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Food Prices and Speculation: Does speculation on the agricultural markets influence prices and volatilities?

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Food Prices and Speculation

Does speculation on the agricultural markets influence prices and volatilities?

By Tim Nieman – *MPP Class of 2013*

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Date: April 08, 2013

Speculation in basic foodstuffs is a scandal when there are billions starving people in the world. We must ensure markets contribute to sustainable growth.

– Michel Barnier, EU Commissioner responsible for financial services regulation (January 13, 2010)

Executive Summary

Food prices in the last decade have seen both an increase in price levels and in price variability. In the same time period, speculative activity in the agricultural futures market has significantly increased. This thesis asks whether food price levels and volatilities are affected by speculation, and whether regulation can curb the potential effect.

This thesis first investigates the welfare impacts of high and volatile prices. It does so because if the impact is limited, there would be a weak argument for introducing regulation. I find that producers benefit from high food prices, whereas consumers are hurt. Next to that, rural households gain relative to urban households. From a macroeconomic perspective, food importing countries have negative impacts on their balance of payments, inflation rates and fiscal breathing space. All these impacts are particularly pronounced in developing countries. This thesis finds that short-term volatilities can have long-term negative consequences for households. Moreover, food producers are less willing to invest in the agricultural system. On a macroeconomic level volatility increases uncertainty and reduces growth. The conclusion is that both high and volatile agricultural prices are welfare reducing.

This thesis finds that there are fundamental supply and demand factors that have increased price levels and volatilities over the last decade. However, it also finds that there is a potential role for speculation in driving up agricultural prices. Speculation plays a more definitive role in increasing price volatilities.

As high and volatile food prices are welfare reducing, and speculation has a role at least in one of these price developments, this thesis investigates policy options to limit the effect of speculation on food prices. It finds that a transaction tax and position limits are two regulatory options that are likely to curb the effects of speculation on food prices, while at the same time they do not create very large market distortions.

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1 Introduction

In one newspaper you could read an article in the finance section about the profits banks have made by being active on the agricultural commodity market. Turning a few pages to the international news section, you would be able to read that as a result of high food prices, millions of the world's poor have been thrown into hunger. Recently, a very polarized and passionate discussion in both the academic and the non-academic debate has started as to whether there is a causal link between the two sections in the newspaper. This debate has significantly intensified after strong food price increases in 2008 and the debate is still ongoing. In October 2012 a letter, signed by 12 international organizations, was send to the German Finance Ministry to plea for regulation on the agricultural financial markets to reduce the effect of speculation. Two months later, in December, a letter signed by a group of economists was send to the German President Joachim Gauck, arguing exactly the opposite: do not introduce regulation on the agricultural financial markets. The topic of high food prices is very relevant, as they can have very large effects on the livelihoods of people. The FAO and WFP (2009) estimate that because of high global prices in 2007/2008 an additional 75 to 160 million people had been thrown into hunger and extreme poverty.

This thesis will explore the question whether high food prices and speculation are related and whether regulation can play a role. More specifically, this thesis will answer the following research question:

> Are food price volatilities and price levels affected by speculation and can regulation reduce those effects?

Answering the research question requires an answer to several separate questions that together form the answer to the main question. These questions are:

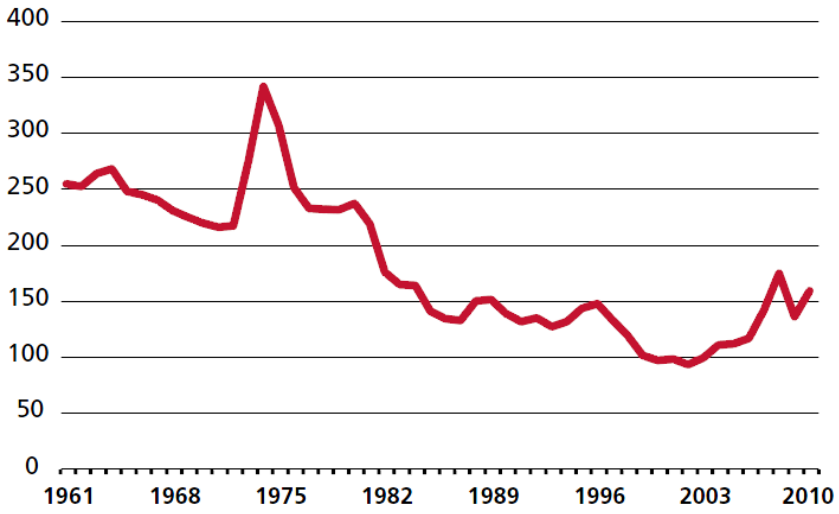
- Are food commodities experiencing higher price levels and volatilities?
- Are increased volatilities and price levels in food prices undesirable?
- What are the fundamental factors that explain food price developments?
- Are food price levels and volatilities linked with each other?
- Can regulation help to reduce the effects of speculation?

This paper is structured as follows. In Chapter 2, I will investigate the recent trends in the prices of agricultural commodities. Thereafter, in Chapter 3**Fehler! Verweisquelle konnte nicht gefunden werden.**, I will analyze the effect of having high and volatile food prices using both theory and case studies. Analyzing the effects of high and volatile food prices will be done by looking at the impacts of opposing groups (e.g. consumers vs. producers) and from a global perspective. Looking at the effects seems like a side-step in answering my research question, but it is necessary to investigate whether the market is operating sub-optimally. Only when that is the case, regulation is justified. In Chapter 4 the basic process of the price formation in agricultural commodities will be investigated. In Chapter 5 one of the mechanisms that could influence price, speculation, is analyzed in depth. Finally, in Chapter 6, policy options relating to speculation on the agricultural commodity market are investigated. This thesis is mostly based on arguments put forward in other studies. The particular contribution of this thesis is the thorough overview and analysis of literature. Moreover, the thesis presents an analysis of various policy options that looks at reducing the impact of agricultural commodity speculation.

2 Food Price Developments

Food prices have decreased steadily since the 1970s, but increased rapidly at the turn of the millennium (IFAD, WFP, FAO, 2011). Figure 1 shows the FAO Food Price Index from 1961 until 2010.

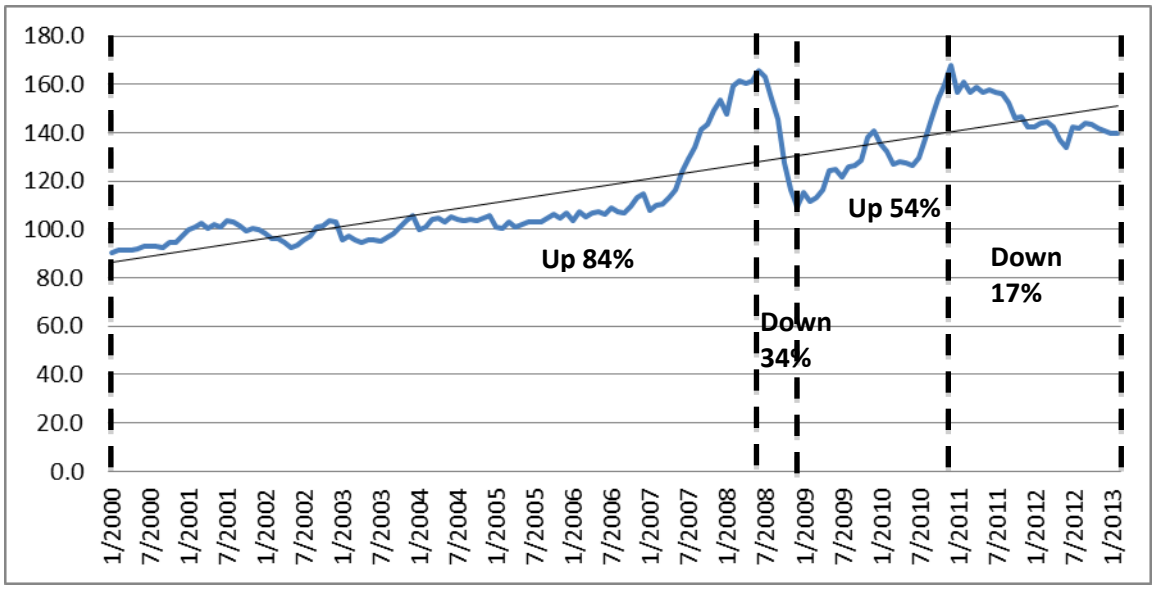
Figure 1: FAO Food Price Index, adjusted for inflation, 2002 = 100



Source: IFAD, WFP, FAO (2011)

From 1961 until 2002 real food prices had decreased with 60%. The spike visible in the early 70s is due to the oil crisis that hit the world at the time. In Figure 2, more detailed price developments since 2000 are shown. After the long period of decline from the 70s until the turn of the millennium, it only took 10 years for food prices to approximately double again from that level. Figure 2 also shows that within this period of 10 years the food index price fluctuated a lot.

Figure 2: FAO Food Price Index, adjusted for inflation, 2000 – 2013



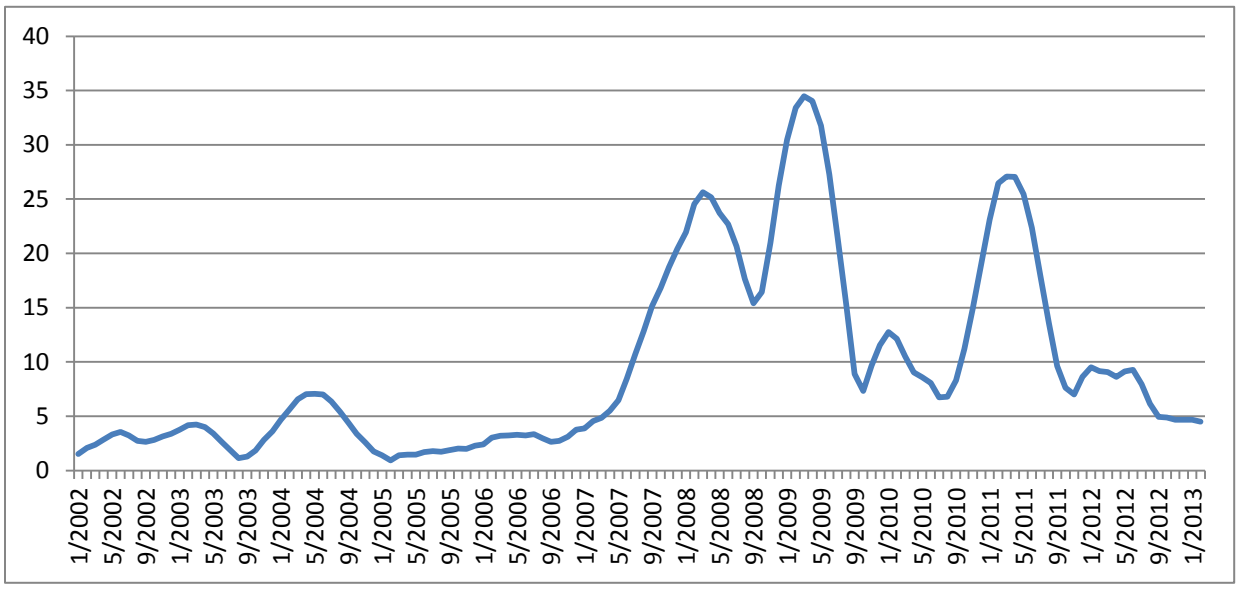
Source: Historical FAO Food Price Index data

These fluctuations in the last decade could indicate that the food commodity prices have an increased variability compared to the period before. In finance, this is often

measured by the variance or the standard deviation of the price over a fixed time interval. In

Figure 3 the standard deviation of the FAO food price index using a 12 month rolling window is depicted. It seems evident that in the last decade food price volatility has increased. However, taking this measure of variability on time series that exhibit trending behavior is problematic. If there is an upward trend in prices, such as seen in the last decade with food prices, the variance and standard deviation will have an upward bias showing that variability increased, while this does not necessarily have to be true.

Figure 3: Standard deviation of FAO Food Price index, 12 month rolling window



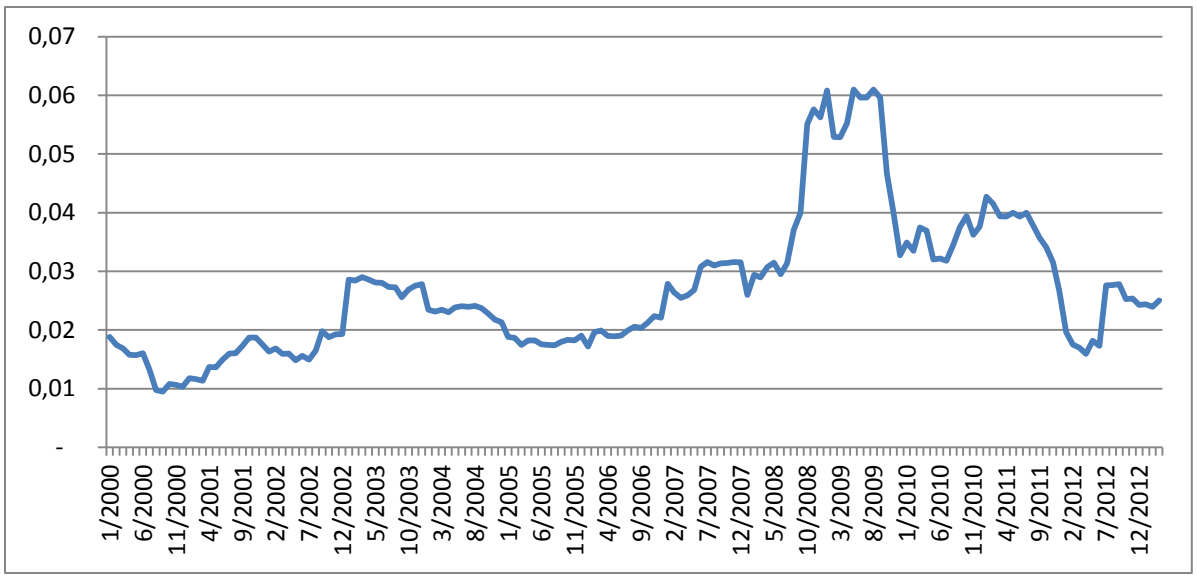
Source: Historical FAO Food Price Index data and own calculations

Therefore, the variability measure is often detrended by either dividing the standard deviation by a rolling average mean or by taking the standard deviation of the logarithmic change per time period. Volatility of the logarithmic change of food prices is depicted in

Figure 4. Using this volatility measure, authors find that it has significantly increased over the last few years (Gilbert & Morgan, 2010).

Other econometric techniques have been developed to investigate whether the variability has significantly changed over time. One approach is to use a generalized autoregressive conditional heteroskedasticity (GARCH) model to estimate the volatilities within the model specification. Roache (2009) does exactly this by using a spline-GARCH model on food price developments and finds that price volatility of food commodities has indeed increased over the last decade compared to the time period before.

Figure 4: Standard deviation of natural logarithm of FAO Food Price index, 12 month rolling window



Source: Historical FAO Food Price Index data and own calculations

3 Impacts of High and Volatile Food Prices

In sum, the last decade has seen significant price level and volatility increases for foodstuffs. In this section I will look at the impacts of high and volatile food prices. This assessment is essential for answering the question whether regulation on agricultural markets is desirable, for the moment assuming that regulation can limit the impact of high and volatile food prices. If the impact of high and volatile food prices is welfare reducing, there is a strong argument for regulation on agricultural markets. If the impact of high and volatile food prices is limited, the argument for regulation is less convincing.

In the first section I will assess the impact of high food prices by grouping households or countries in different categories: (1) consumers vs. producers, and (2) urban vs. rural. Subsequently I will look at the macroeconomic impacts from a food importer and food exporter perspective and finally at the global aggregate welfare impact of high food prices. In the second section I will assess the impact of volatile prices, which will have a less categorical assessment. The methodology I use is a literature review and a review of existing empirical studies.

The following sections are mostly focused on developing countries, although I will also look at developed countries. This focus can be justified. Table 1 shows that the majority of the world population (a cumulative 84%) lives in low or middle income countries.

Table 1: Population grouped by World Bank country classification scheme

Country Classification	GNI per Capita	Countries (no.)	Population in millions (% of world total)
Low income	< $1,005	35	817 (12%)
Lower middle income	$1,006 - 3,975	57	2,466 (36%)

Upper middle income	$3,967 - 12,275	54	2,449 (36%)
High income	> $12,275	70	1,123 (16%)
World	$9,097	216	6,855 (100%)

Source: adopted from Perkins, Radelet, Lindauer & Block (2012)

Moreover, a significant share of the population in developing countries is poor, illustrated by Table 2. The poor in these countries are particularly impacted by changes in food prices, as they spend up to 80% of their income on foodstuffs. For most OECD countries this figure lies between 15% and 25% (OECD, 2008). Therefore, for the poor in developing countries in particular, the relative welfare impact of changing food prices is more significant than the poor in developed countries (FAO, 2011).

Table 2: Poverty headcount ratio by World Bank country classification scheme

Country	Poverty headcount ratio at $1.25 a day (PPP, year = 2008) (% of population)	Poverty headcount ratio at $2.00 a day (PPP, year = 2008) (% of population)
Low income	48%	74%
Lower middle income	30%	59%
Upper middle income	9%	20%

Source: World Bank Poverty and Inequality Database

Finally, high and volatile food prices particularly impact the poor in developing countries as they have fewer coping mechanisms compared to those in more developed countries. (FAO, 2011).

3.1 High Food Prices

In this section I will look at the impact of high food prices. First, I will look at the differences between consumers and producers. This is done because consumers spend income on food whereas producers receive income from food. Second, I will analyze

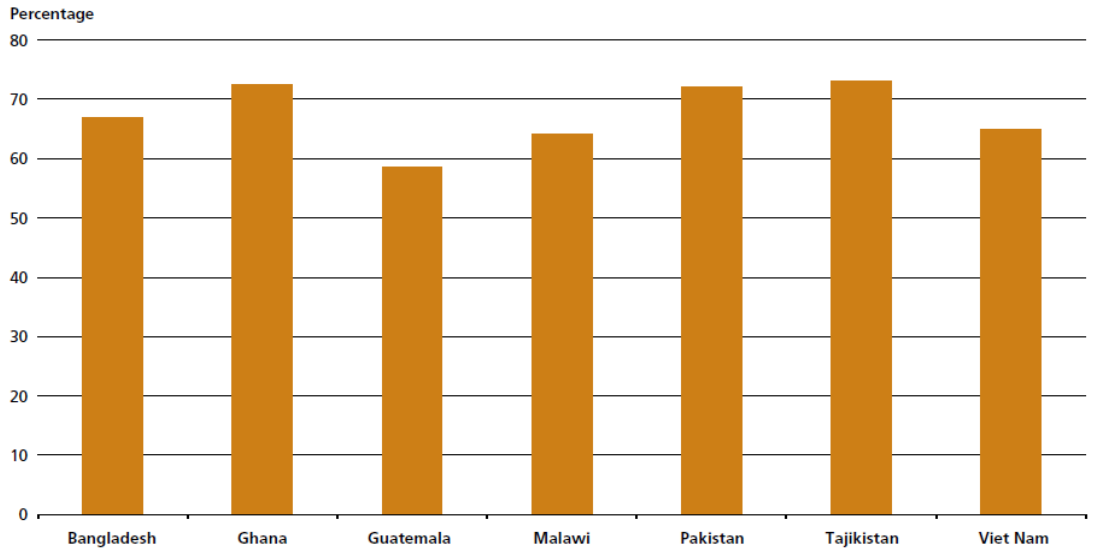
the urban and rural households. I will do so because urban households typically cannot fall back on production, and therefore have fewer coping mechanisms compared to the rural population. Subsequently, I will assess the macroeconomic impacts of high food prices, and investigate the differences in impacts for food importing nations and food exporting nations. Finally, anticipating that the effects of high food prices can be either positive or negative depending what your position is in the agricultural market, I will investigate what the overall impact is on a global level.

3.1.1 Consumers – Producers

When a household is a net consumer of agricultural products, the real income of that household will decrease when food prices go up. For the poorest the impact of increasing food prices on the real wage can be extremely large, as a large share of their income is spend on food. In

Figure 5 the percentage share of the household budget spent on food for the lowest quintile of the population is shown. These shares range from almost 60% in Guatemala to over 70% in Bangladesh.

Figure 5: Percentage of household budget spent on food by the lowest expenditure quintile of the population



Source: FAO (2011)

The poor have few coping mechanisms at their disposal to deal with the increases in food prices. One mechanism used is to switch to cheaper foods that are less nutritional but that do fill the stomach; another mechanism is to reduce the intake of food altogether (Brinkman *et. al,* 2009). The WFP (2008) analyzes the effect of lower nutritional intake and they conclude that there are long term negative effects for those that cope with high food prices in such a manner. Box 1 shows an example of Nicaragua.

Box 1: Impact of high food prices in Nicaragua

Nicaragua as a country is dependent on the import of cereals to satisfy the dietary requirements within the country. In 2008, the price for cereals increased, leading to higher prices for consumers. Next to that, Nicaragua was hit by Hurricane Felix and fell victim to extraordinary heavy rains, which further increased prices. As a result of the higher food prices, the WFP estimates that the total food intake by the poorest families had been reduced by as much as 26% per day.

Source: World Food Program (2008)

Globally, this trend of reducing nutritional intake as response to higher food prices has been investigated by Brinkman *et al.* (2009). Table 3 is adopted from their research and shows that the food consumption is dependent on the income elasticity of demand of food (higher income translates into higher food consumption) and the price elasticity of demand of food (higher prices translates into lower food consumption). The table shows that in Africa the change in food consumption in response to a price increase is largest compared to other regions.

Table 3: Changes in food consumption as a result of food price and income changes

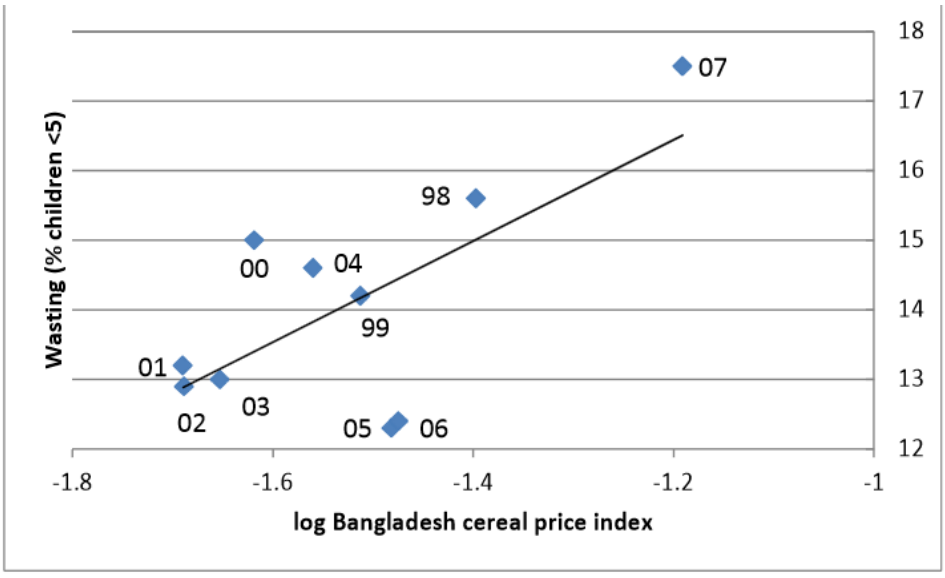
Region	Price elasticity of demand for food	Income elasticity of demand for food	Real food price increase 2006-2010	GDP per capita growth 2006-2010	**Change in food consumption (%)**	Additional hungry population (millions)
Africa	-0.56	0.69	37	-1	**-21.3**	239
East Asia	-0.48	0.59	37	32	**1.0**	0
South Asia	-0.57	0.70	37	21	**-6.8**	111
Western Asia	-0.48	0.59	37	4	**-15.4**	21
Latin America and the Caribbean	-0.48	0.58	37	4	**-15.7**	87

Source: adopted from Brinkman et al. (2009)

The scatterplot in

Figure 6 shows the relationship between cereal prices and wasting (which is defined as the weight being too low for height) for children under 5 in Bangladesh. There is a strong positive correlation between wasting and high cereal prices. Low nutritional intake for young children can have permanent negative impacts for the rest of their lives (Save the Children, 2011).

Figure 6: Cereal prices and wasting in Bangladesh



Source: Save the Children (2011)

Next to reducing nutritional intake, another coping mechanism of net consumers of agricultural products after a price increase is to reduce their expenditure on non-food items in order to keep their nutritional intake constant. This could be achieved by, for example, removing the children of the household from school. This has long-term economic impacts, as the level of education goes down. Bangladesh is used as an example in Box 2 to illustrate the potential impact high food prices have on the level of education.

ox 2: The effect of food prices on education in Bangladesh

Early in 2008, the prices of all crops increased significantly, threatening the food security of households in Bangladesh. As a result, many households reduced their caloric intake. However, a large amount of households managed to keep their nutritional intake constant. Those households that kept nutritional intake constant often did so by removing the children from school. Not paying tuition fee resulted in a saving in monthly expenses of on average 9% of total monthly. Next to that, the children which were initially enrolled in school were often sent to work to increase the monthly income of the households. This resulted in an increase of household income by

Net producers on the other hand benefit from increased prices, as part of their income is derived the sale of agricultural goods. Aksoy and Dikmelik (2008) use a sample of

nine developing countries and find that net producers of food on average receive 56 percent of their income through the sale of crops. Moreover, they also find that the remaining 44% of income is closely related with the sale of agricultural products. An increase in crop income translates into a similar increase of their non-crop income. In Box 3 the effect of an increase in rice prices on rice growing farmers in Vietnam is elaborated on.

Box 3: Food price increases and poverty in Vietnam

72% of the Vietnamese households are farming households and 75% of these households grow rice. In the poorest quintile, 90% is farmer and 85% of them farm rice. As a result of a socialist land policy, many rural poor own land and are net sellers of agricultural products (usually rice).

Using 2008 household data it is possible to estimate the effect of a 20% increase in price of rice. The impact of this increase in price for rice growing farmers is a decrease in poverty, from an incidence of 23.4% to 22.2%, including short-term substitution effects by consumers of rice. Although the food price increase is poverty alleviating, the effect seems quite limited. This is because the results are the aggregate results for all farmers growing rice, including those who are actually net consumers.

Source: Vu and Glewwe (2008)

The link between farmer's income and price levels depends on several assumptions. One of them is that farmers possess the knowledge to benefit from higher food prices (FAO & OECD, 2011). Another is that the higher global prices are passed through to the selling price of local farmers. When farmers are located in remote areas with low infrastructure quality and conversely high transportation costs, the price increase at a global level is not necessarily passed through local farmers. The pass-through rate is lowest in the poorest countries (IFAD, 2009), indicating that in those countries net producers benefit relatively less from higher food prices compared to other countries.

Another assumption is that consumers do not shift in large scale to alternative agricultural goods. Andreyeva *et al.* (2010) review 160 studies that have estimated cross-price elasticities of agricultural goods and find that none of the elasticities for any of the groups of agricultural goods have a cross-price elasticity higher than 1. This means that a 1% increase in price results in a smaller than 1% shift away from the product, which would mean (with a 100% pass-through rate) that net producers are better off with higher food prices.

To conclude, the effect of high food prices depends on whether you are a net producer or a net consumer of foodstuffs. Net consumers have limited coping mechanisms, and as a result can be permanently negatively impacted by high food prices. Net producers, on the other hand, benefit from high prices. Therefore, as a result of high food prices, the terms of trade shift from net consumers to net producers. This shift in terms of trade is most pronounced in developing countries.

3.1.2 Urban – Rural

The second grouping is one between the urban and the rural population. Table 4 shows the share of households that are net producer in nine countries. On average, a minority of the total population is a net producer in these countries. Only looking at the rural households, on average 32% is a net producer and this figure increases with the share of the rural population compared to the total population. The urban population that is a net producer of foodstuffs is much lower compared to the rural population. Therefore, just looking at the shares of net producer and net consumer, a price increase of agricultural commodities would translate into a terms of trade shift towards the rural households, as explained in the previous section.

Table 4: Net sellers as percentage of population

Country	Percentage rural	Percentage of households that are net producers

	population	Urban	Rural	All
Ethiopia	51%	6%	27%	23%
Zambia	48%	3%	30%	19%
Cambodia	60%	15%	44%	40%
Bangladesh	80%	4%	23%	19%
Vietnam	71%	7%	48%	38%
Madagascar	76%	13%	38%	32%
Nicaragua	44%	4%	39%	17%
Bolivia	42%	1%	25%	10%
Peru	36%	3%	15%	7%
Average	**56%**	**6%**	**32%**	**23%**

Source: adopted from Aksoy and Dikmelik (2008)

If the 32% of the rural population that is net producer are those households with large farms and high incomes, it would mean that the negative impact of a price increase in the rural areas would fall on the poor (which would be net consumers), whereas the richer rural households (net producers) would benefit from the increase. Aksoy and Dikmelik (2008) find that the net producers of foodstuffs are found quite evenly throughout the income distribution. Therefore, both the negative and positive impacts of high prices are not concentrated in either the lower or higher regions of the income distribution in rural areas.

Apart from a larger share being net producer in rural areas, the consumption pattern of net consumers in rural areas is different compared to net consumers in urban areas. Ruel *et al.* (2009) find that net consumers in rural areas often have some form of agriculture and therefore buy a smaller share of their food intake compared to the urban net consumers. Romanik (2008) further investigates this and estimates that in Sub-Saharan Africa 90% of the consumed food is purchased in urban areas, but that this figure is 30% for rural areas. Box 4 elaborates on this difference between urban and rural areas using a case study of Malawi.

Box 4: Urban-Rural divide in Malawi

Malawi is one of the poorest countries in Sub-Saharan Africa and has many difficulties in promoting food security with its population. The migration rate from rural areas to the cities is approximately 7% per year, one of the largest rates of urbanization measured globally. This brings many rural poor to cities, which increases the food security problem as the urban are less likely to be net producers of foodstuffs. Apart from that, the authors also find that the urban net consumers buy a larger share of their total food consumption compared to the rural net consumers.

Another important effect that distinguishes between the urban and the rural population is a longer-term effect and works through the labor market. High food prices shift the terms of trade in favor of rural areas, which increases the wages in rural areas. If rural wages increase due to higher food prices, the effect of the higher food prices for rural net consumers would be partly offset by their higher wages. This poverty mitigating effect of high food prices through the labor market holds for those countries that have a relatively modern agricultural sector (Ferreira *et al.*, 2013). In those countries, most of the individuals active on the rural labor market use wage contracts rather than producing crops to sell on their own account. Ferreira *et al.* (2013) argue that without contracts, the income in rural areas would not go up as significantly in reaction to higher food prices. In Box 5 the wage effects after increases in food prices are elaborated on using a case study of Brazil.

Box 5: Wage effects after food price increases in Brazil

Brazil is a large producer and exporter of food and therefore rising prices should, on the aggregate, benefit the country. The agricultural production system of Brazil is predominantly based on wage contracts, and therefore just focusing on the short-term effects of rising food prices on real wages would overestimate the negative effect on poor farmers. By only taking the short-term change in real income into account after the increase in prices in 2008, the extreme poverty

Another longer-term effect of high food prices which is beneficial for the rural population is that investments in the agricultural production systems become more attractive (Abbott, 2009). Higher international prices translate into higher import-parity prices and thus agricultural systems which are not competitive at lower international food prices could become competitive, shifting the food production domestically. This would benefit the rural population. Whether high prices translate into investments in the domestic agricultural system depend on the supply responsiveness of the country; how fast can the domestic agricultural system adapt to higher prices. Kamgnia (2011) investigates the supply responsiveness and finds that in her sample countries which are already net exporters of agricultural commodities increase their agricultural output faster as response to increases in prices compared to countries that are net importers. Nevertheless, net importers do respond to higher prices, albeit slower. Box 6 elaborates on rice production in Africa as response to higher international rice prices.

Box 6: Rice production in Africa

Out of the 39 African countries that consume rice, 29 are heavy importers with self-sufficiency ratios between 0% and 62.8%. Demand for rice in will continue to increase, mainly because of increasing rates of urbanization.

High global rice prices have influenced the domestic resource cost (DRC) in Africa. The DRC is the ratio of the total cost of importing rice over the total cost of producing rice locally. In a sample of five countries (Benin, Guinea, Mali, Nigeria and Senegal), the DRC was less than unity, meaning that it is cheaper to produce locally than to import. African countries have the potential to produce a large share of their rice domestically, and high international prices provide incentives to invest

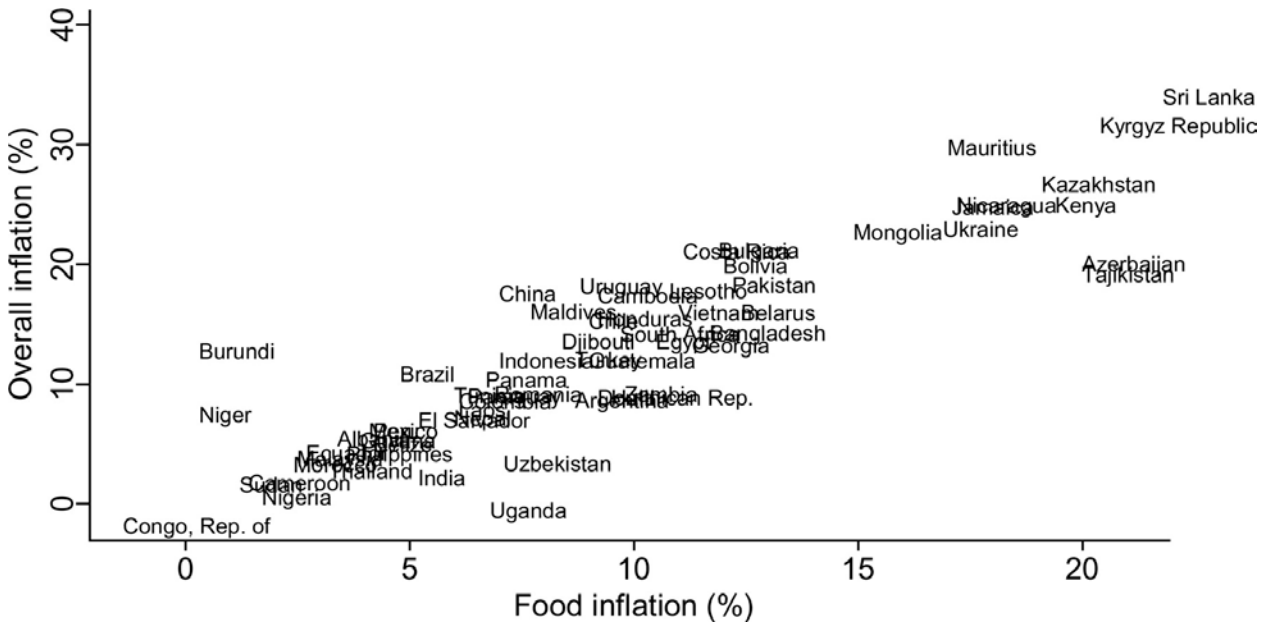
To conclude, the share of the population that is net producer of foodstuffs is larger in rural areas compared to urban areas. The share of food intake that is purchased is lower in rural areas compared to urban areas. Therefore, high food prices likely shift the terms of trade in favor of rural areas. This is likely to stimulate investments and

increase wages, which can be growth enhancing. Consequently, rural poverty will likely decrease as it is closely linked to growth (Irz, Lin, Thirtle, & Wiggins, 2001). Thus, the terms of trade shift in favor of the rural population.

3.1.3 Macroeconomic Impacts

I will now investigate the impact of high food prices from a macroeconomic perspective. When the consumption of food is a large share of overall consumption, higher food prices could lead to higher inflation. Especially in developing countries the consumption of food is a large share in overall consumption, making inflationary pressures due to high food prices especially relevant for these countries. Higher food prices do not necessarily have to correspond to inflation, due to factors such as a weaker dollar, domestic infrastructure changes and monetary policy (Kamgnia, 2011). Regarding the latter, the government could curb total inflation by following a contracting monetary policy. However, the downside of lowering inflation through such a policy is that it also is growth dampening. In Figure 7 a scatterplot between food inflation and overall inflation is given. The estimated correlation coefficient between food inflation and overall inflation is 0.89, indicating that the possible mitigating factors between high food prices and high overall inflation are either not very effective or not very often used. The inflationary pressure introduced by food prices is likely to hinder future growth by increasing uncertainty and distorting economic planning, especially in developing countries (Kamgnia, 2011).

Figure 7: Scatterplot of food inflation to overall inflation



Source: Kamgnia (2011)

Next to inflation, the balance of payments is also affected by high food prices. High food prices lead to changes in the current accounts, as the value of food imports or exports increase. For a net importing country, the larger value of imports requires additional foreign currency for paying for the imports. This leads to a relative increase in demand for foreign currency and an increase in supply of domestic currency, causing a downward pressure on the exchange rate of the importing country. This further increases the cost of imports. Countries that are net exporters of agricultural commodities will see the reverse: a larger current account surplus and subsequently an upward pressure on the exchange rates. Some major importing countries have large foreign exchange reserves due to oil exports (such as the OPEC countries or Russia) or because of large non-oil trade surpluses (such as China and Japan). These countries have a less significant pressure on their current account and exchange rate as result of rising food prices compared to countries without large foreign exchange reserves (Trostle, 2008). Low income food importing countries generally have very low foreign

exchange reserves. The pressures on the current account are highest for these countries (Wiggins, Compton, & Keats, 2010). The foreign exchange shortage can be a growth constraint as the goods and services necessary for development need to be imported (requiring foreign exchange). Higher food prices leave less room to import these other goods. Exporting countries, on the other hand, will build up foreign exchange reserves. These reserves can then be used to import raw materials and equipment to stimulate growth (Moreira, 2005).

Finally, high food prices can have large impacts on fiscal accounts. Wodon and Zaman (2009) find that approximately half of the 120 countries in a global survey introduce or extend subsidies on agricultural products as a response to increasing food prices. They find that especially in low income countries these responses had large fiscal pressures on the government and tended to crowd out government investment on other social programs. Other fiscal reactions are to cut tariffs or lower tax revenues on foodstuffs so that consumers are partly protected from the increase in food prices (Abbott, 2009). The significance of fiscal pressures is shown by the USD 1.2 billion Global Food Crisis Response Program launched by the World Bank in 2008, which was partly designed to give countries more "fiscal space." For food exporting countries with an agricultural policy in place that promises a specified price for agricultural products to farmers, high food prices would provide some fiscal relief.

In Box 7 Eritrea is used as an example to illustrate the various macroeconomic impacts of high food prices.

Box 7: Food price increases in Eritrea

Eritrea's GDP per capita in PPP terms is USD 800, one of the lowest in the world. The country does not export oil and has very limited exports of foodstuffs, making it dependent on agricultural imports.

Inflation was 9% in 2006, but skyrocketed to 30% in 2008, in large part due to food price inflation. Next to that, as there are no offsetting trade gains from high food prices, the impact of the 2008 food price increase on the balance of payments was severe. It has been estimated that the impact of high food and oil prices impacted the balance of payment in the order of 8.5% of GDP. The impact of high food prices

To conclude, high food prices can lead to significant inflation when food consumption represents a large share of the total consumption pattern and monetary policy is not or cannot be used to curb the inflationary pressures. Food importing nations face current account pressures, which for low income countries can be translated in downward exchange rate pressure due to limited foreign exchange reserves. Food exporting nations on the other hand receive additional foreign currency due to high prices and have an upward pressure on their exchange rates. High food prices can result in fiscal pressure when governments try to keep domestic prices in control through lower tariffs, lower taxes or increased subsidies. Thus, high food prices tend to shift the terms of trade in favor of food exporting nations. Moreover, food importing developing countries are particularly prone to macroeconomic problems as a result of high food prices.

The above shows theoretical arguments why low income food importing nations are the most vulnerable nations. Agricultural trade data shows that these nations are not the exception, but rather the rule. Trade flows have increased over the last decades as a result of increased specialization and lower barriers to trade (Aksoy & Ng, 2010). In Table 6 net food importers are shown grouped by region. Sub-Saharan Africa in terms

of number of countries is the largest net food importing region, whereas Latin America has the largest number of countries that are net food exporting.

Table 6: Net food importers and exporters by region

Region	Time period: 2005-2009		
	Net Food Importing	Net Food Exporting	Total
East Asia & Pacific	14	6	20
South Asia	7	1	8
Latin America & Caribbean	22	8	30
Europe & Central Asia	13	7	20
Middle East & North Africa	12	-	12
Sub-Saharan Africa	43	3	46
Total	111	25	136

Source: adopted from Valdes and Foster (2012)

Another grouping of net food importers and exporters is made in Table 7. Most of the net food importing countries are located in middle income countries. In percentage terms of the total number of countries in the income group most of the net food importing countries are in low-income countries. This is in contrast to the 1980s, where most of the developing nations were net exporters. This transformation is due to a decline of traditional products, such as bananas and tropical beverages combined with an increase in cereal imports. The trend of increased agicultural imports by developing nations is expected to continue at least until 2030s. (Sarris, Conforti, & Prakash, 2010)

Table 7: Net food importers and exporters by country classification

Country Classification	Food Trade		
	Net Food Importing	Net Food Exporting	Total
Industrial Countries	20 (61%)	13 (39%)	33 (100%)
Middle-Income	69 (66%)	36 (34%)	105 (100%)
Low-Income	42 (72%)	16 (28%)	58 (100%)
World Total	131 (67%)	65 (33%)	196 (100%)

Source: adopted from Aksoy & Ng (2010)

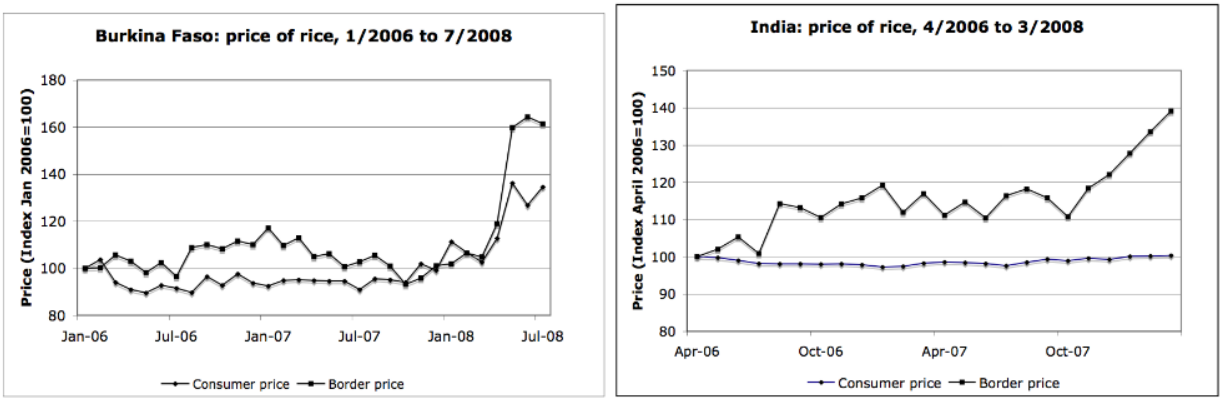
Next to that, the net importing industrial countries on average have a much smaller share of agricultural imports to total imports. Therefore, they are less prone to the macroeconomic problems associated with high food prices compared to lower income countries that are net food importers (Aksoy & Ng, 2010). Thus, the negative macroeconomic impacts of high food prices that are associated with net food importing countries are often most severe in developing nations. Moreover, industrial countries are on average less likely to be a net food importer. Therefore, in general, high food prices shift the terms of trade in favor of industrial countries.

3.1.4 Global Aggregate Impact

High food prices create winners and losers and therefore investigating the aggregate impacts of high agricultural prices requires analyzing the various shifts in terms of trade and macroeconomic impacts from global perspective.

Janvry and Sadoulet (2008) argue that some countries have been better able to shelter the domestic market, through for example fiscal policy, from the increase in food prices compared to other countries. For example, Figure 8 shows the difference in the pass-through of international prices to domestic prices for Burkina Faso and India. Burkina Faso is more vulnerable to food price increases compared to India. Cranfield & Haq (2010) find that pass-through rates are highest for poorer countries, whereas more developed countries can better shield their domestic market from price increases. Janvry and Sadoulet (2008) classify vulnerable countries as those that (1) have a high food import dependency, (2) have a share of food imports to total imports, and (3) are low or middle income countries. They introduce the last criteria because low GDP per capita often implies limited policy, fiscal and administrative capacity to respond to increasing food prices.

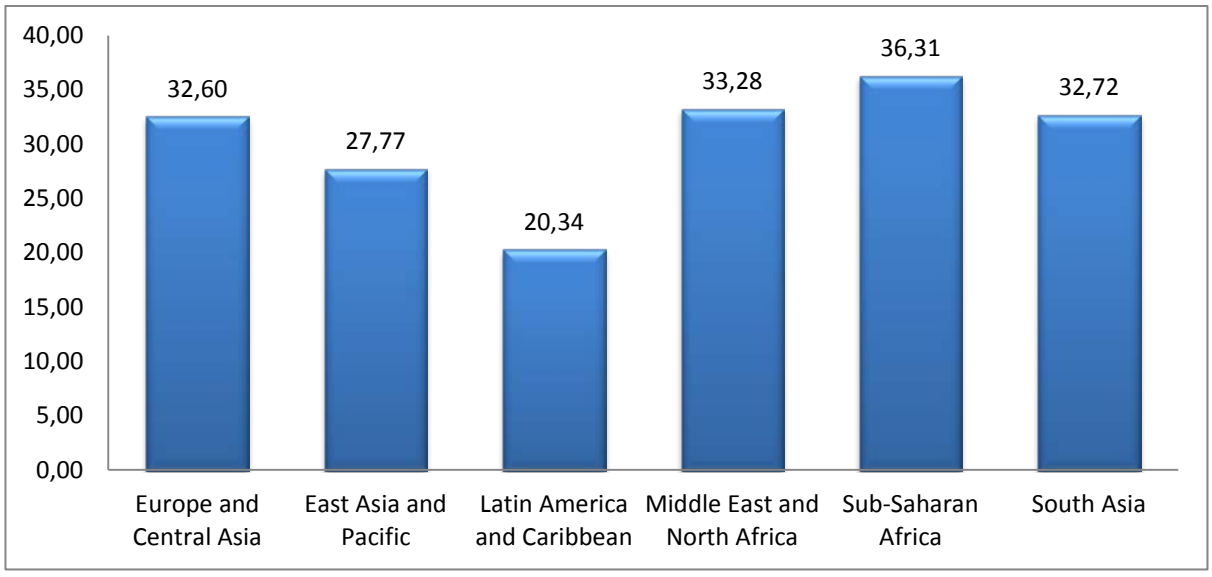
Figure 8: Price transmission in Burkina Faso and India



Source: Janvry and Sadoulet (2008)

Kamgnia (2011) uses the above three characteristics of vulnerable countries to create a vulnerability index. Figure 9 shows the average vulnerability index score for various regions, where a higher score indicates a higher vulnerability. Looking at individual countries, she finds that 14 out of the 22 most vulnerable countries are Sub-Saharan African countries.

Figure 9: Vulnerability index scores by region



Source: adopted from Kamgnia (2011)

Importantly, the vulnerability index leaves out those countries with high incomes or countries that are net food exporters. Arguably, the negative effects of high food prices on vulnerable countries could be offset by gains in other countries. Cranfield & Haq (2010) estimate global welfare effects of increasing food prices. They estimate the per capita compensating variation for low, lower-middle, upper-middle and high income countries. The compensating variation is the amount of additional money a household would need to reach its initial utility after a price change. They find that on average the compensating variation is positive throughout all income cohorts, indicating that the per capita welfare losses are larger than the welfare gains, regardless of country income group. Next to that, they find that the compensating variation is relatively larger in low income countries compared to high income countries, providing evidence that on a per capita level low income countries have larger welfare losses compared to high income countries. Valenzuela *et al.* (2008), using a general equilibrium model investigating the effects of agricultural policies in industrial nations, find that the welfare losses of high food prices for low income countries are more than double compared to the welfare losses in high income countries. Again, the overall welfare impact for both developed and developing countries is negative. These studies suggest that high food prices shift the welfare distribution towards high income countries, but that on average all countries, regardless of income group, are faced with welfare losses as a result of high food prices.

Focusing on the most vulnerable countries, low-income countries, various studies have assessed the effect of high food prices on poverty. Ivanic and Martin (2011) investigate the effect of the 2008 food price increases on developing countries. Table 8 shows that in the both in low and middle income countries, 0.4% of the total amount of population

escapes extreme poverty as a result of the food price increases. However, the share of people that gets caught in extreme poverty is higher in low income countries (1.5%) compared to middle income countries (1.2%). This indicates that, in terms of poverty headcount ratio, low income countries are hit harder by high food prices compared to middle income countries.

Table 8: Changes in extreme poverty headcount as percentage of total population

	Escaping poverty	Entering poverty	Total change
Low Income Countries	-0.4	1.5	1.1
Middle Income Countries	-0.4	1.2	0.7

Source: adopted from Ivanic & Martin (2011)

de Hoyos and Medvedev (2011) review the above results and include second order effects, such as the labor market effects discussed earlier, in their model. After including these second-order effects they find that some of the movement into poverty is mitigated. However, they also find that the largest impact of high food prices is in low income countries.

To conclude, from an aggregate global perspective high food prices introduce welfare losses. Low income countries are particularly vulnerable to high food prices as they usually are more dependent on food imports and have fewer coping mechanisms. High prices move more households in these countries into poverty than out of poverty, and the poverty impact is more severe for countries with the lowest GDP per capita.

3.2 Volatile Food Prices

In this section I will investigate the impact increased price volatility. I will assess the impacts on the household level as well as on the macroeconomic level.

On the household level I will first distinguish between consumers and producers of agricultural goods. Short-term price volatility for consumers could potentially have

long-term consequences. Temporary price increases can lead to households having to draw down on their assets. For rural net consumers this could for example be a distress sale of their livestock or land if they need to increase their current income to meet their food requirements. Drawing down on assets now reduces the ability to cope with future crises and will reflect in poorer future productivity (von Braun & Tadesse, 2012). Urban net consumers often do not have a livestock or land to sell and could be forced to take on debt that is difficult to repay. Other examples of coping mechanisms to temporary shocks are also those described earlier: removing children from school or reducing nutritional intake.

The responsiveness of net consumers to change their consumption pattern or to engage in other coping mechanisms depends on income. Strauss and Thomas (1990) find that in Brazil the lowest income decile has an income elasticity of caloric intake of 0.26 (meaning that a 1% decrease in income leads to a 0.26% decrease in caloric intake), but that the income elasticity of calories for the richest decile only is 0.03. Thus, volatility affects the poorest more significantly compared to the richer households. Further evidence for this is given by Rapsomanikis and Sarris (2006), who find that poorer households experience larger variation in their income after food price shocks compared to richer households. This pattern is due to the fact that poorer households spend a larger fraction of their income on foodstuffs, and therefore are more susceptible to food price shocks compared to richer households.

For net producers volatility has negative consequences as well. Price swings do not affect the net producers much in terms of nutritional intake, as they could always consume their own harvest. However, volatile prices are detrimental for net producers as they risk losing their current investments when prices fall during the period of time that the producers are locked into investment strategies that require higher prices for the net producers to benefit (FAO & OECD, 2011). One example is farmers that invested

capital in seeds and already have planted their crops. These net producers might not be able to get access to finance in the next harvesting season as they still are required to repay their previous loan. Therefore, excess volatility might result in investment strategies by farmers that are very risk-averse and not optimal from a welfare perspective. Furthermore, short-term volatility dos not provide an option for net producers to increase their output to benefit, as the price spikes are too short lived for farmers to react with increased output (Ivanic & Martin, 2011). Some coping mechanisms are being developed for farmers, as elaborated on in Box 8, but they are rather the exception than the rule.

Moreover, through agricultural price volatility the income of net producers is more volatile as well. This limits their access to credit, which in turn limits the adaptation of innovations that could increase the responsiveness of the net producers to rising prices (Ackello-Ogutu, 2011).

Box 8: Warehouse Receipt Systems in Tanzania

Warehouse receipt systems (WRS) are systems in which a farmer deposits its produce at a warehouse and receives a receipt in return. The farmer can then wait with selling their produce until they deem the market conditions favorable. This reduces the risk of price volatility of the farmer, where at the same time the post-harvest losses are reduced because the warehouse typically is of higher standards than the farmer's storing facilities.
The effects of a WRS project in Tanzania, funded by the Common Fund for Commodities, in the coffee value chain were very positive. After the introduction of the WRS, access to finance for farmers increased, the quality of coffee increased and income for farmers and intermediaries increased as well. More importantly, farmers were able to wait for global coffee prices to be at a specific level before

At the macroeconomic level there are negative effects of increased volatility as well. Increased volatility in prices will lead to volatility in the balance of payments. As discussed earlier, agricultural imports of food importing low income countries

generally represent a large share of total imports. Moreover, these countries have relatively small foreign exchange reserves. Thus, volatile prices can translate into more volatile exchange rates, in particular for low income food importing countries (Gilbert & Morgan, 2010). For exporting countries there are negative effects as well, as volatility in the balance of payments tends to diminish GDP growth rates (Combes & Guillaumont, 2002). Collier and Dehn (2001) also find that trade shocks (both imports and exports) significantly reduce growth rates. Finally, food price volatility can also translate into volatility in government expenditure. This could result in governments having more difficulties managing their investments as uncertainty increases. This higher uncertainty will cause lower investments by the government, as Ramey and Ramey (1995) have shown. This in turn will lead to lower long-term growth of the country.

To conclude, high price volatility in agricultural goods leads to negative impacts on the household level. The negative impacts are felt by both net producers and net consumers of foodstuffs. Moreover, poorer households are particularly affected by food price volatility. On a macroeconomic level, price volatility has negative impacts as well. Pressure on trade balances and fiscal accounts have a dampening effect on growth rates. Therefore, on the aggregate, increases in agricultural price volatility are welfare reducing.

4 Agricultural Pricing Fundamentals

In the previous section I have established that increased food prices and volatilities have profound effects on both countries and individuals. In this section I will investigate how agricultural commodities are priced. Foodstuffs are goods, and therefore the price discovery mechanism should follow the standard demand and supply pricing process. In the next sections, I will go over the demand, supply and other factors and outline how they influence price levels and volatilities.

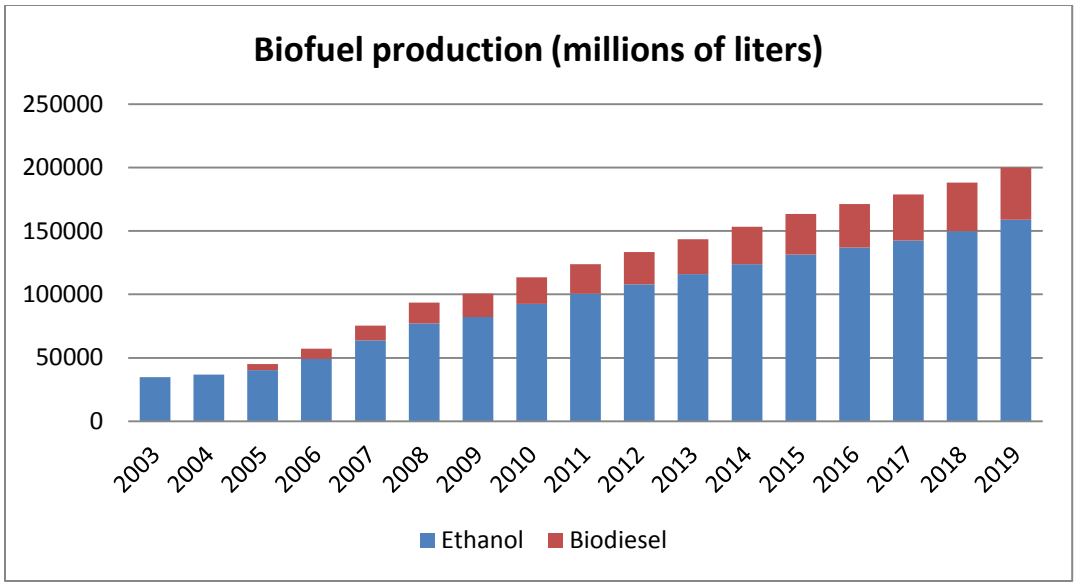
4.1 Demand and Supply Factors

There are several **demand factors** that have caused prices for foodstuffs to increase over the last decades. In large part this is due to an increasing world population. According to the UN (2010), world population will increase from 7 billion in 2000 to 9 billion in 2050, with the largest increase located in emerging economies. This will put an upward pressure on the demand for food, which in turn will put an upward pressure on prices.

Apart from a growing population, diets are also shifting towards foods that are more crop-intensive to produce. This dietary shift is due to urbanization and an increase in average world income (Helbling & Roache, 2011). It is estimated that the effect of the growing population and the dietary shift combined will require that in 2050 the world food production will need to be increased by 70% (Sample, 2007). As with the population growth, the increase in demand due to a dietary shift will put an upward pressure on agricultural commodities.

Finally, the increased use of biofuels is an important demand driver for agricultural goods. Biofuel demand has rapidly increased and is projected to continue along this growth path, as seen from Figure 10. It competes with traditional crops grown for consumption, and biofuel subsidy programs have caused demand for agricultural commodities, in particular for maize and sugarcane, to grow rapidly over the last years. An indirect effect is that the incentivizing effect to stimulate biofuel use has shifted land previously used for other crops towards crops that can be processed into bioethanol, lowering the supply of crops previously grown for consumption (FAO, 2011). Rosegrant (2008) estimates that the price for maize might drop by as much as 21% if a ban on bioethanol were to be introduced. Cassava prices would decrease 19%, sugar with 12% and wheat with 11%.

Figure 10: Actual and projected biofuel production in millions of liters

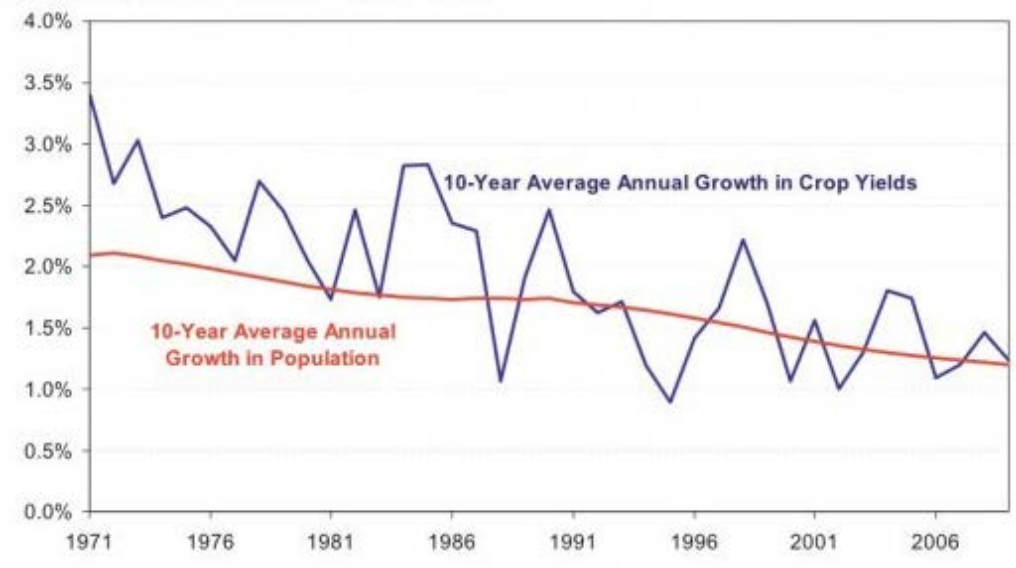


Source: OECD & FAO (2011)

There are various **supply factors** that influence the price levels of food commodities. When looking at the basics of supply, the total supply of foodstuffs is the average yield multiplied by the acreage on which food is produced.

Average yields have been increasing over the last 40 years, but at a decreasing rate. This increase in yields is due to technological advancements throughout the whole value chain, from improved fertilizers to better storage capacity. In the 1970s, yield growth was much higher than population growth. However, in recent years the average annual yield growth of crops has been declining more rapidly than the average population growth (see Figure 11). This has introduced relatively more scarcity on the market, which increases prices.

Figure 11: Average growth in crop yields and population growth



Source: BusinessInsider.com (2012)

A factor that influences both the average yields and the amount of land that can be produced on is climate change. Although the effect of climate change on yields differs per region, the net effect is negative. Climate change also has an effect on the total amount of land that can be used for agricultural production. The effect on the amount of land is negative, due to for example floods or desertification. Both these effects - lower yields and less arable land - increase prices (Helbling & Roache, 2011)

Another supply factor is the price of oil, on which the prices of inputs for agriculture are dependent, such as fertilizers. When the cost of production increases, supply decreases which in turn increases the price of the goods. Another link between oil prices and the price of agricultural commodities is through transportation costs (Mitchell, 2008). Moreover, an increase in oil price could result in the production of biofuels becoming profitable, as the cross-price elasticity of oil and biofuel is positive. This would further increase demand for agricultural products, driving prices up (FAO & OECD, 2011).

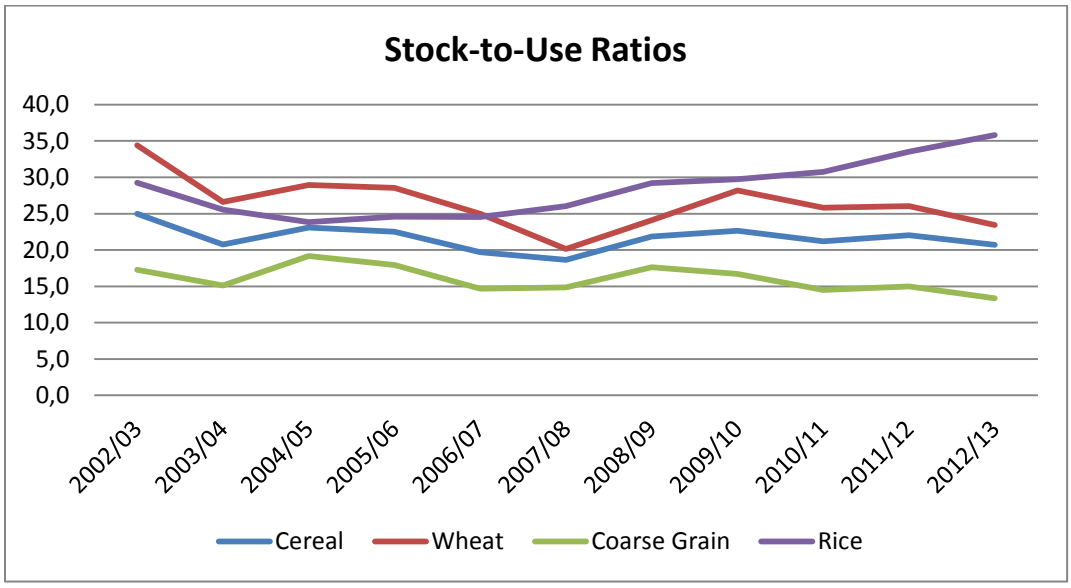
To conclude, the demand for foodstuffs is increasing at a pace that is higher than the increase in supply can cater to. This will lead to increased price levels of these goods.

The previous paragraphs have focused on the price levels of agricultural commodities. However, volatility of prices is also (partly) determined by the fundamental supply and demand factors, but rather by the interplay of these factors.

The increasing demand and lagging supply results in a decreasing stock-to-use ratio of food commodities. A lower reserve of food means that there is a smaller buffer to react to market shocks, which increases the volatility of the price. In

Figure 12 the stock-to-use ratios for some of the main crops is depicted. Cereal, wheat and coarse grains are all experiencing declines in their stock-to-use ratios. Contrary to that, rice sees an increasing stock-to-use ratio. This can be explained because of higher stocks in China, but also because policy shifts by the Thai governments that divert rice away from the market into stocks (FAO, 2013).

Figure 12: Stock-to-use ratios for selected agricultural commodities



Source: FAOStat data and own calculations

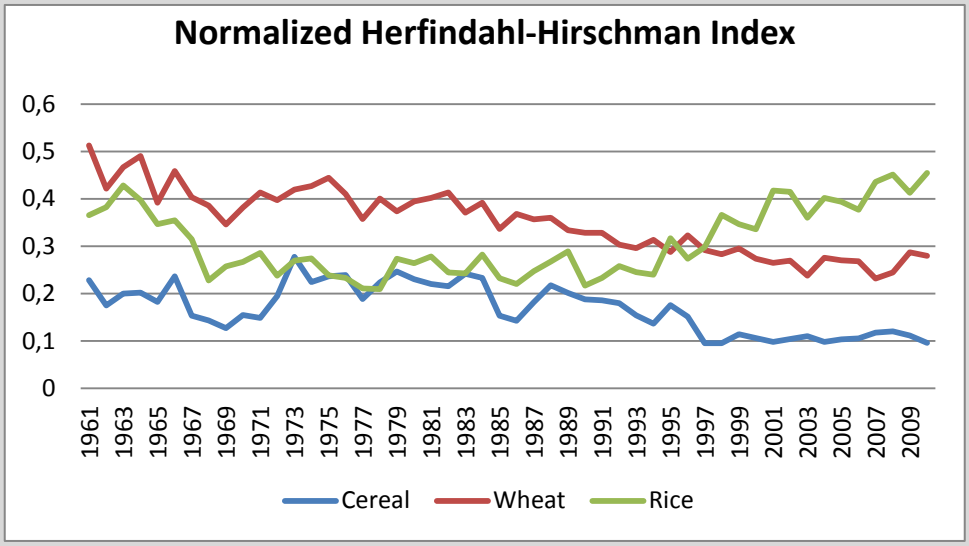
Next to decreasing global stocks, the food supply chain is experiencing a period of increased interconnectedness (Anderson, 2010). The production of specific types of crops is becoming more focused on specific regions that then export to the rest of the world (see Box 9 for a more detailed perspective on this). This concentration of production leads to increased variability, as local shocks have global implications. This is especially true because specialization occurs in those regions that are potentially more

fragile. Yields in these regions are less stable and supply is more variable compared to other parts of the world, further adding to the variability (FAO, 2013).

Box 9: Hirfindahl-Hirschman Index

In Figure 13 the normalized Herfindahl-Hirschman indexes (HHI) for three commodities shown. The HHI measures concentration in a market, where a lower HHI means that the market is less concentrated.
The graph, apart from rice, seems to contradict the belief that markets are becoming increasingly concentrated. However, the HHI that I have calculated might not be representative for two main reasons: (1) I have used regional data rather than country based data, and (2) the cereal and wheat market are aggregates of many products. Both points could show a declining HHI that actually mask an increasing production concentration within regions in a specific sub-group of cereals or wheat.

Figure 13: Normalized Herfindahl-Hirschman Index for selected commodities



Source: FAOStat data and own calculations

Apart from the concentration on the production side, there is a trend of increased concentration on the food retailers' side as well, with fewer firms handling more of the

global food supply (Konig, 2009). An effect analyzed by Konig (2009) is that large foreign-owned food retailers often burden smaller local food producers in developing countries, due to a lack of bargaining power of these small local food producers. As a consequence, governments of developing countries that are concerned with their local smallholder farms have increased protectionist measures, directly influencing the price and volatility of the foodstuffs.

Finally, many of the same factors that influence the increased demand for agricultural goods (population growth, increases in wealth, dietary shifts, urbanization and the demand for biofuels), also increase the pressure on other resources, such as land or water. The constraints on the supply of these resources are more locally than globally determined and there is a growing concern about the resulting increased uncertainty in the agricultural production of goods. This increased uncertainty leads to higher prices and volatilities (FAO & OECD, 2011).

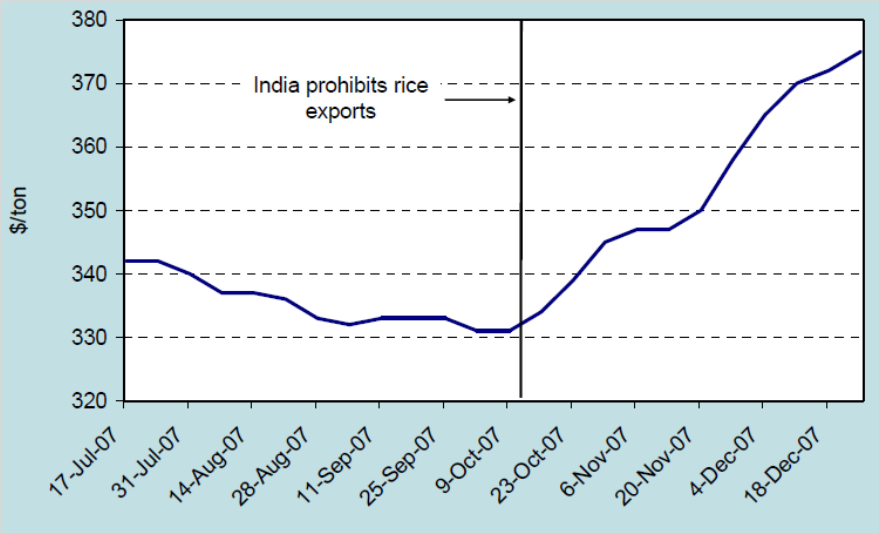
4.2 Other Factors

There are other factors that also influence prices with food commodities, apart from the demand and supply factors. One very important force that influences the price setting process of food commodities is regulation. In Box 10 an example of the Indian rice regulation is given. Governments tend to react with unilateral regulatory changes, such as the Indian rice regulation, to global price changes. For each country individually, this is rational. However, on a global level, additional instabilities are created which increase price levels and volatilities (von Braun & Tadesse, 2012).

Box 10: Indian rice regulation

In 2007, the Indian government decided to prohibit rice exports. India did so because non-rice food commodities were rising and it wanted to keep the overall domestic food prices down by forcing the domestic rice price to a low level. This had profound effects on the world rice price, as illustrated in Figure 14. With the government intervening in the agricultural market, both agricultural prices and volatilities increased.

Figure 14: Price development of rice before and after India prohibits rice exports



Source: Gilbert (2011)

Another market factor that influences the price of food commodities are currency movements. As virtually all trading of commodities is done in USD, currency movements greatly influence the local price paid for food commodities. A depreciation of the USD lowers import prices for food commodities which increases local demand (Food Price Watch, 2012). The increase in prices for agricultural goods in 2008 was partly mitigated by a depreciating USD due to the financial crisis. Variability of agricultural prices is influenced by currency movements as well, as price fluctuations

on the foreign currency markets have a large effect on prices on the agricultural markets (FAO, 2011).

A final market factor that has gathered a lot of attention is speculation, which will be discussed in the next section.

5 Agricultural Speculation

Some authors have argued that changes in fundamental factors and trade policies cannot fully account for the upward trend in agricultural prices and the increased levels of volatilities, and that therefore speculation must be the driver of the residual price movements (Ghosh, 2011) (von Braun & Torero, 2008). However, the professional and academic debate on this matter is not settled and in this section I will provide an overview of that debate by means of a review of the existing literature and existing empirical studies.

According to the U.S. Commodity Futures Trading Commission (CFTC), a speculator can be defined as follows: *"in commodity futures, a trader who does not hedge, but who trades with the objective of achieving profits through the successful anticipation of price movements."* This is different to a hedger, which the CFTC defines as *"a trader who enters into a position in a futures market opposite to a position held in the cash market to minimize the risk of financial loss from an adverse price change; or who purchases or sells futures as a temporary substitute for a cash transaction that will occur later*" (CFTC, 2012). Thus, a speculator is attracted to the market by profits, whereas a hedger has a business rationale for entering the trading market.

Because speculators are attracted by profits and not the underlying business, they are not interested in the commodities they are trading in. Therefore, they are active in derivate markets that use the agricultural commodities as underlying assets. Almost all

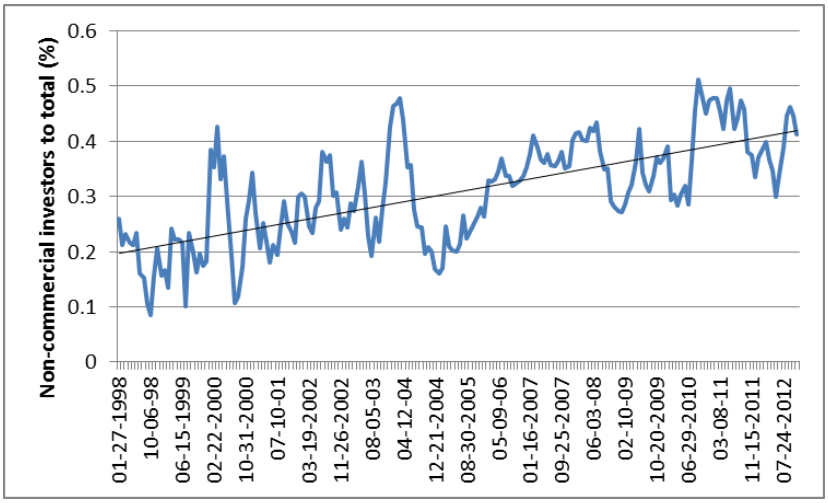
of the speculation on food commodities takes place in the futures market (MiFID, 2012). Futures are agreements to purchase or sell the underlying asset in the future at a price that is determined at initiation of the contract. A speculator can enter into an offsetting contract before the expiration of the original contract, which settles the initial futures contract without the need of a physical settlement of the underlying commodity. That implies that a speculator can be active on the food commodity market while never actually owning the commodity. As futures markets are standardized agreements, they can be traded on electronic exchanges. On these exchanges, the counterparty (the other side of the contract) is the clearinghouse.

The futures market for agricultural commodities was introduced as a way to reduce uncertainty for actors in the agricultural value chain. By going into the short side of a futures contract (the obligation to sell crops), a farmer knows the exact price at which he is able to sell the harvest at a specified time in the future. Intermediaries, by going into the long side of a futures contract, know the exact price of the agricultural inputs they use in their business. To make this futures market work, some speculation is necessary to introduce enough liquidity in the market so that every business participant can enter into the positions they want. Thus, speculators make sure that there always is someone at the other side of the contract.

Speculative activity on the agricultural futures market has increased rapidly over the last 10 years. In monetary terms, Masters (2008) states that assets allocated to commodity indices increased from USD 13 billion at the end of 2003 to USD 260 billion in March 2008. The inflow of capital has continued after that time period. One reason for this continuation is that as a reaction to the subprime housing crisis, the European debt crisis and low interest rates on US treasury bills, money managers have shifted their portfolios towards other, alternative, asset classes, which include agricultural commodities (UNCTAD, 2012).

The CFTC publishes data on the amount of contracts that are settled by commercial investors (hedgers) and non-commercial investors (speculators). I have used this data to graph the ratio of non-commercial investors to the total amount of reportable long positions in futures contracts in Figure 15. There is a strong trend of increasing importance of non-commercial investors. This trend is not only visible in the corn market, but also in the various wheat futures markets and the futures market for soybeans.

Figure 15: Ratio of non-commercial investors of total investors in corn futures



Source: CFTC data and own calculations

At the same time of the inflow of speculative money into the commodity futures market and the growing importance of non-commercial investors, the price of agricultural goods developed as discussed in Chapter 2: the became higher and more volatile. There is a concern that the futures market has moved towards a state of excessive speculation. This concern, combined with the joint development of increased speculation and high and volatile food prices, led many to assume that there is a causal relationship between these developments (for example, Chamberlain (2013), Bawden (2012) and Westerberg (2011). However, correlation need not imply causation and thus further scrutiny is

necessary to investigate the effect of speculation on food price levels and volatilities. In the next two sections I will discuss the arguments made with respect the link between speculation and price levels, and thereafter the link between speculation and volatility.

5.1 Price Levels

I will start with looking at the effect of speculation on price levels using classic finance theory. According to that theory, the introduction of additional speculation on the futures market has two effects on the price levels. First, it results in additional liquidity on the market, which should make the futures market more efficient and reflect more accurately what the fundamental price of the agricultural commodity should be. The second effect has to do with information flows rather than additional liquidity. As there are more participants in the market, information about changes in the fundamentals is dissipated more rapidly throughout the market. Therefore, after a change in fundamentals, prices move more quickly to their natural fundamental level. Both these effects combined lead to the efficient market hypothesis: international prices are what they should be according to their fundamentals.

Opponents of classic finance theory state that the level of speculation is excessive and has moved the agricultural market into a bubble. A first step of analyzing this statement is to define what a bubble is. I use Stiglitz's (1990) definition: *"[I]f the reason that the price is high today is only because investors believe that the selling price is high tomorrow – when 'fundamental' factors do not seem to justify such a price – then a bubble exists."*

The statement of the opponents of classic finance theory is more complex than it initially seems. To understand why it is necessary to make a distinction between futures prices and spot prices. Eventually, what the opponents are concerned about and what leads to the impacts as discussed in Chapter 3 is the spot price. This is the price that is

used for market transactions today. If excessive speculation has caused a bubble in the spot price, two things must hold true:

1. Excessive speculation causes futures prices to increase, and
2. Futures prices influence spot prices

The next two sections will cover the two links in more detail.

5.1.1 Futures Price Bubble

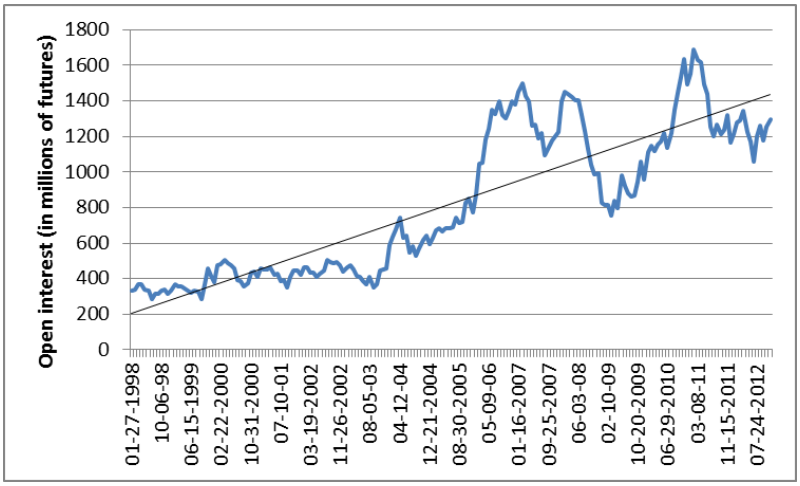
I will first discuss the link between speculation and futures prices. Often, it is simply assumed that a large inflow of speculative money on the futures market leads to higher futures prices. However, the classic theory of increased demand leading to higher prices is not as straightforward as it sounds in futures markets, as futures can be created almost freely. Therefore, an increased demand can be readily met by an increased supply. Next to that, classic finance theory states that for every long position there must be a short position, and therefore futures prices should not change as reaction to increased activity. However, there are some arguments made that allow for a price increase in agricultural futures prices after an inflow of money, which will be discussed in the next paragraphs.

A large share of the increase in speculation on the futures market is due to the increased activity of index funds (FTI, 2011). These funds try to mimic the returns of the underlying market or asset class. Importantly, to mimic these returns without actually holding the asset, these funds can only go long on the futures market (as going short would mean that they would go against the return profile of the underlying market). These funds have caused a very large increase in the activity on the futures market. Using data from the CFTC I calculated that each future, on average, changes hands approximately seven times per week. Unfortunately, the data is not detailed enough to make a breakdown of activity between the long and the short side of the contract.

However, I expect that the total activity on the futures market is dominated by activity on the long side of the contracts.

There is a proxy for increased activity on the long side of the market: the open interest. Open interest is a measure that indicates the amount of contracts which are not settled in the market (there has been no delivery, cash settlement or opposing position in a future). A positive open interest means there are more long compared to short positions, a negative open interest the opposite. Figure 16 shows a strong upward trend in the open interest market, indicating increased activity on the long side. This development does not only hold for the corn market, but also for other futures markets.

Figure 16: Open interest in the corn futures market, 1998 - 2012



Source: CFTC data and own calculations

It is interesting to look at open interest developments in conjunction with price developments. Murphy, in his book Technical Analysis of the Financial Markets (1999), writes that when open interest is increasing in a market of rising prices, it implies that there are "real" buyers. These are market participants that are actively trying to build a portfolio of long positions, and they are willing to pay higher than usual prices in order to do so. The open interest is positively correlated with the price developments in the

agricultural futures markets. Thus, this could indicate that futures prices are increasing because of excessive demand for the long positions only (as proxied by the increasing open interest in the market). That then could indicate a bubble forming because of the inflow of capital and not 'normal' price increases because of the fundamentals.

Implicit in the above argument is that arbitrage on the futures market does not hold anymore. Classic finance theory says that if futures are priced above their equilibrium level, arbitrage would bring the prices on futures down. Arbitragers would do so by selling the futures contract (that obliges them to deliver the underlying asset) and buy the good at the same time. At expiration, they would simply deliver the goods they had bought earlier to close out the position, and earn a risk-free difference between the futures price (which are too high) and the equilibrium futures price. This would eventually drive the futures price down to their equilibrium level. However, some interesting things can be noted with arbitrage theory in relation to food commodities:

- Food perishes eventually, so they cannot be indefinitely stored. This could mean that arbitrage pricing cannot be as efficient as with other assets that do not perish over time
- Actual food inventories are limited to the extent that they are consumed. The entire production of food commodities is traded at a multiple each year. Therefore, settling each futures contract with the underlying asset is simply impossible.

These differences compared to 'normal' underlying assets indicate that it could be possible for futures prices to rise above their equilibrium without an opportunity for arbitragers to drive the price down. This theory would suggest that if there are other commodity markets that do not perish but also have experienced a boom, investors with deep pockets would invest in storage capacity to take benefit of the arbitrage

possibilities. Interestingly, this is a development seen in the market in recent years. Glencore (Reuters, 2011), Goldman Sachs and JP Morgan (Blas, 2010) are all building warehouse facilities to store metals.

Acharya *et al.* (2011), apply the limits to arbitrage theory to commodity markets. They find that excessive demand on the long side in the futures market influences the futures price due to the limited arbitrage possibilities. The same limits to arbitrage argument has been used by Hong and Yogo (2012). They show that futures prices have become less informative about the underlying real economy, which includes spot prices of the commodities. However, empirically the debate has not been settled. One group of studies finds that speculation on the futures market had an impact on the price levels in the futures market (Gilbert C. , 2009; 2010; Einloth, 2009; Tang & Xiong, 2010). On the other side there is another group of empirical studies that do not find this effect (Buyuksahin & Robe, 2010; Stoll & Whaley, 2010; Sanders & Irwin, 2010a; 2010b). The conclusion is that finding a statistical causal relationship between futures activity and futures prices changes with the methodology and data used. Henderson *et al.* use a confidential dataset on Commodity-Linked Notes to construct a model in which they find that the financialization of agricultural commodities caused an upward pressure on futures prices. Furthermore, they find that this upward pressure does not show any signs of returning to the fundamental levels. Singleton (2011) focuses on crude oil, and finds evidence of an economically and statistically significant effect of increased investment flows on futures prices.

Another piece of empirical evidence which hints at the existence of a futures market where arbitrage opportunities cannot be perfectly exploited is presented in a report to the U.S. Senate Permanent Subcommittee on Investigations (Gensler, 2008). The report shows that over the past several years the futures price and the spot price for wheat failed to reach convergence at maturity. This should not happen according to classic

finance theory, as a simple, risk-free, arbitrage opportunity exists when there is no price convergence at maturity. The report finds that the average difference between the Chicago Board of Trade (CBOT) wheat futures price at contract expiration and Toledo spot prices rose from an average of about 5 cents per bushel in 2005 to 47 cents in 2006, narrowed to 24 cents in 2007, but widened again appreciably to $1.07 in 2008.

To conclude, classic finance theory predicts that futures markets cannot experience a bubble as a result of speculative money inflow. However, arguments are made with respect to the character of the inflow (long-only index funds) and the limits to arbitrage in the agricultural commodity market. Empirical evidence is not conclusive on the issue. However, there are several studies which show conclusively that the agricultural futures market is not as efficient as classic finance theory would predict.

5.1.2 Link from Futures to Spot Price

In the previous section I have investigated the arguments made that link the inflow of speculative money on the futures market to higher futures prices. In this section I will investigate the link between the futures price and the spot price.

Classic finance theory disagrees with the direction of this link. The futures price, according to this theory, is calculated from the current spot price with several adjustments. These adjustments deal with the time value of money, the convenience (or inconvenience) of holding the asset, and storage costs. Therefore, causality runs from the spot market to the futures market, and not the other way around. In turn, the spot market price is determined by the fundamentals discussed in Chapter 3, but not speculation. Furthermore, Krugman (2008) writes that it is impossible for speculation on the futures market to influence the spot price, because the speculators never physically own the assets. Therefore, the fundamental factors are not changed, and thus the spot price remains unchanged.

However, there are arguments as to why causality could run from the futures market to the spot market. First, Pindyck (1993) created a model between futures and spot prices using convenience yields (which are time value of money, storage costs and convenience of holding the asset). He argues that the spot price is the present value of future convenience yields. Changes in current and future demand have a direct effect on spot prices, but also change the convenience yields of futures. This in turn has an effect on spot prices as well. However, the link from futures to spot in this model is more a second order effect rather than a direct effect. Hochman *et al.* (2011) investigate the role of inventory adjustments in the spot price setting process and come to similar conclusions as Pindyck (1993): futures prices do influence spot prices, but only through second order effects.

A second argument, related to the inventory adjustments investigated by Hochman, is the behavior of food commodity producers. When they are faced with high futures prices and expect futures prices to increase in further time periods, they rationally do not sell their produce at current market prices. Instead, they choose to increase inventories, effectively reducing the total supply of foodstuffs. This in turn leads to an increase in prices on the spot market. Petzel (2009) investigates this argument, stating that the short side of the futures contracts are those with stocks and they choose to roll-over their short contract to benefit from increasing prices, as keeping commodities in storage profits them. Related to the decreasing stock-to-use argument in Chapter 2, increases in stocks lower supply and increase prices. The fact that they roll-over their short side of the contract as response to the demand of the index funds' continued long positions implies that demand on the futures market is transferred directly to the spot market, even though this demand is synthetic and in theory should not be transferred to inventory levels.

A final argument that links developments on the futures market to developments on the spot market is the theory of expectations. If market participants active on the spot market see futures prices as indicative for future prices developments on the spot market (the futures market changes their expectations), a bubble on the futures market would automatically be transferred to the spot market. This argument is strengthened by looking at details of spot price transactions. Often, contracts that specify buying foodstuffs on the spot market are actually drafted using the futures market price of contracts that are about to expire. This is practice is also visible in the oil market (Kane, 2011).

Empirical evidence for the causal relationship from futures to spot markets is often done by utilizing Granger causality tests. Ghosh (1993) uses this technique to establish that futures prices Granger cause spot prices for equities. Hernandez and Torero (2010) look specifically at agricultural markets and use standard linear Granger causality tests and also nonparametric Granger causality tests. They find that agricultural futures markets generally dominate spot markets. Price changes in futures markets lead price changes in spot markets more often than the reverse, especially when examining returns. However, Granger causality is not causal in the statistical sense of the word, it only shows co-movement. Thus, the developments could be influenced by a third variable, or there might be a rational lag in spot price adjustments.

Other empirical evidence that argues in favor of the link looks at the correlation between spot price movements. One paper shows that the correlation between spot price movements has increased since the inflow of capital on the futures market (Tang & Xiong, 2010). This paper argues that index investors often invest using fixed baskets of different commodities. If there is an effect of speculation on the futures market, it can be expected that the correlations between spot prices increase after increased speculative activity because of these fixed baskets. The authors indeed find that result.

Next to that, they contrast it to developments within China where there is less speculative activity on the commodity market and find that the increase in correlation did not occur there. Again, this does not show strict causality, as the correlation between the increase in correlation between commodities and the influx of speculative money could be because of spurious reasons.

5.1.3 Conclusion

To conclude, classic finance theory states that an inflow of speculative money to the futures market cannot raise average price levels of that futures market. However, several arguments have been made that link speculative money to bubbles in the futures market. Empirical evidence on the topic is not conclusive.

Apart from that, classic finance theory poses that futures markets cannot influence the spot market. It states that the inverse holds true; the spot market influences the futures market. However, there are arguments made that show that a link from the futures market to the spot market could exist. This would mean that bubbles on the futures market are transferred to the spot market. Authors agree that a correlation between increased speculative behavior and price increases is not enough, but the more advanced empirics linking futures to spot is not conclusive.

Both phenomena, if these relationships exist, have a positive feedback loop. If speculative money is attracted to the high prices of agricultural commodities increase the prices of futures, that in turn increase the prices on the spot market, which will attract even more speculative money etc. etc.

5.2 Price Volatility

Speculators are often held responsible for another development on the food commodity market; increased volatility. Increased volatility implicitly assumes that speculators

have some effect on the spot market (as the increased volatility is visible on the spot market). However, it is slightly different than the previous argument of an increase in average prices paid for food commodities. Volatility does not say anything about whether or not there is a change in average price on the spot market, but something about the fluctuations around the average price level.

The main argument used in the debate on increased volatility deals with a specific investment method utilized by speculators: technical analysis. This method entails forecasting future price movements by purely looking at technical indicators, such as ratios or price trends ("the trend is your friend"). It lets go of the fundamentals underlying the assets. When a technical analysis identifies an upward trend, a speculator would take on long positions and "ride the trend". After the upward trend has come to a stop, the long positions are cancelled and the speculator earns a profit.

The concern is that a random event leading to an upward movement in a price may be taken as indicative of a positive trend resulting in buying pressures and with that driving the price further upwards, despite an absence of any fundamental justification. But as positions are unwound after the trend has ended, the price falls again and the average price level is not influenced, but it would increase the volatility of the prices. It has been estimated that approximately 20% - 30% of the speculators active in the futures market use technical trading analysis (Schulmeister, 2012). De Long *et al.* (1990) show that if there are enough speculators that invest on irrational strategies (such as technical analysis rather than fundamental analysis) it is rational for other investors that do not use technical analysis to switch strategy towards one of technical analysis.

Next to the additional volatility introduced by technical analysis, Frenk and Turbeville (2011) analyze the effects that the large share of long-only index funds have on the agricultural spot markets. They statistically exploit the fact that almost all index funds

roll their futures position over between the 5th and the 9th business day of the month. They find that in this 5-day "rolling-over window" the prices on the spot market systematically show an upward bias, which is not based on fundamentals but on the need of the index funds to roll over their positions. This upward price bias reverses after the roll-over period, thus creating additional volatility on the market.

Apart from the effects of investing using technical analysis and long-only index funds, speculative money can have another specific volatility effect. Money invested for speculating purposes on the agricultural futures market is often part of a larger trading firm. In the 2008 commodity price plunge, it has been argued that the fall in equity prices caused margin accounts of investors to shrink (Garner, 2010). As the clearinghouse that write out the futures contracts called the investors that were long in the market on their margin because equity prices were decreasing, they could not deliver the required cash (due to the plunging prices in different markets as well). This resulted in forced liquidations of long positions, pushing the prices down. This is another example of how speculative money can increase volatility in the market.

The academic debate has much more empirical consensus about the effect of the speculative inflow of money on the agricultural futures market compared to the effect on price levels. Examples are by Du *et al.* (2011), Roache (2009), FAO (2011) and Tse and Williams (2011). Finally, Irwin and Holt (2000) provide empirical evidence deriving from confidential CFTC data which indicates that speculation has led to increased volatility.

6 Conclusion & Policy Options

Before discussing policy options regarding regulation on the agricultural futures market, I will first conclude on the previous sections. First, as discussed in Chapter 2, food prices have seen two developments over the last decade: (1) they are higher, and (2) they are more volatile.

In Chapter 3 I analyzed what the impacts are of these two developments of food prices. I analyzed high food prices using several groupings. In assessing the impacts on consumers and producers, I conclude that net producers generally benefit from high food prices. Net consumers are negatively impacted, and this effect is particularly strong in developing countries as net consumers spend a large share of their income on foodstuffs and have limited coping mechanisms. As a result, the terms of trade shift from net consumers towards net producers. In the grouping between the urban and rural population, I conclude that the rural population tends to relatively benefit from high prices due to increased incentives to invest in the agricultural system, labor market effects and the fact that the rural population tends to spend a smaller share of their income on food. Thus, the terms of trade shift towards the rural population. Subsequently, I looked at the macroeconomic impacts of high food prices and find that high food prices negatively affect net importers from a fiscal, balance of payments and inflation perspective. Low income net importers are particularly hit by high food prices. Overall, the impact of high food prices is strongest in developing countries compared to developed countries, not only because most of the poor live in these countries but also because the adverse macroeconomic effects of high food prices are particularly pronounced in these countries. I then continued analyzing the global aggregate effect and find that high food prices are welfare reducing on a global scale. Thus, high food prices are suboptimal, which makes the argument for regulation that can curb high food prices strong.

The second price development I analyzed in Chapter 3 is increased price variability. I find that short-term price variability can have long-term detrimental effects for net consumers, but that net producers are also hurt as they cannot make optimal investment decisions. From a macroeconomic perspective, high price volatility translates into balance of payment volatility and fiscal volatility, especially for developing nations. This leads to reductions in growth rates. Overall, high price volatility is detrimental for everyone in the agricultural value chain and therefore is welfare reducing. Again, this makes the argument for regulation that can curb volatility strong.

In Chapter 4 I analyzed various trends in the fundamental pricing factors of agricultural goods. Increased demand and a food supply which is lagging behind cause prices to increase. Moreover, lower stocks and increased use of national regulation increases volatility. In Chapter 5 I looked at speculation in the agricultural futures market. I argue that there are theoretical arguments that link increased activity on the futures market with higher prices on the futures market. Moreover, I show that there are arguments that link increased prices in the futures market to the spot market. Combining these two arguments show a possible relationship between increased activity by speculators on the futures market with higher spot market prices. Empirical evidence is inconclusive and results depend on the data and econometric techniques used. However, there is empirical evidence showing that the agricultural futures market is not performing as efficiently as classic finance theory would predict. In Chapter 5 I also show the arguments that link increased activity on the futures market to increased volatility on the spot market. Empirical evidence on this matter is much less divided and consensus exists that speculation increases volatility.

Thus, both high and volatile food prices are globally welfare reducing, but especially for the poor in low income countries. If regulation can limit the effect speculation has on

the price level and volatility of agricultural goods, it would be welfare enhancing. Even though the academic and professional debate regarding the impact of speculation on price levels is not settled yet, discussing policy options that limit the impact of speculation is still warranted for at least two reasons. First, if empirical evidence in the future conclusively determines that speculation has an effect on price levels, having discussed policy options before will make the implementation of these changes faster and more thoughtful. Second, having a possibility that speculation purely based on financial motives has such severe real implications for the poorest is a strong argument for introducing regulation.

6.1 Policy Options

There are many policy options mentioned in the literature that are concerned with curbing the effect of high and volatile food prices. However, most of these options are not focused specifically on curbing the effect of speculation on the high and volatile food prices. However, there are some options for regulation discussed in the literature, and fundamentally these options can be grouped in two categories:

- Rules for information and transparency;
- Rules to limit speculative activity

6.1.1 Rules for information and transparency

Frenk and Turbeville (2011) argue that the rolling over of futures contracts by commodity index traders has resulted in higher and more volatile prices of agricultural commodities. The price pressures generated by these traders are seen as credible fundamental price changes by the other market participants, as the funds are not transparent. They continue their analysis that if commodity index traders were to be required to **disclose their roll-over process** to the market, some of the uncertainty about price signals being the result of changing fundamentals or the result of trading activity

would be taken away. This reduced uncertainty in turn would at least lead to lower volatility on the market, and possibly lower prices.

Another policy option that is related to providing more information is creating a **global virtual agricultural reserve**. According to Ghosh (2011), creating a global virtual stock reserve would remove uncertainty in the market, lowering volatility in the futures market and therefore making the futures market less attractive for financial speculation. However the main difficulty is that accurately counting stock levels is difficult, as much of the agricultural stock is held privately.

However, I believe that the impact of increased information and transparency would be limited. First, a large share of speculators are trading using technical analysis; for these trading strategies it would not matter if a price change is due to changes in fundamentals or due to non-fundamental factors. One could theorize that by making more information available about speculation arbitrageurs would be able to reduce the impact of non-fundamental factors on price levels and volatility. However, in Chapter 5 I introduced the limits-to-arbitrage theory, which would apply in this case as well. Even with full information, there are limits to arbitrage and the effect of speculation would likely still persist.

6.1.2 Rules to limit speculative activity

A different direction of policy options is less focused on providing information and more on directly limiting the amount of speculation in the agricultural futures markets.

von Braun and Tadesse (2012) suggest a **transaction tax** on agricultural futures to reduce the amount of speculation. With this proposal each market participant classified as non-commercial hedger would pay a certain tax over each futures transaction. This would reduce the amount of speculation. However, Pavaskar (2008) argues that a transaction tax would drive most speculators out of the market. This would be

troublesome, as discussed in Chapter 5 some speculation is necessary for the futures market to exist at all. The futures market is desirable for those involved in the food value chain as it reduces uncertainty. Therefore, to drive all speculators out of the market would not be welfare increasing. Ghosh (2011) argues that setting a transaction tax low enough would not drive out all speculators. If any type of speculator would be driven out of the market, it would be those that operate on the lowest profit margins, which are the technical analysis traders.

Another method designed to curb excessive speculation is to make **delivery on contracts** or portions of the contract compulsory (von Braun & Torero, 2008). If each future is required to be (partly) settled by the underlying commodity, it would not be possible to be active in the futures market in a pure financial fashion. However, the cost of transport, owning and delivery of the underlying commodity is likely to amount to a higher cost than the transaction tax previously described. This would drive out much of the speculation, possibly stalling the entire futures market.

Clapp and Helleiner (2012) investigate the option of setting **higher margin requirements** for participants in the agricultural futures market. This would, similar to a transaction tax, increase the cost of participating in the agricultural futures market. However, Ghosh (2011) argues that this would place a disproportional burden on smaller market participants, driving them out of the market.

Ghosh (2011) discusses **position limits** in the futures market. This would place a limit on the amount of contracts any market participant is allowed to hold. He argues that this limit should not be put on the non-commercial investors only, as he finds that speculators can easily manipulate in which CFTC grouping they are categorized. The size of the limit should be set so that commercial hedging is still possible, but that the effects of excessive speculating are mitigated. Ghosh (2011) argues that the median of all

positions currently held by all futures market participants could be more effective rather than basing the limit only on the positions of non-commercial investors, precisely because speculators can easily manipulate their CFTC grouping. Limiting the total amount of positions market participants have would reduce speculation in the market. Most importantly, technical analysis traders would not be able to execute their high frequency trading strategies.

From the regulatory options described in this section, position limits and a transaction tax have a best potential to reduce the effect of speculation on agricultural prices. Both reduce the amount of speculation, while they do not have as severe market distorting effects as the other regulatory options described. Some authors have expressed concerns with regard to regulating financial markets. For example, LiPuma and Lee (2004) argue that regulation of the derivate market is impossible because these markets can change location so easily. If one nation decides to adopt regulation, speculators would simply move to another financial center. Clapp and Helleiner (2012) argue that this is not necessarily the case for agricultural futures. These futures markets are very concentrated in the USA, with some specific goods also being traded in the EU. They argue that the USA has a leading role in setting regulation and that the other financial centers are willing to follow the USA in their regulatory process. But more interestingly, the flexibility of the futures market's location could also lead to the implementation of regulation. Farchy (2010) writes about 16 cocoa organizations that threatened to lo move their hedging activities from the EU to the USA. They did so because they demanded regulation on the futures market.

6.1.3 Answering the Research Question

In this thesis I ask the question *"Are food price volatilities and price levels affected by speculation and can regulation reduce those effects?"* With respect to the first part of the question, I can conclude that price volatilities are affected by speculation and that price

levels could be affected by speculation. There is a strong argument for regulation on the agricultural futures market, because high and volatile food prices are globally welfare reducing. From the two groups of policy options – (1) rules for information and transparency, and (2) rules to limit speculative activity –, the second group is more promising to limit the effects of speculative activity. More specifically, position limits and a transaction tax have the largest potential to reduce the effects of speculative activity.

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