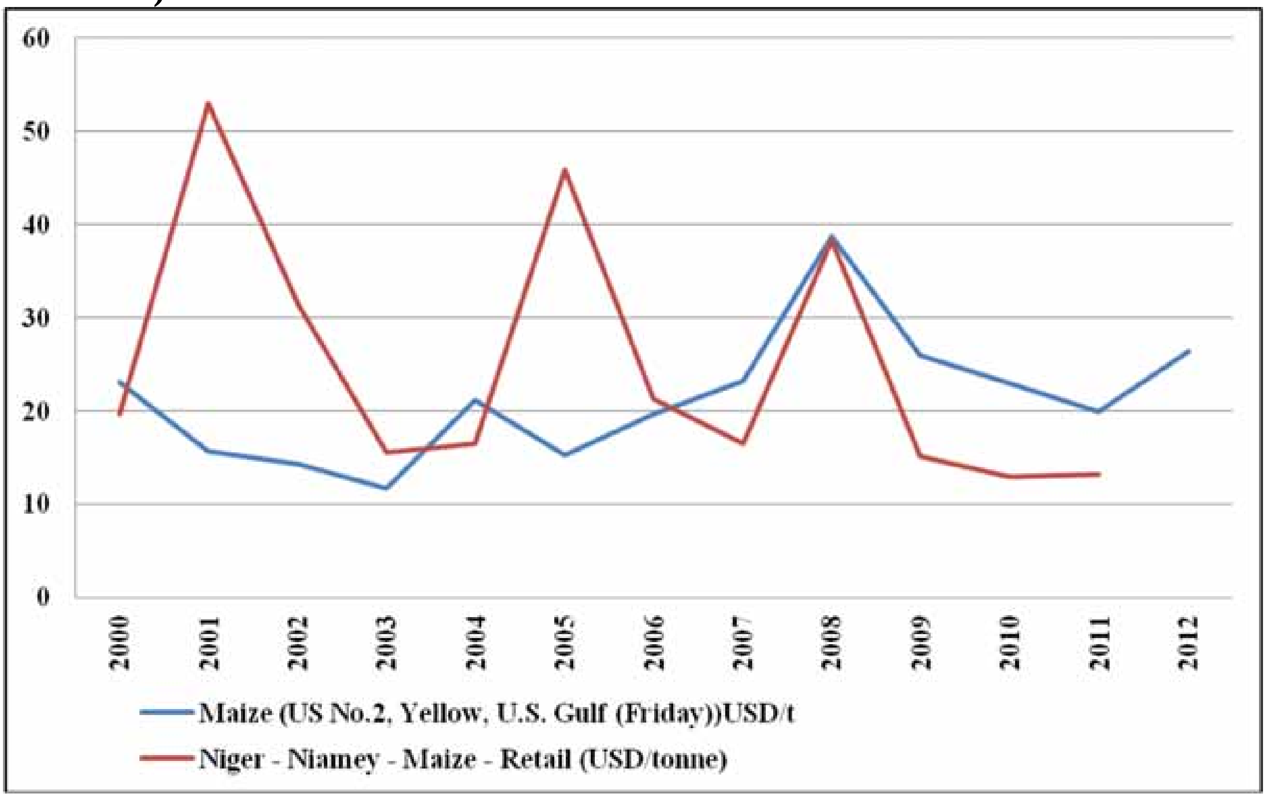
D1: Price volatilities of sorghum on world and domestic markets in Niger (2000 - 2012)



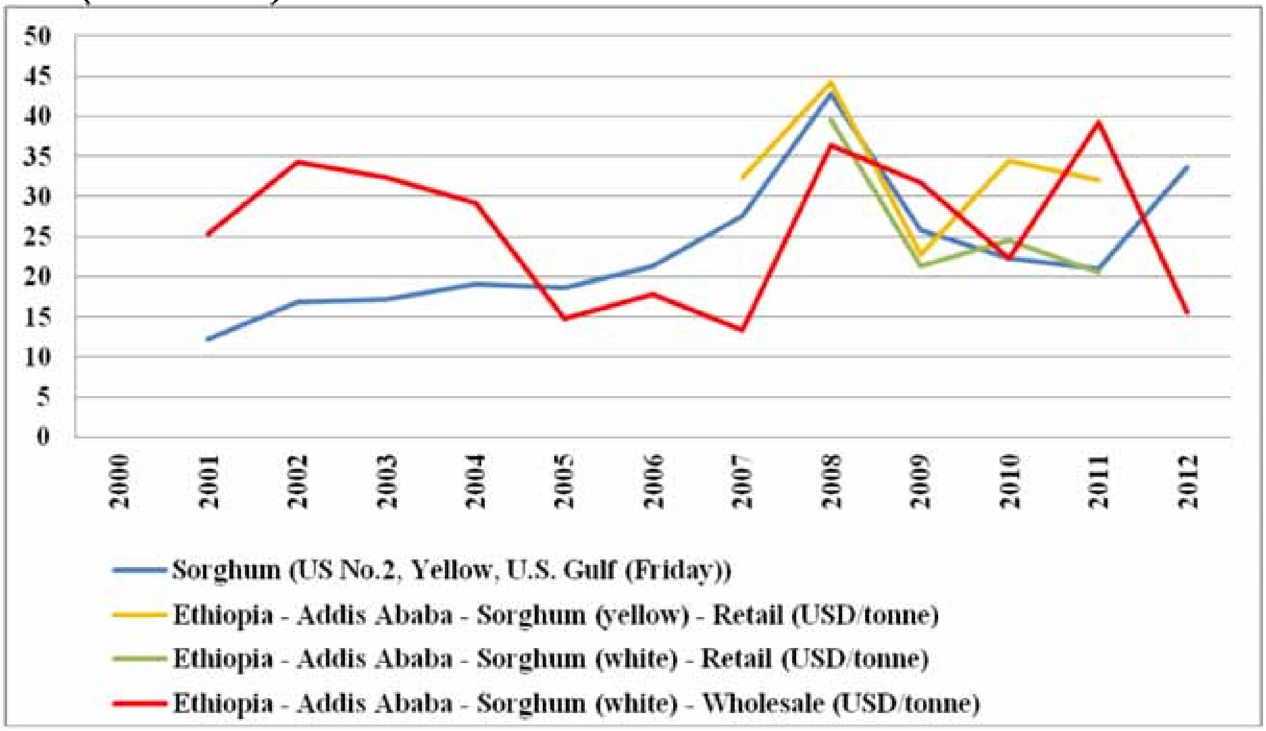
D2: Price volatilities of rice on world and domestic markets in Niger (2000 - 2012)



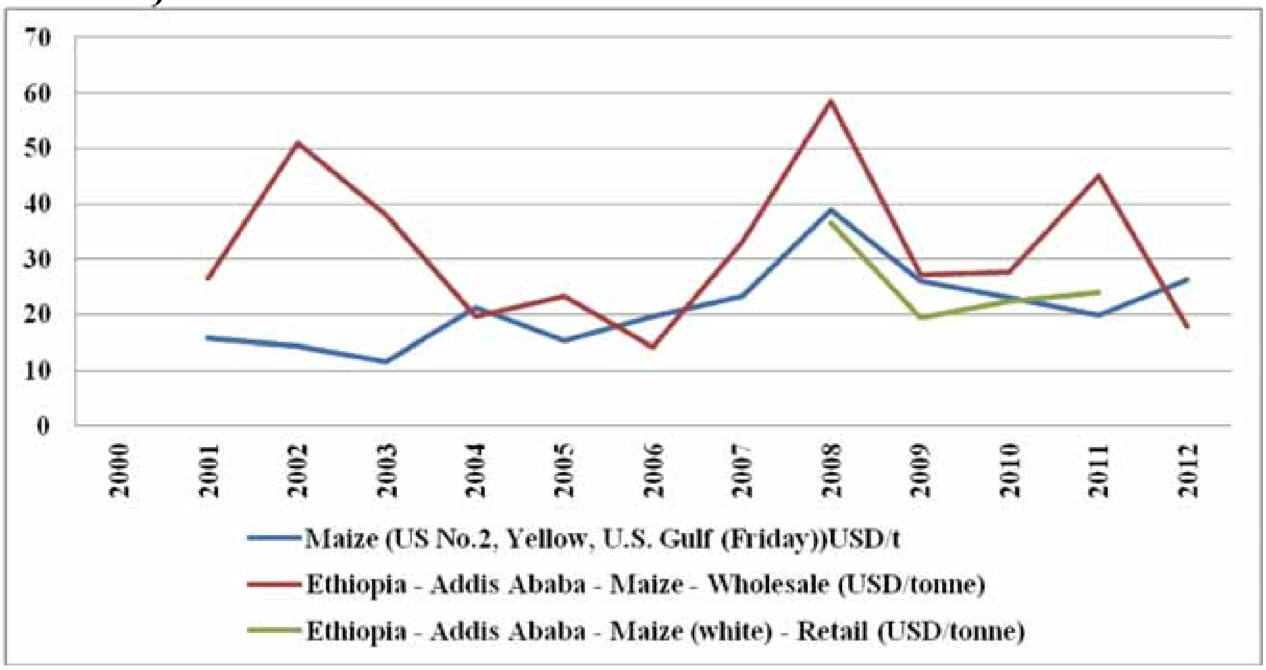
D3: Price volatilities of maize on world and domestic markets in Niger (2000 - 2012)



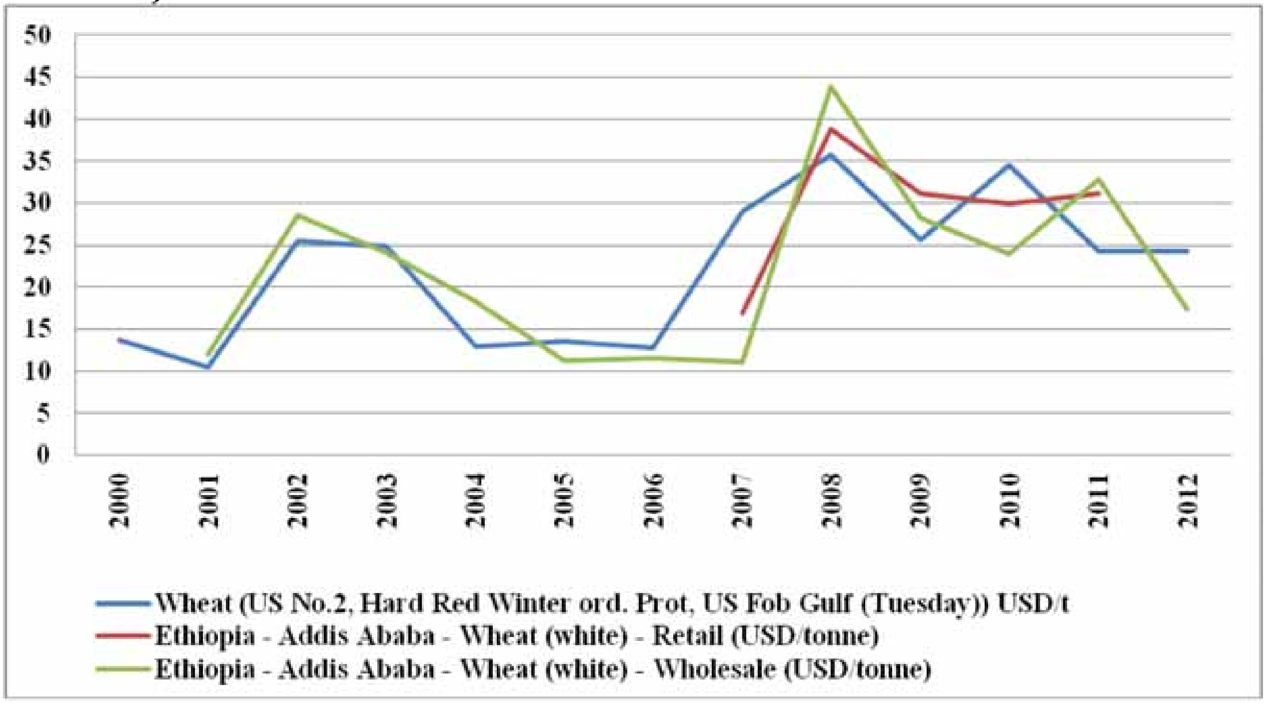
D4: Price volatilities of sorghum on world and domestic markets in Ethiopia (2000 - 2012)



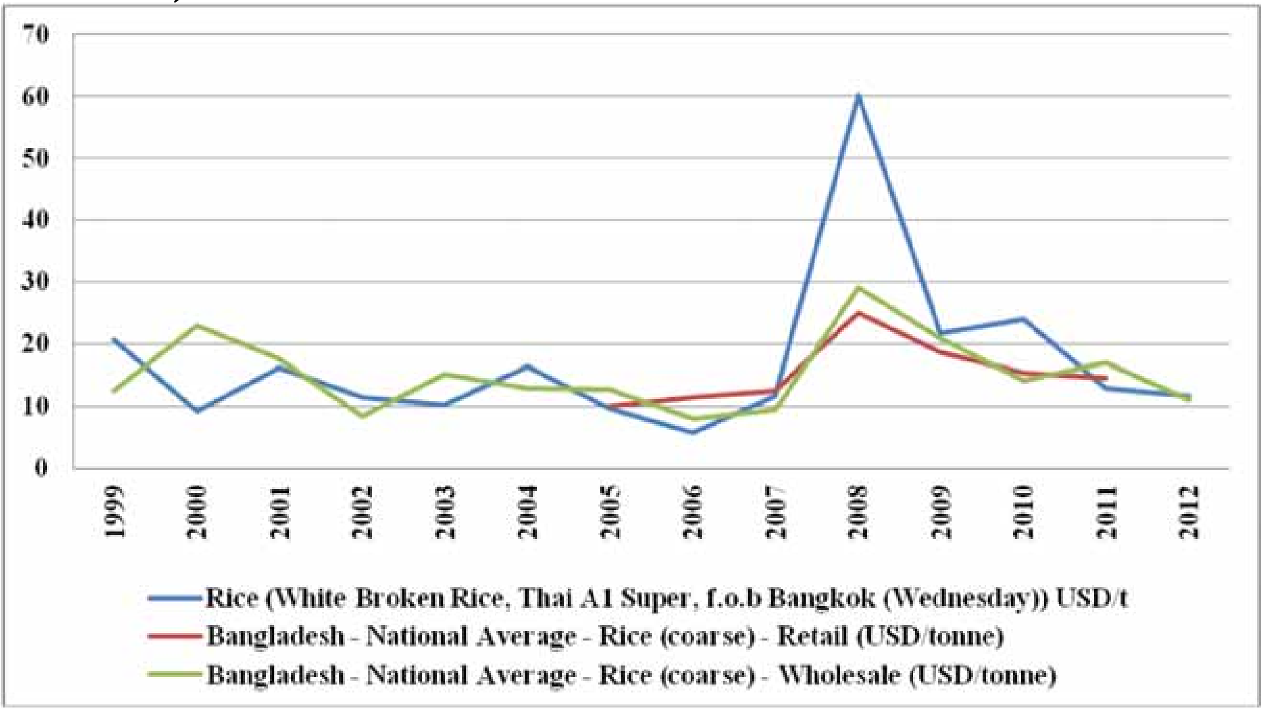
D5: Price volatilities of maize on world and domestic markets in Ethiopia (2000 - 2012)



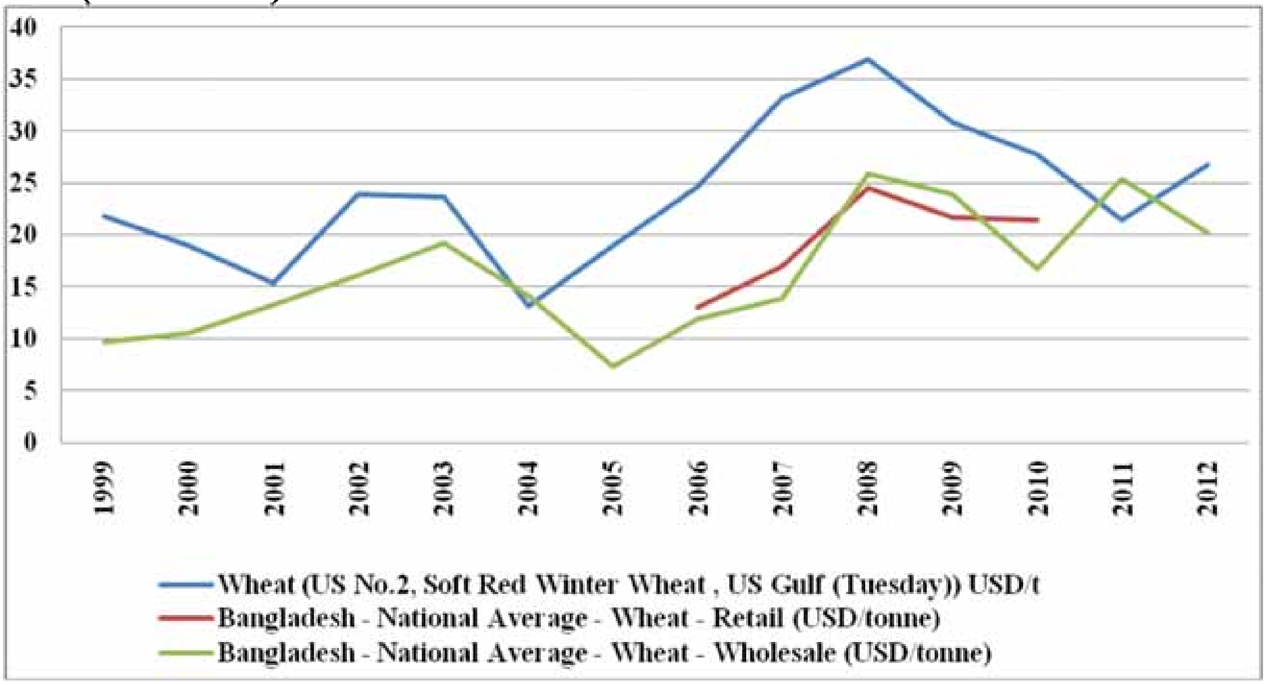
D6: Price volatilities of wheat on world and domestic markets in Ethiopia (2000 - 2012)



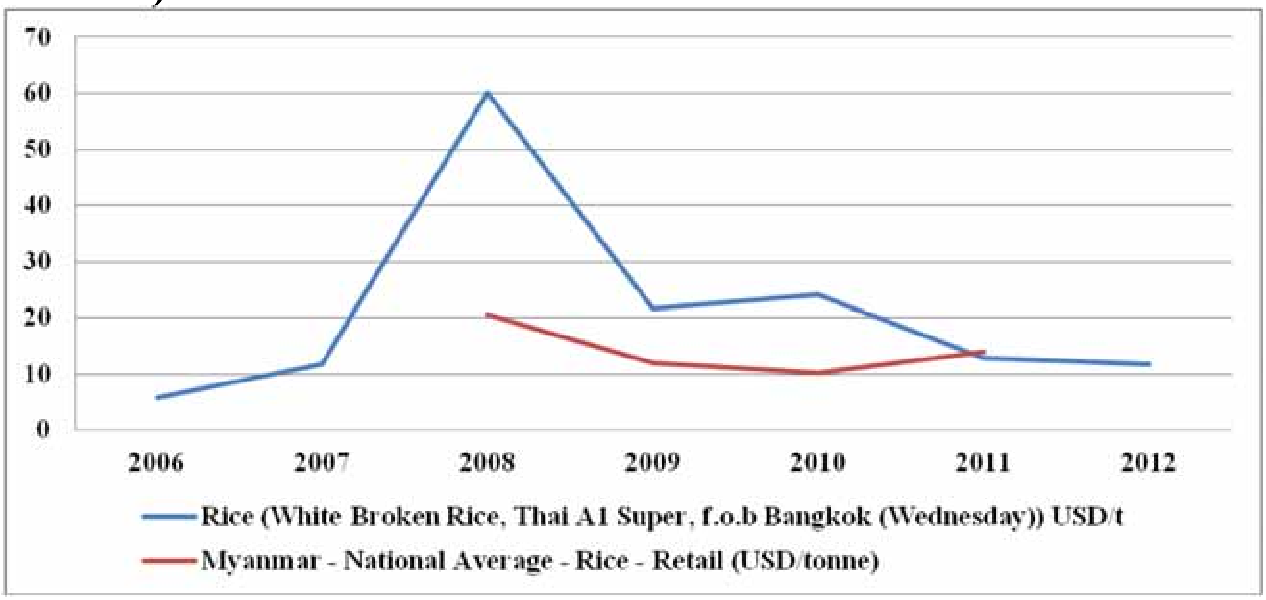
D7: Price volatilities of rice on world and domestic markets in Bangladesh (2000 - 2012)



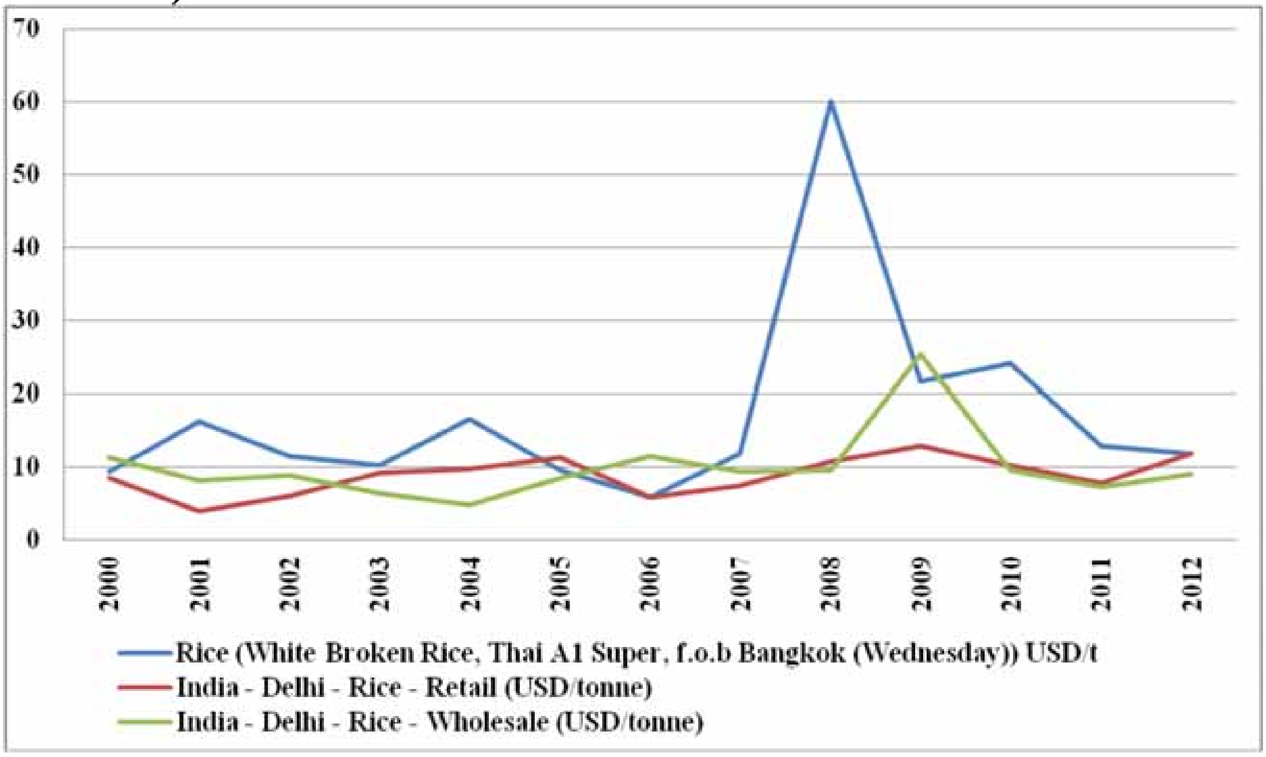
D8: Price volatilities of wheat on world and domestic markets in Bangladesh (1999 - 2012)



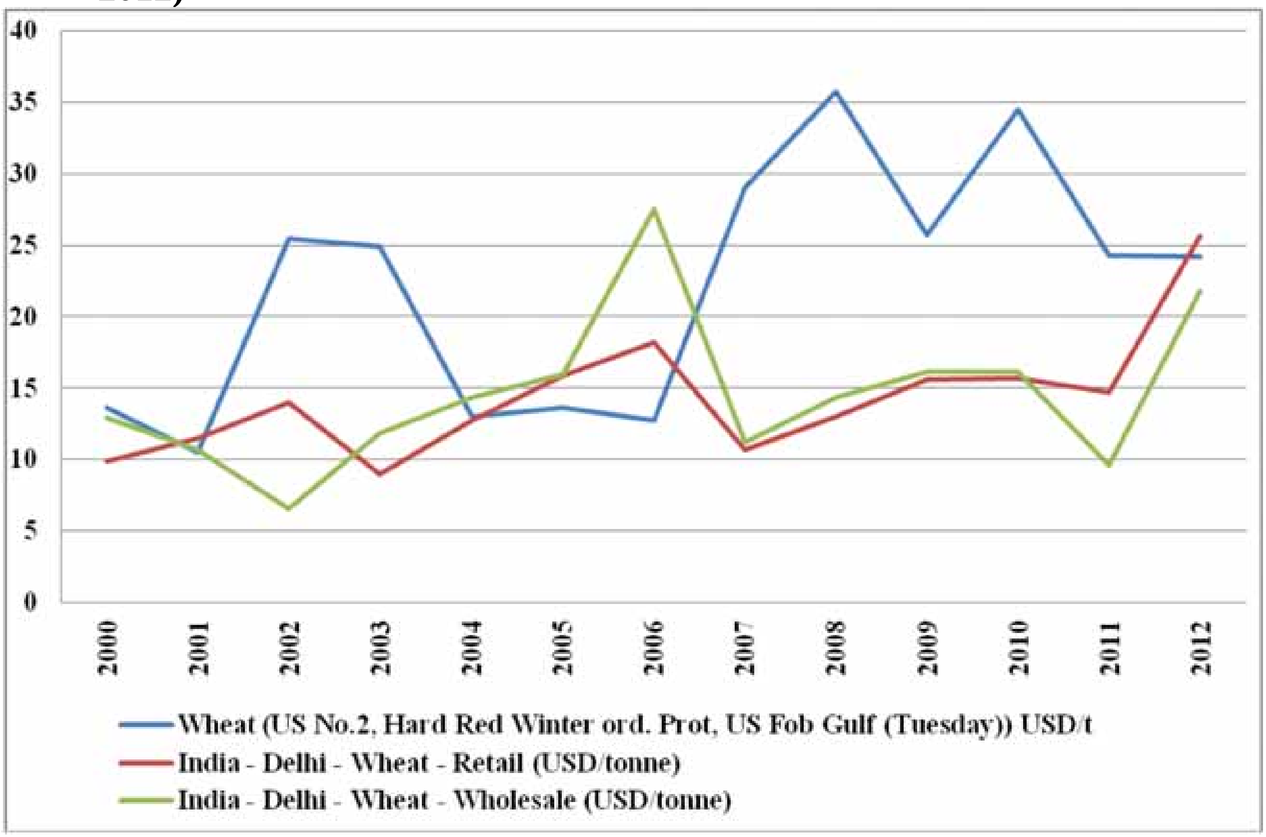
D9: Price volatilities of rice on world and domestic markets in Myanmar (2006 - 2012)



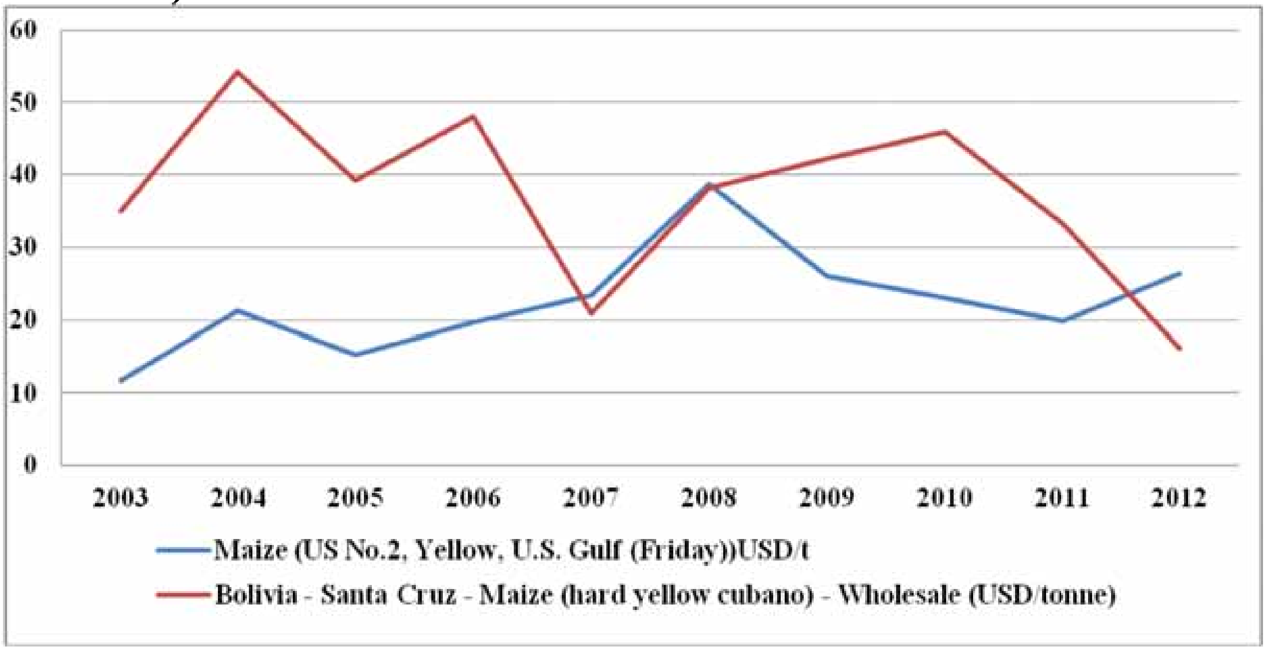
D10: Price volatilities of rice on world and domestic markets in India (2000 - 2012)



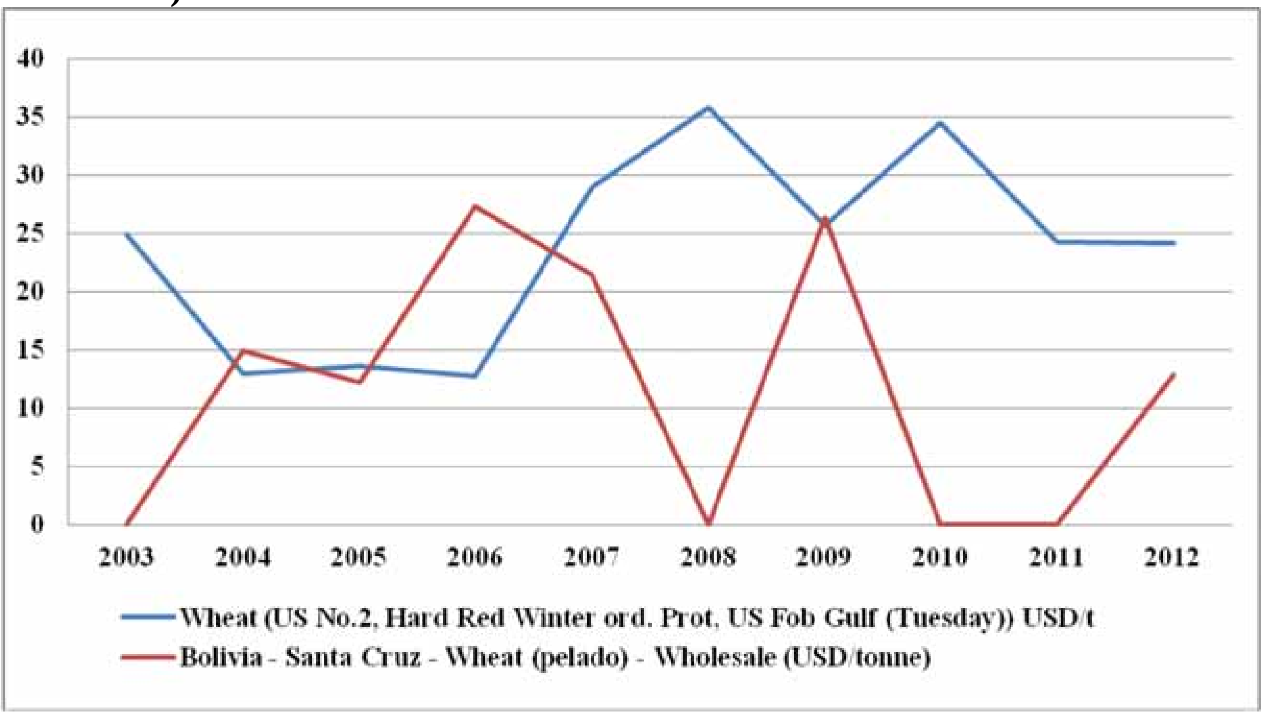
D11: Price volatilities of wheat on world and domestic markets in India (2000 - 2012)



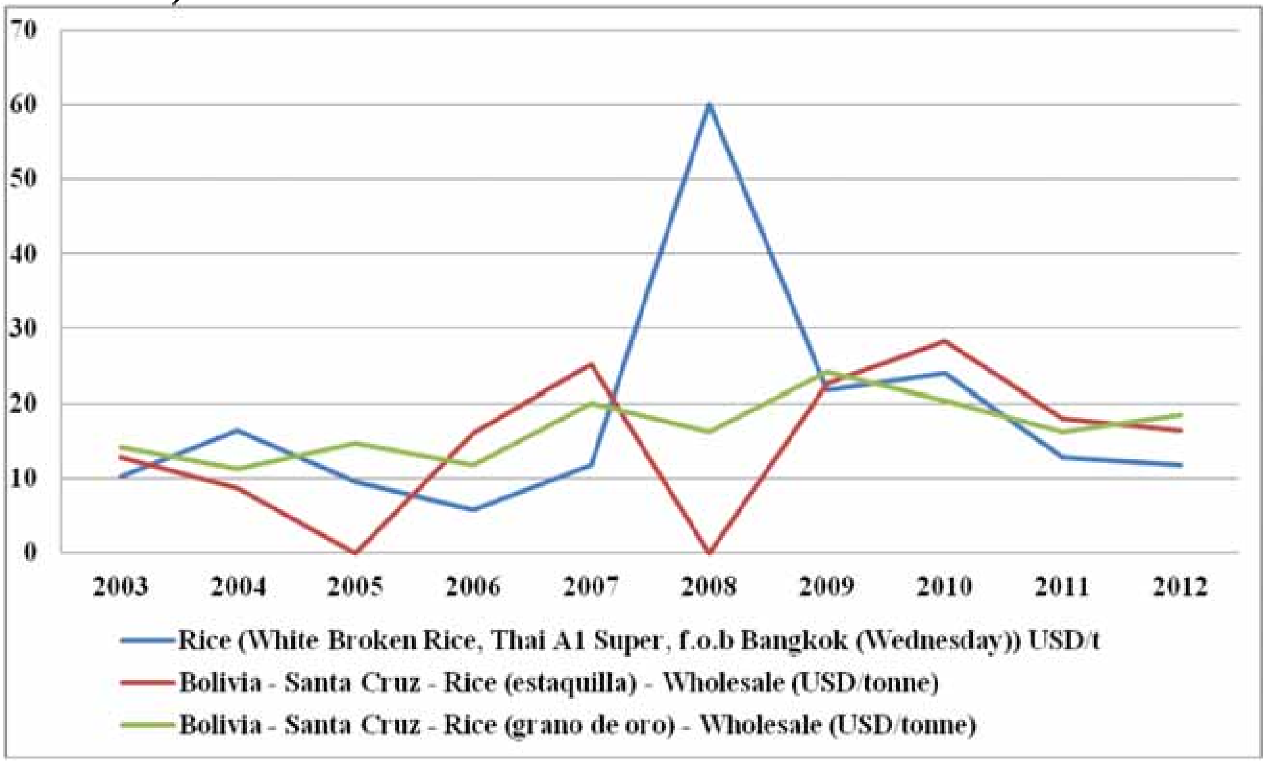
D12: Price volatilities of maize on world and domestic markets in Bolivia (2003 - 2012)



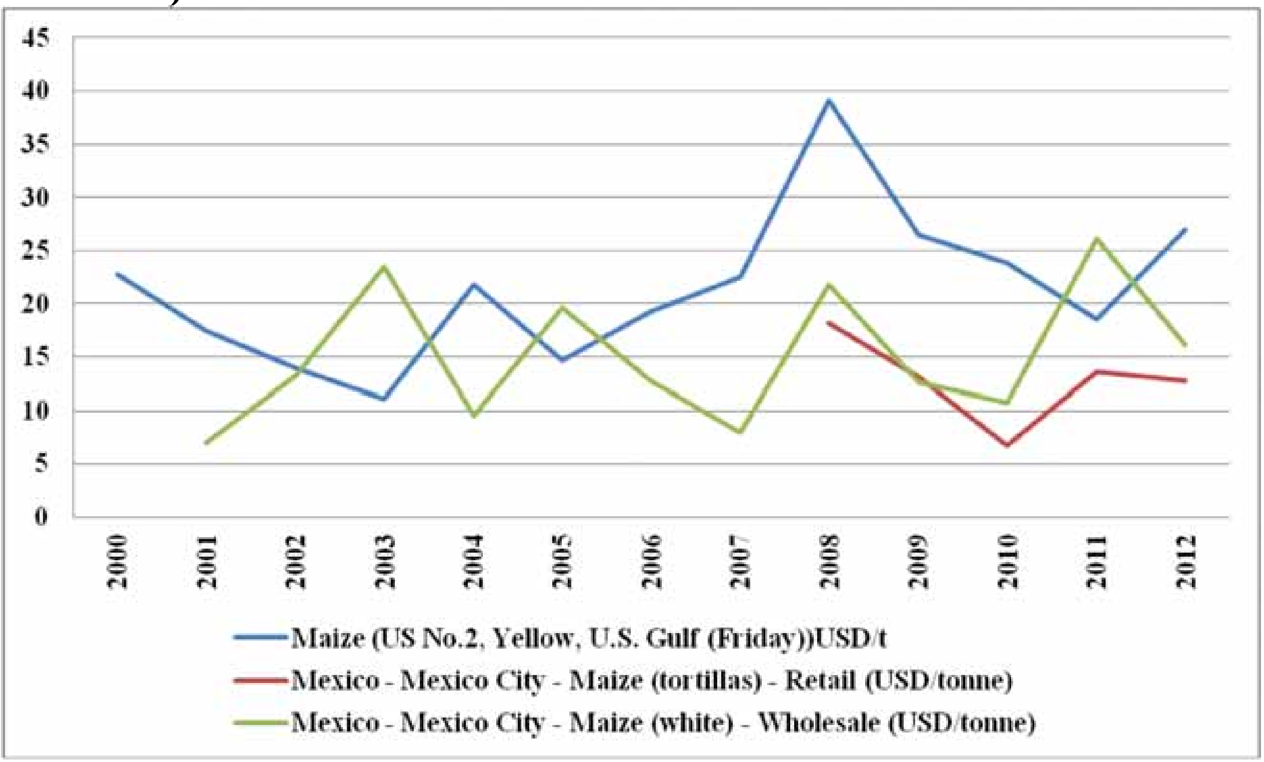
D13: Price volatilities of wheat on world and domestic markets in Bolivia (2003 - 2012)



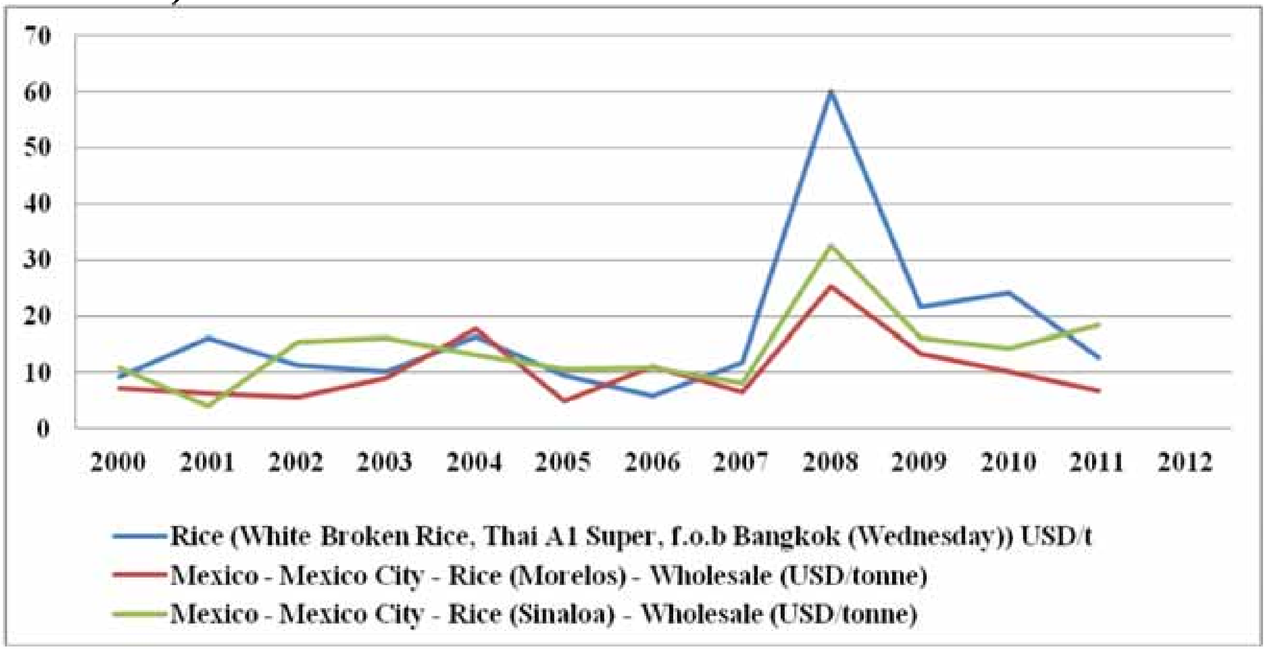
D14: Price volatilities of rice on world and domestic markets in Bolivia (2003 - 2012)



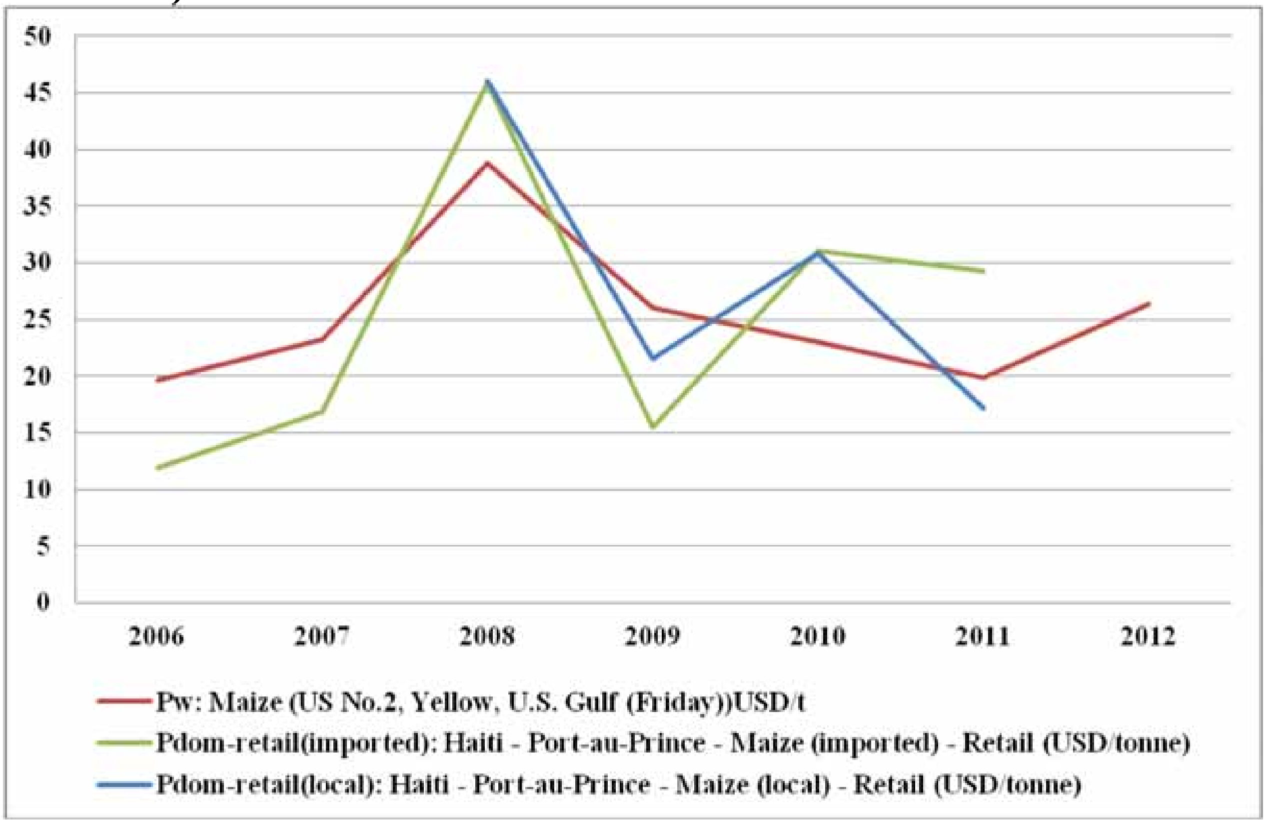
D15: Price volatilities of maize on world and domestic markets in Mexico (2000 - 2012)



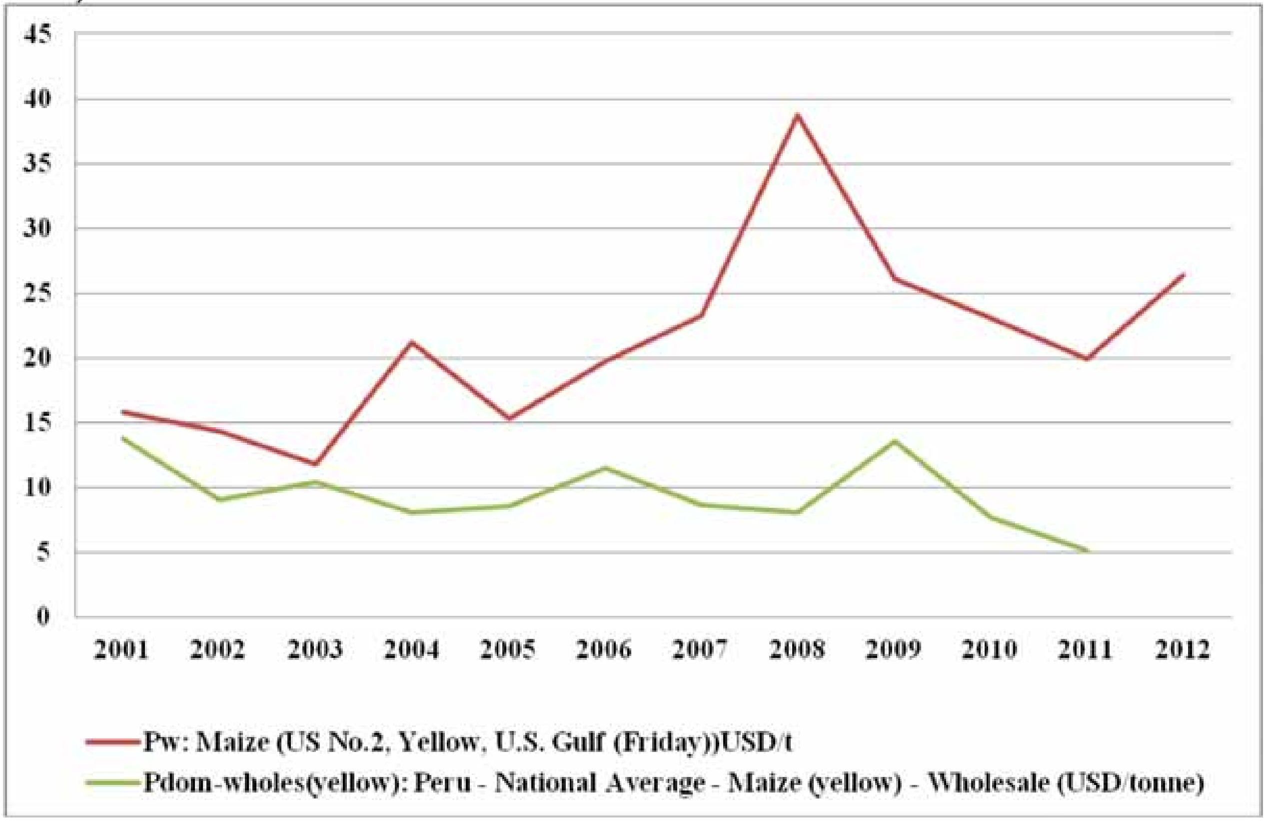
D16: Price volatilities of rice on world and domestic markets in Mexico (2000 - 2012)



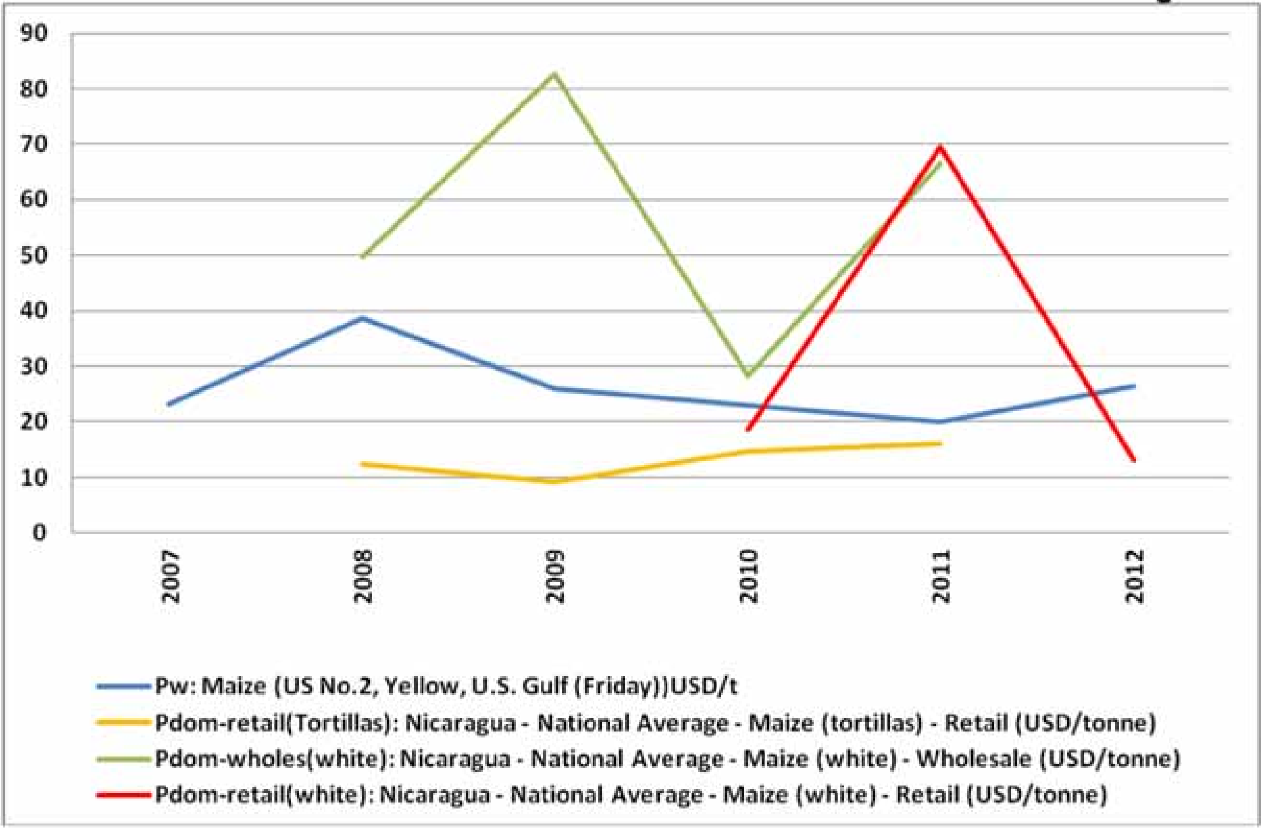
D17: Price volatilities of maize on world and domestic markets in Haiti (2000 - 2012)



D18: Price volatilities of maize on world and domestic markets in Peru (2000 - 2012)



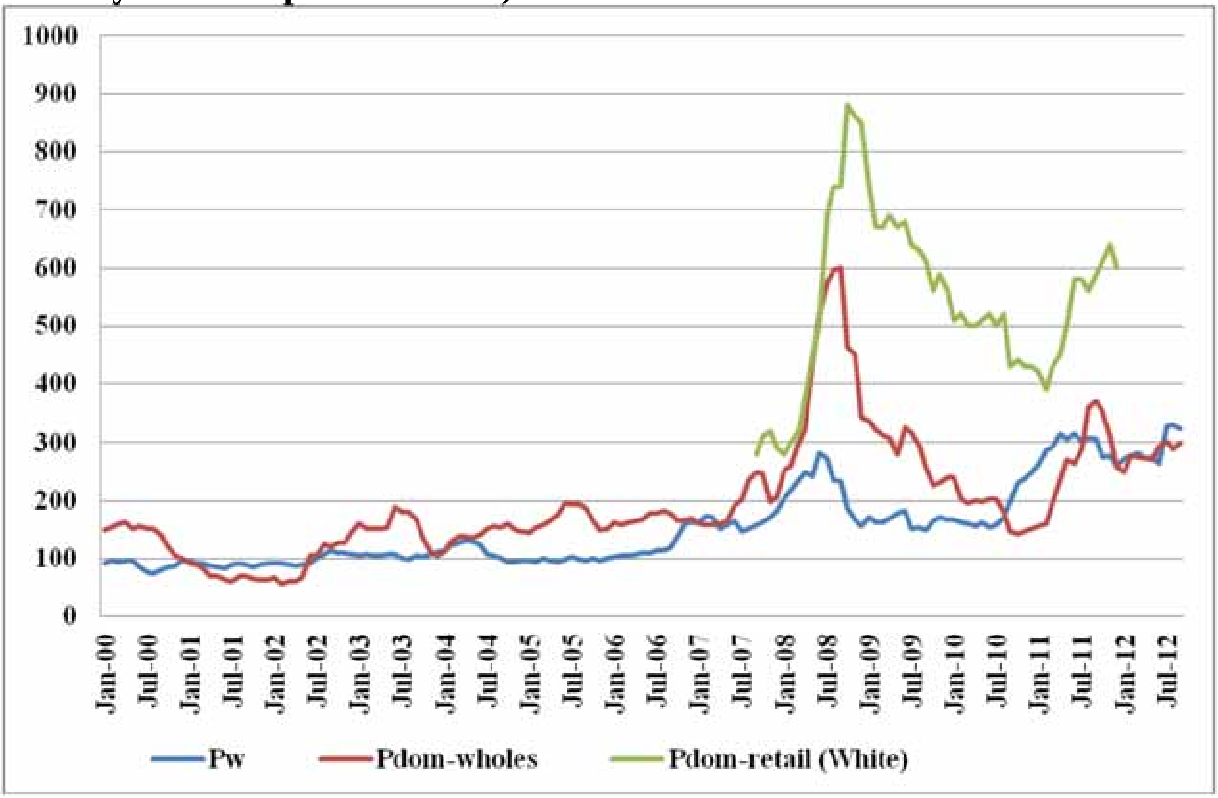
D19: Price volatilities of maize on world and domestic markets in Nicaragua



Appendix E

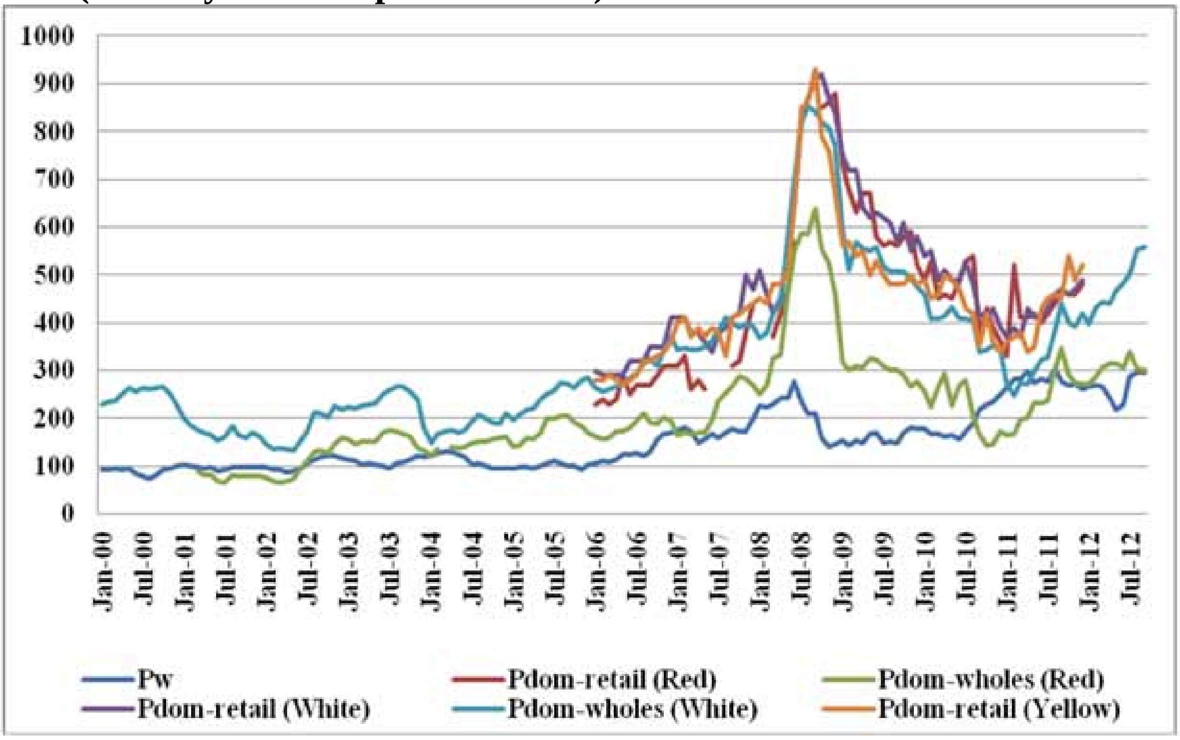
Comparing price levels on world and domestic markets for selected developing countries

E1: Price levels of maize on world and domestic markets in Ethiopia (January 2000 - September 2012)

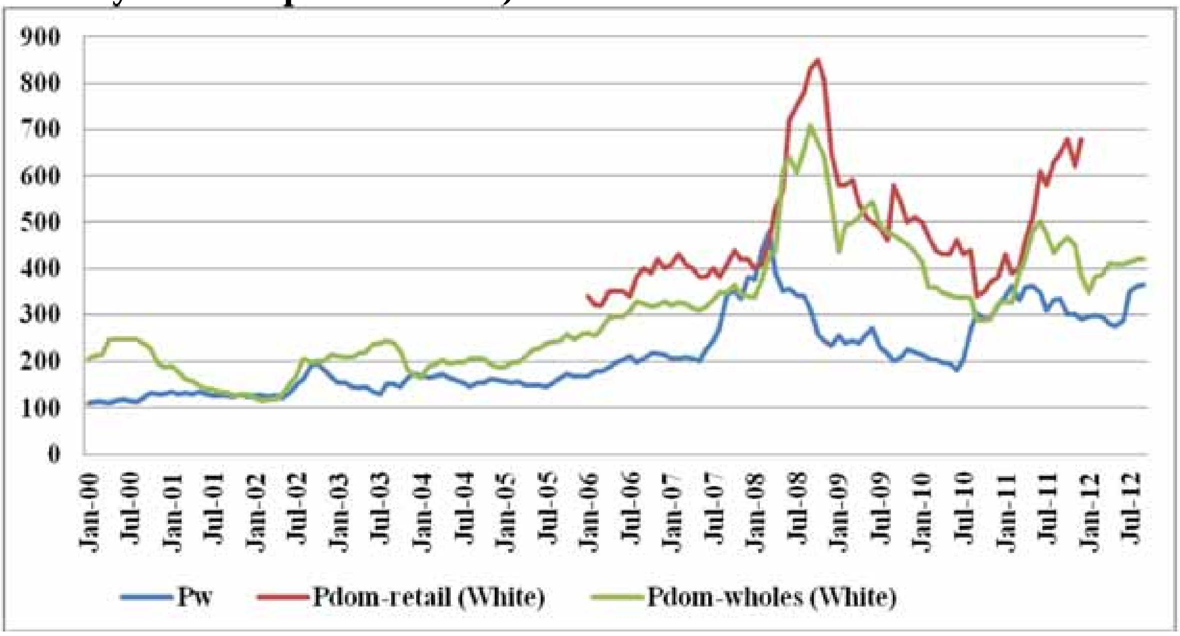


Pw = World market price
Pdom = Domestic price
Pdom-retail = Domestic retail price
Pdom-wholes = Domestic wholesale price

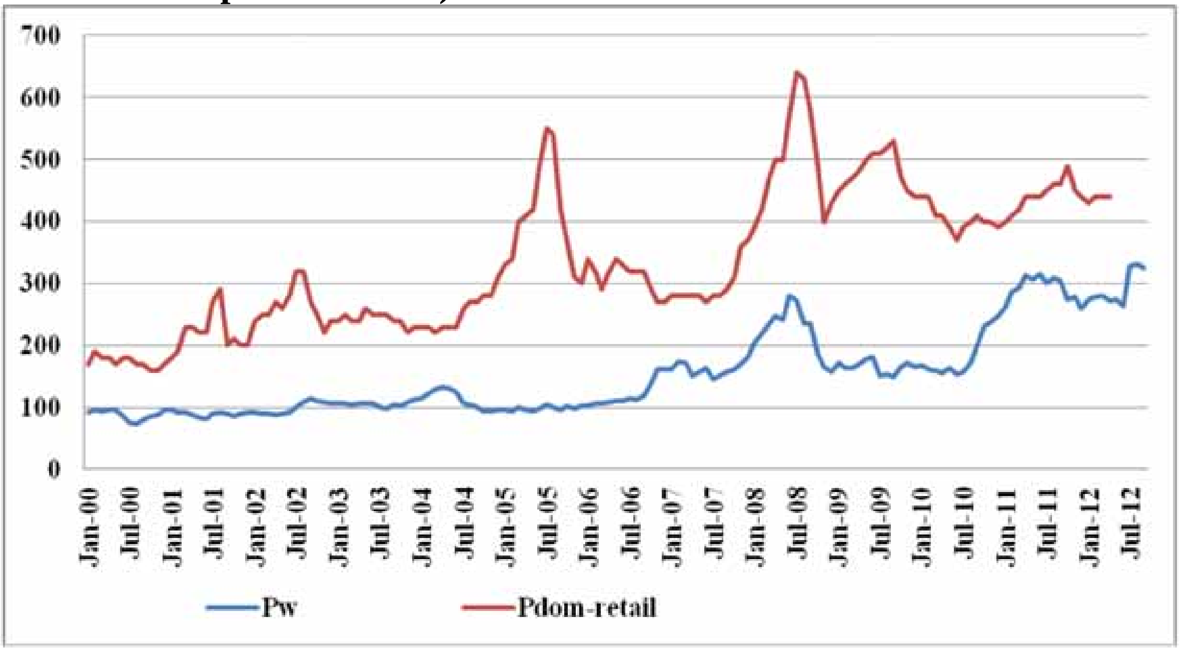
E2: Price levels of sorghum on world and domestic markets in Ethiopia (January 2000 - September 2012)



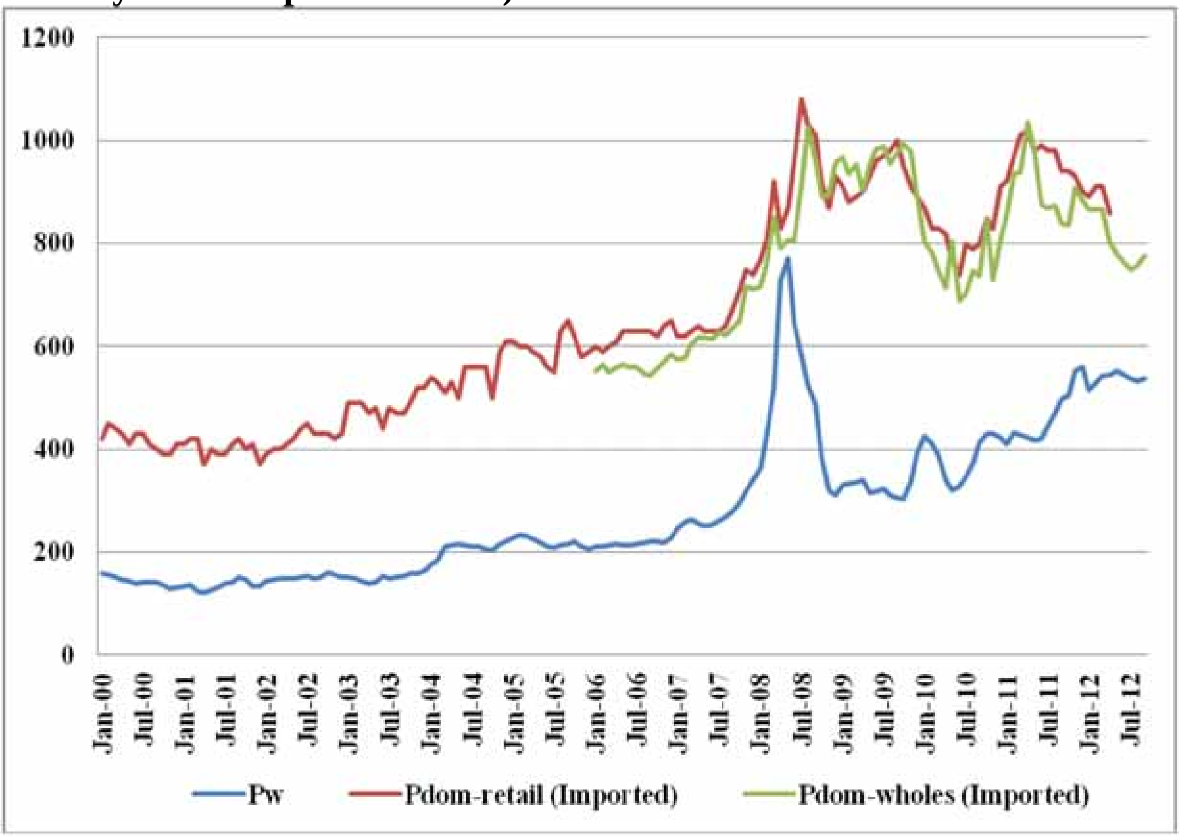
E3: Price levels of wheat on world and domestic markets in Ethiopia (January 2000 - September 2012)



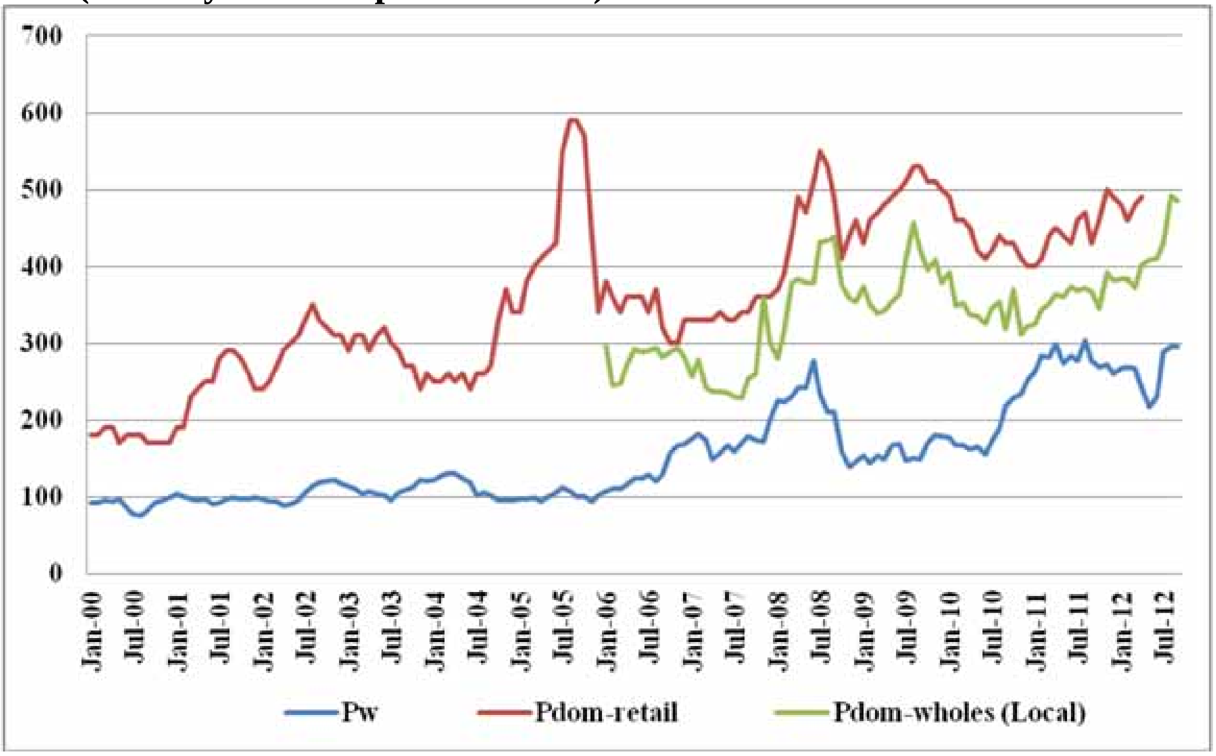
E4: Price levels of maize on world and domestic markets in Niger (January 2000 - September 2012)



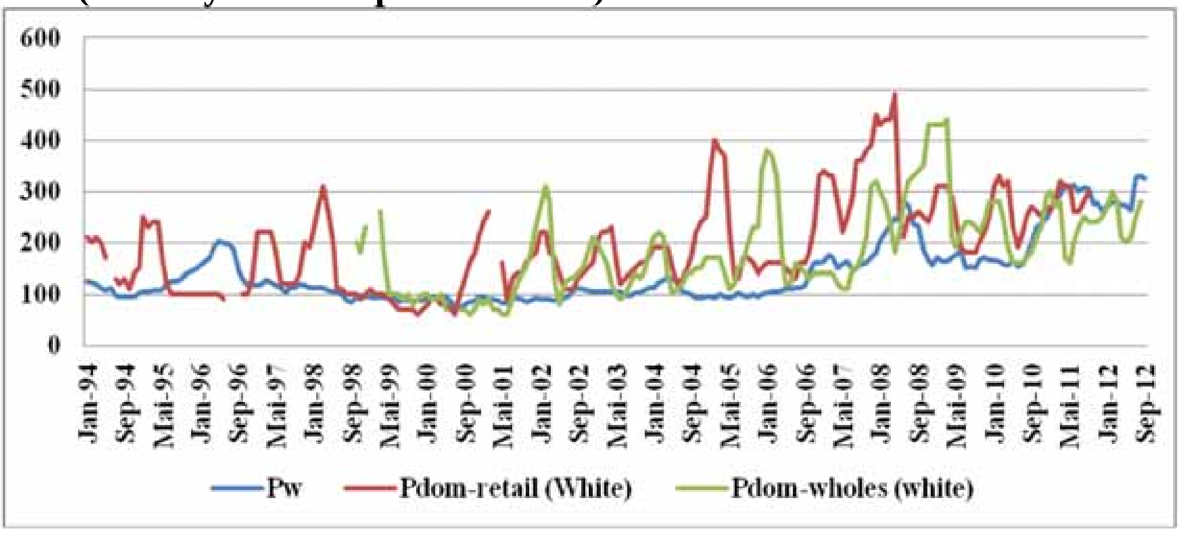
E5: Price levels of maize on world and domestic markets in Ethiopia (January 2000 - September 2012)



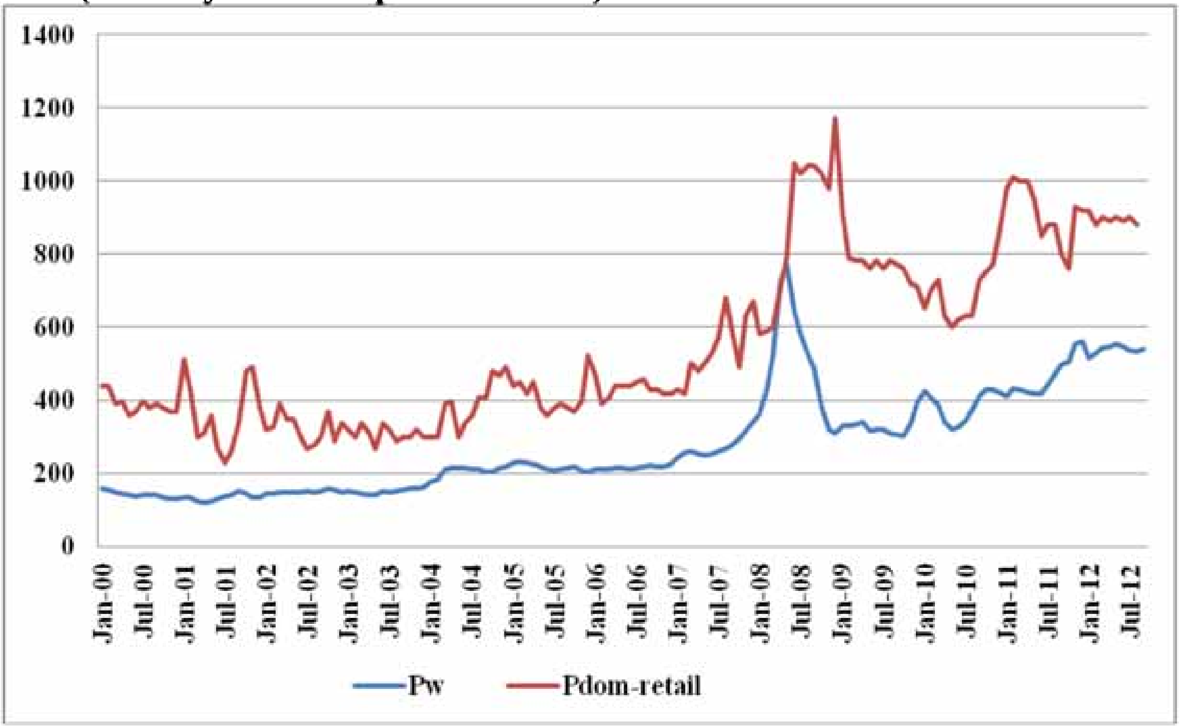
E6: Price levels of sorghum on world and domestic markets in Ethiopia (January 2000 - September 2012)



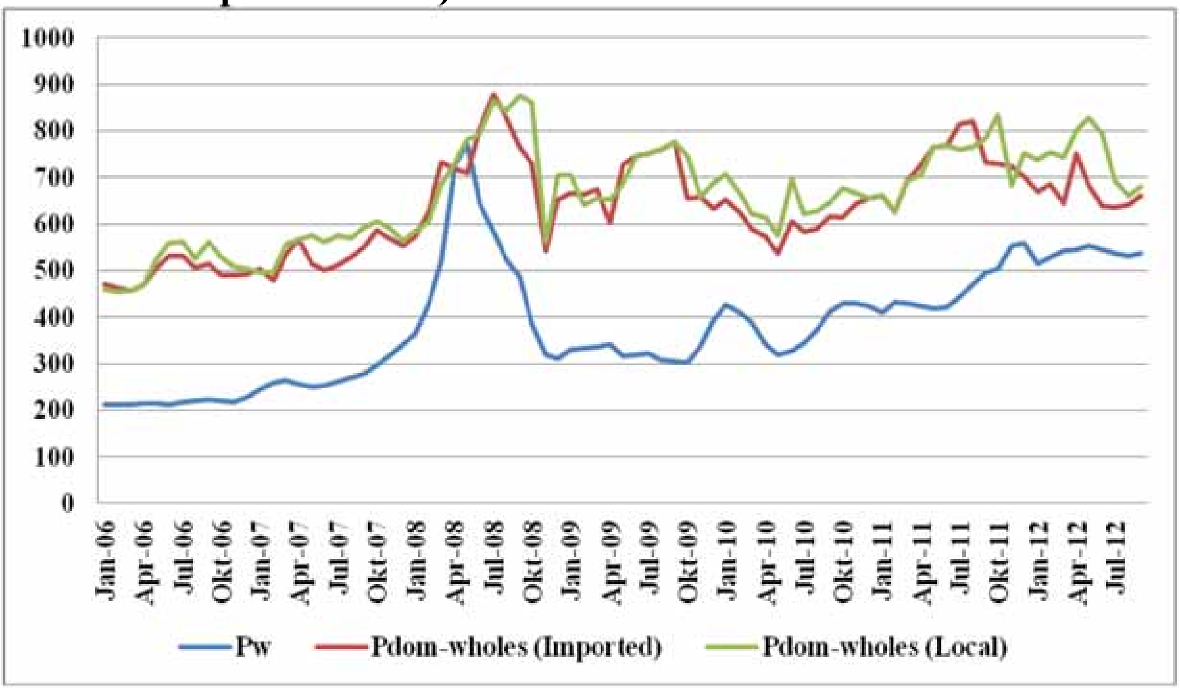
E7: Price levels of maize on world and domestic markets in Mozambique (January 1994 - September 2012)



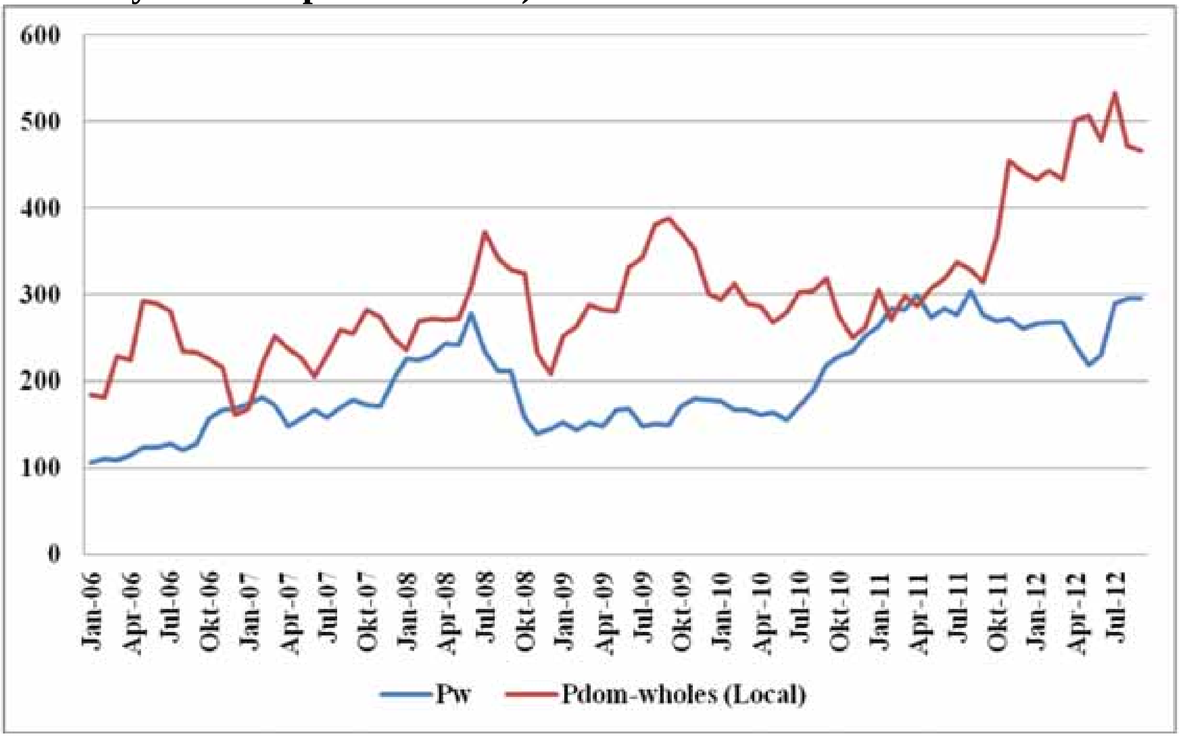
E8: Price levels of rice on world and domestic markets in Mozambique (January 2000 - September 2012)



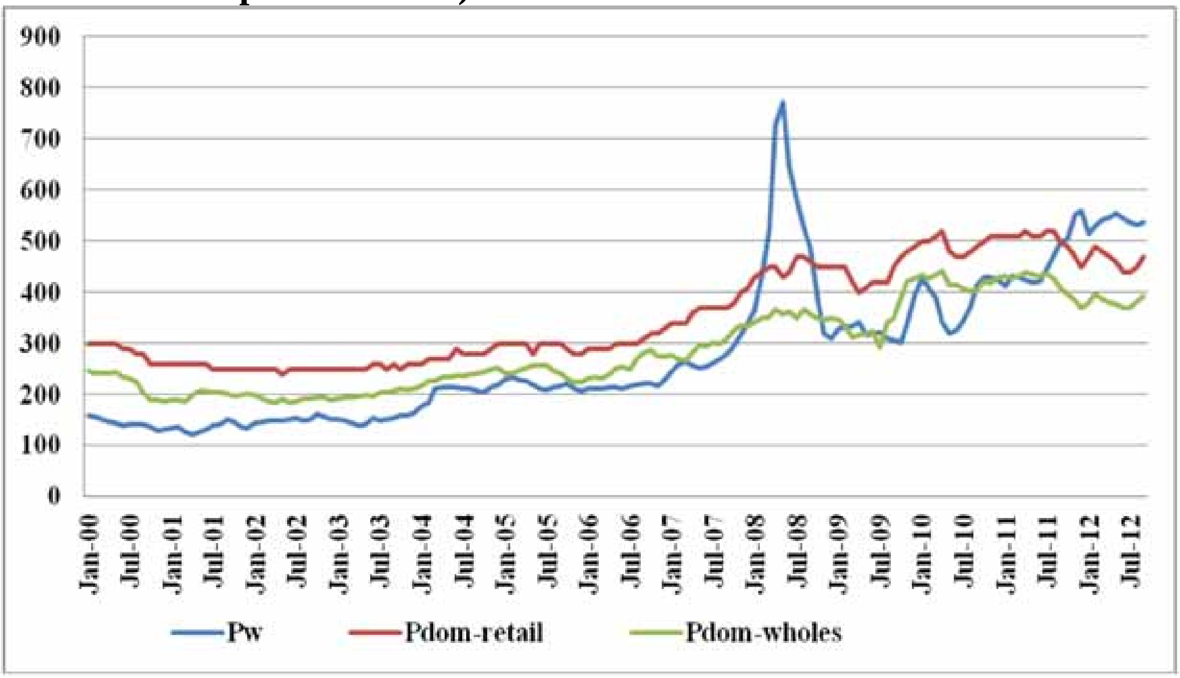
E9: Price levels of rice on world and domestic markets in Mali (January 2006 - September 2012)



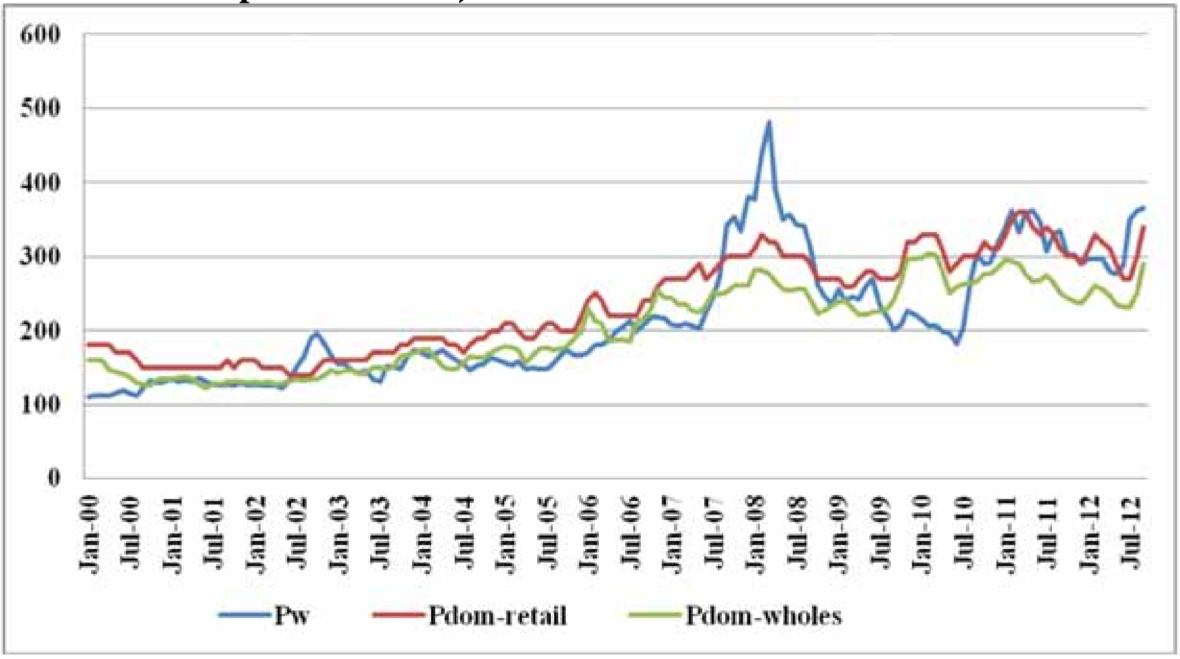
E10: Price levels of sorghum on world and domestic markets in Mali (January 2006 - September 2012)



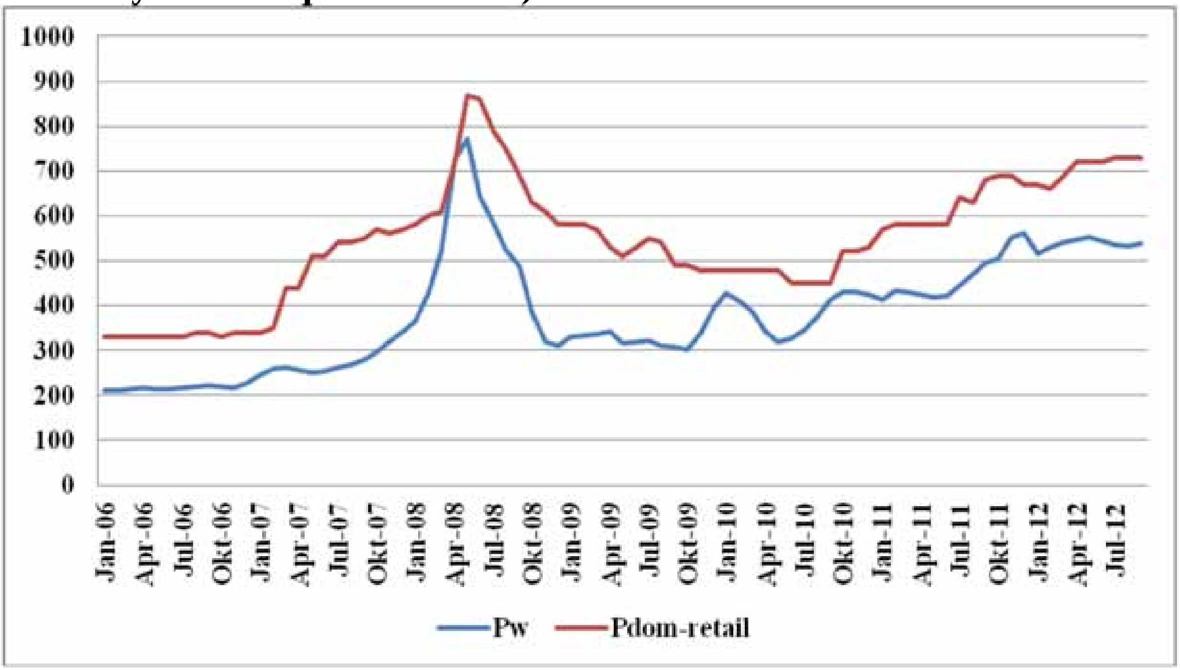
E11: Price levels of rice on world and domestic markets in India (January 2000 - September 2012)



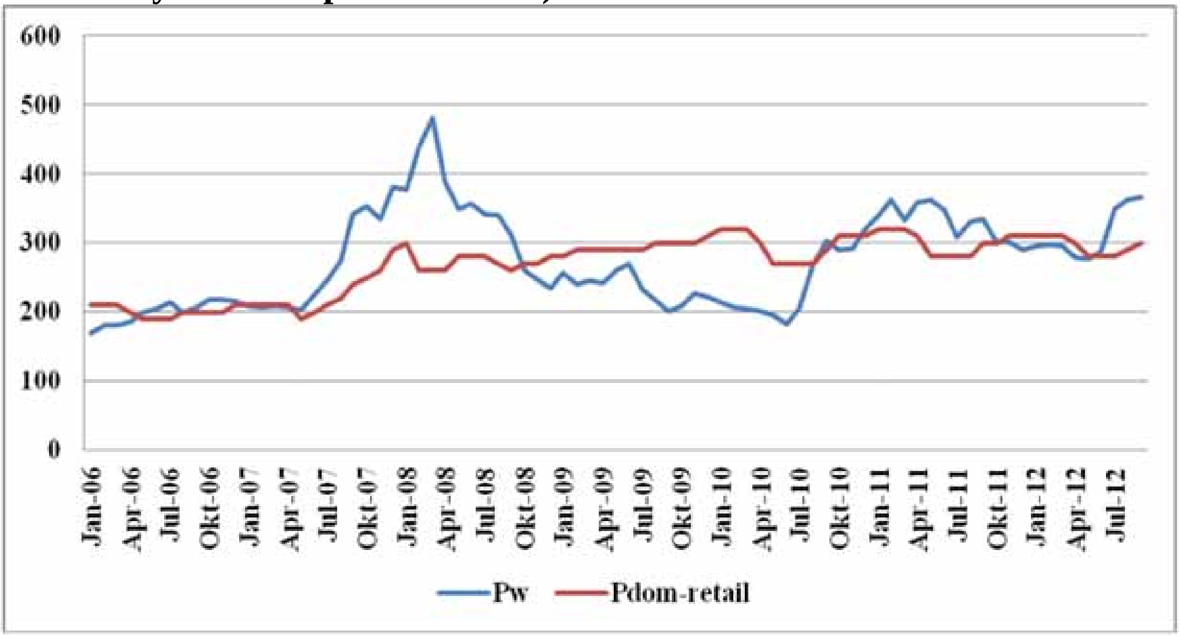
E12: Price levels of wheat on world and domestic markets in India (January 2000 - September 2012)



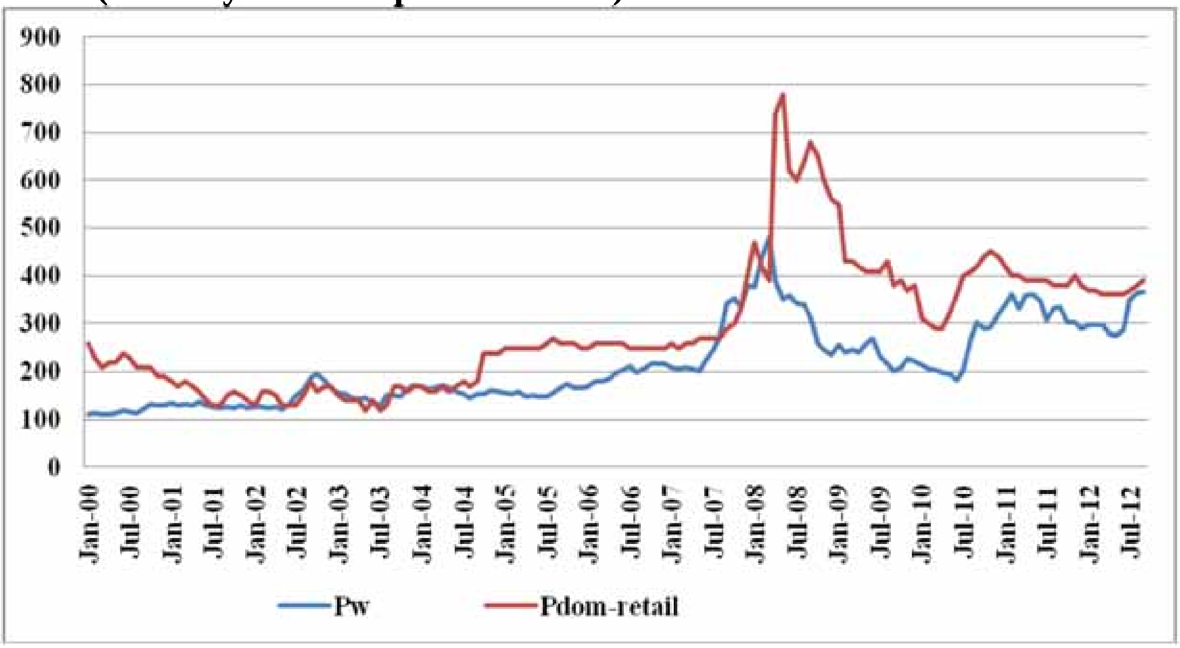
E13: Price levels of rice on world and domestic markets in Pakistan (January 2006 - September 2012)



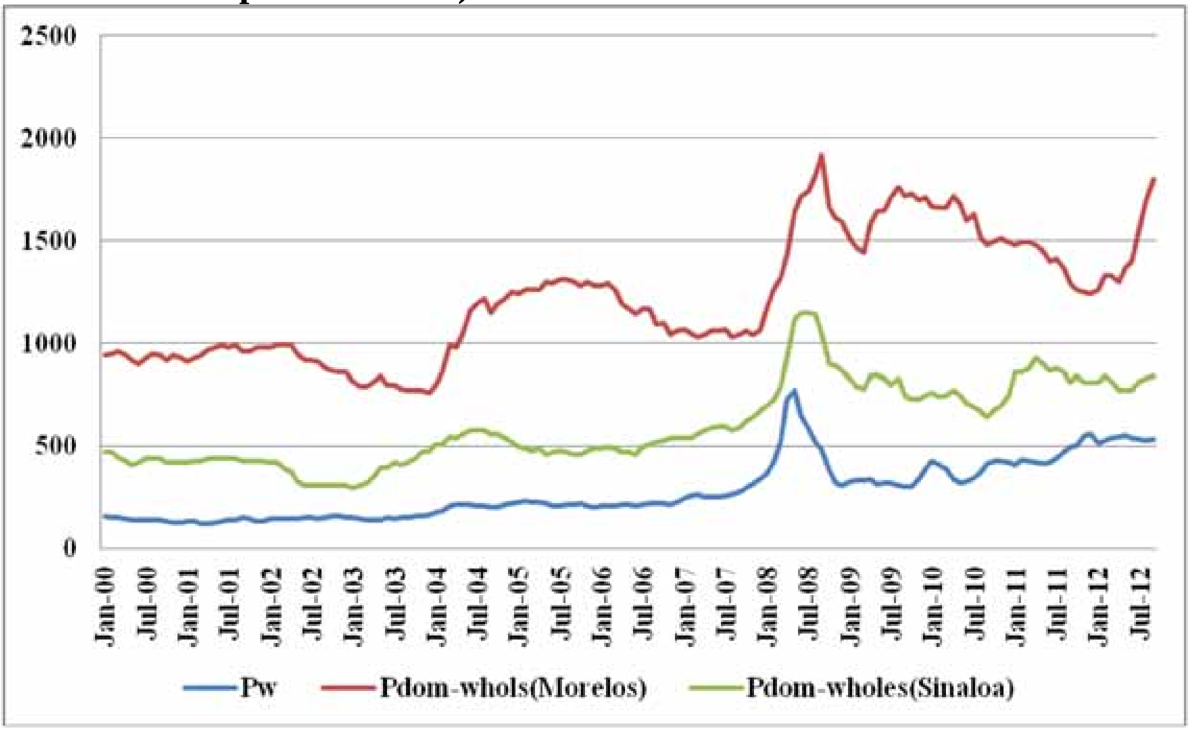
E14: Price levels of wheat on world and domestic markets in Pakistan (January 2006 - September 2012)



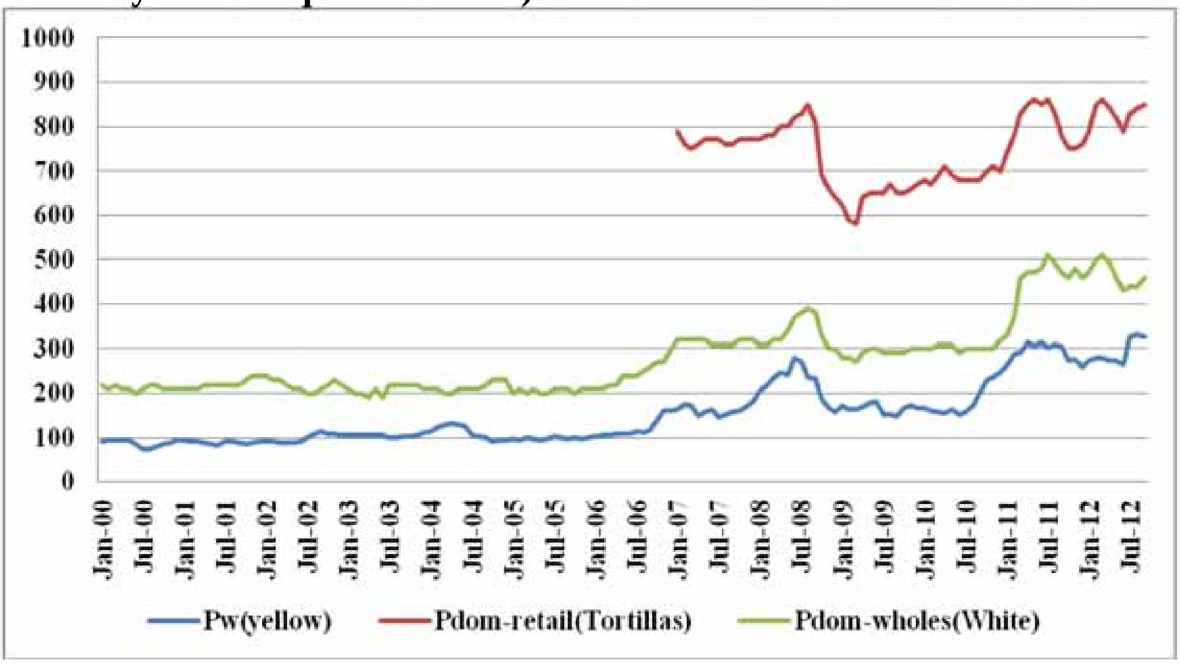
E15: Price levels of wheat on world and domestic markets in Afghanistan (January 2000 - September 2012)



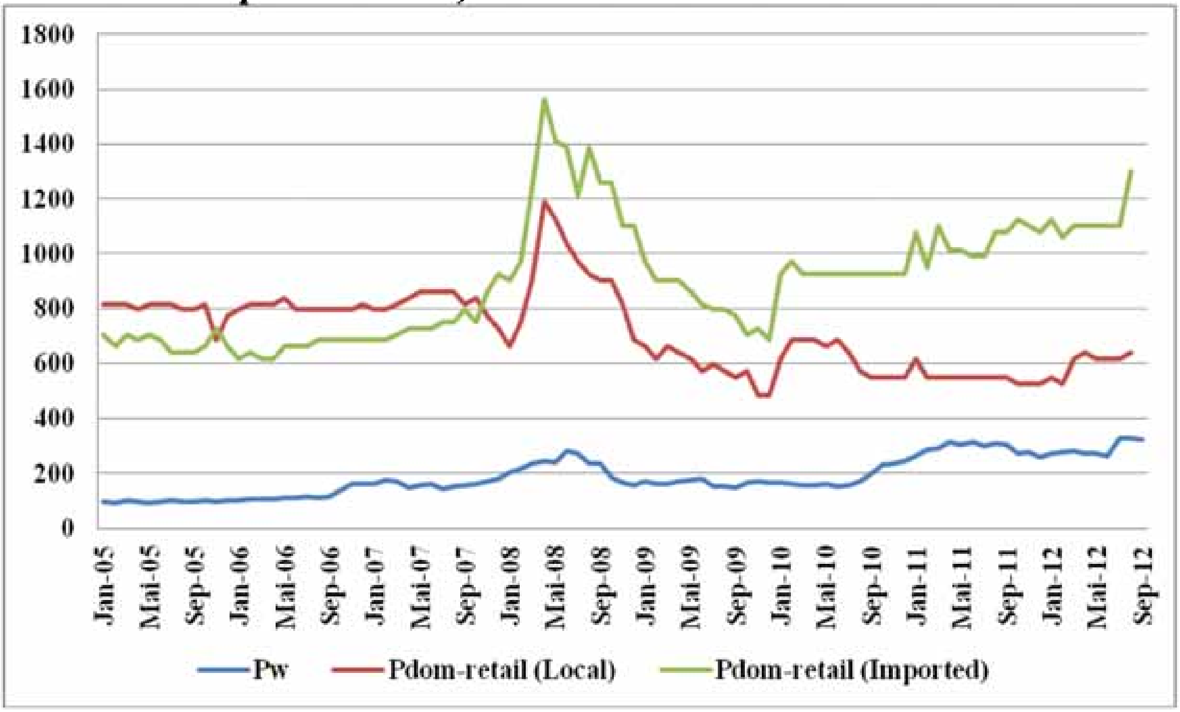
E16: Price levels of rice on world and domestic markets in Mexico (January 2000 - September 2012)



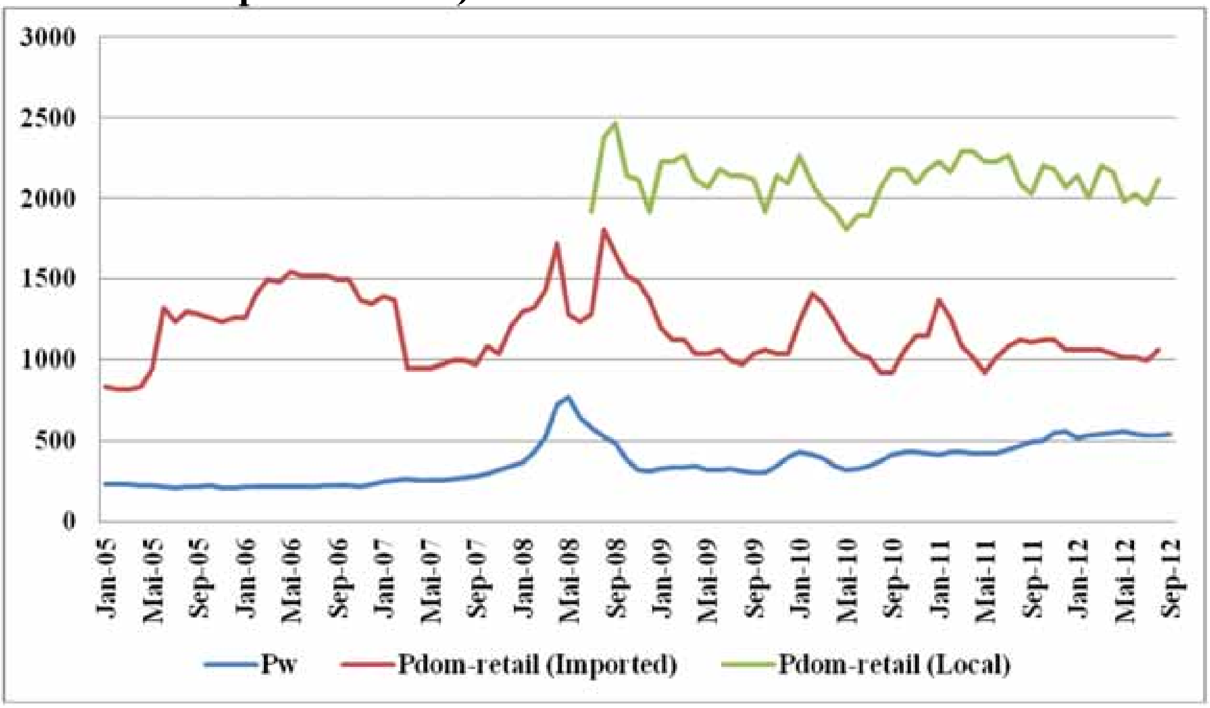
E17: Price levels of maize on world and domestic markets in Mexico (January 2000 - September 2012)



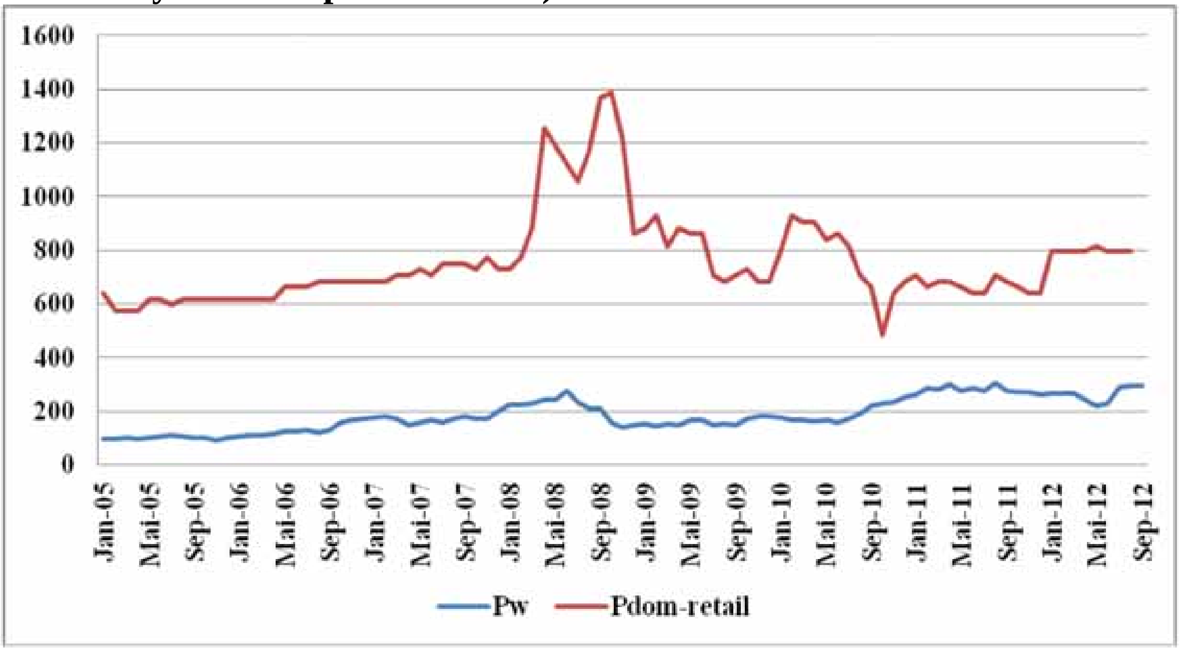
E18: Price levels of maize on world and domestic markets in Haiti (January 2005 - September 2012)



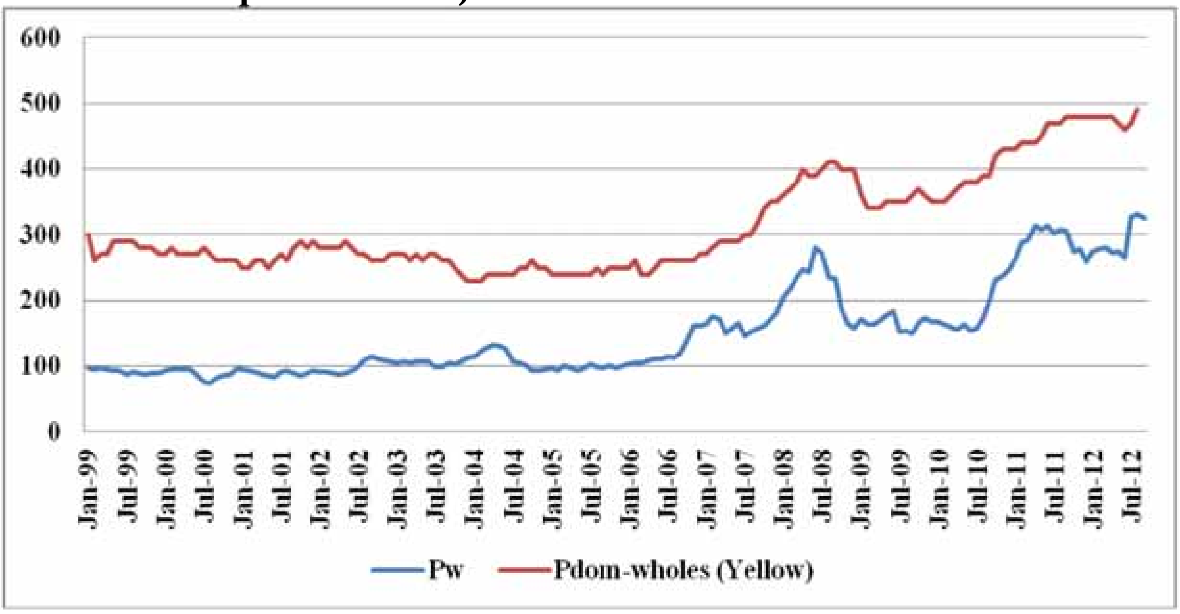
E19: Price levels of rice on world and domestic markets in Haiti (January 2005 - September 2012)



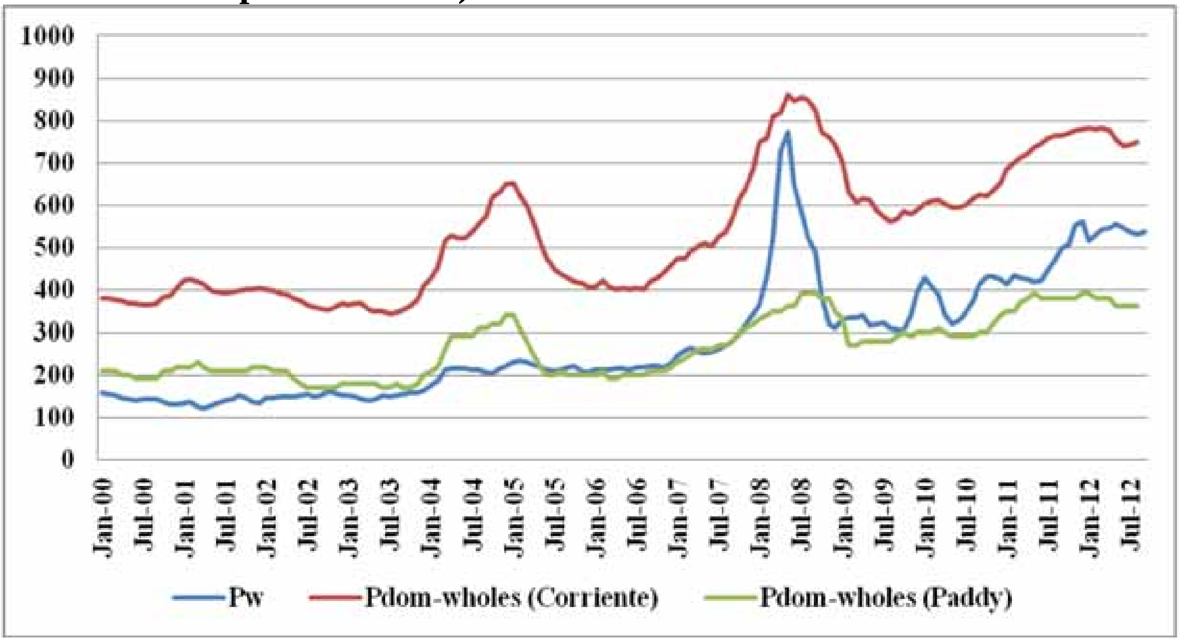
E20: Price levels of sorghum on world and domestic markets in Haiti (January 2005 - September 2012)



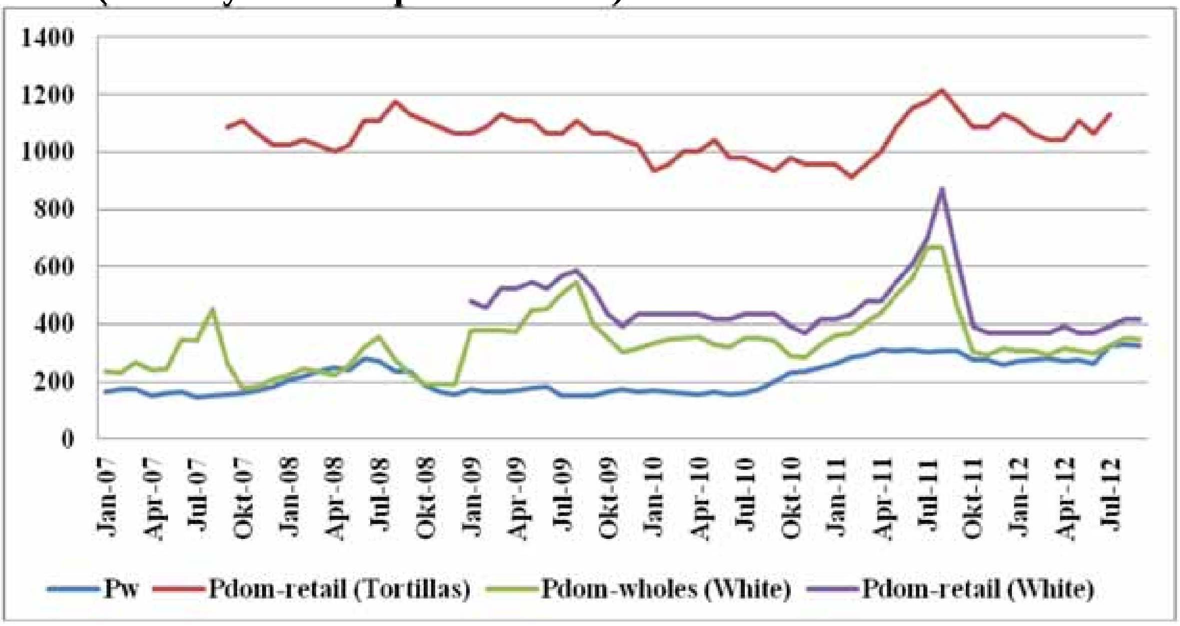
E21: Price levels of maize on world and domestic markets in Peru (January 1999 - September 2012)



E22: Price levels of rice on world and domestic markets in Peru (January 2000 - September 2012)



E23: Price levels of maize on world and domestic markets in Nicaragua (January 2007 - September 2012)



E24: Price levels of rice on world and domestic markets in Nicaragua (January 2005 - September 2012)