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Price volatility on the German Agricultural Markets

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Abstract

In this contribution, the development of price volatility on German agricultural markets is analyzed. We quantify the degree of price volatility for selected German agricultural markets and determine how it evolves over time and search for policy driven structural changes in volatility levels measured by the historical volatility. Based on annualised historical volatilities t-test were performed to identify if the change in the volatility levels show any relationship to the process of reform of the CAP. An increase in volatility could be identified for the main German markets regulated by the Common Market Organisations. A positive relationship among the reform process of the CAP and the changes of the volatility levels could be identified particularly for the cereals markets.

Keywords: volatility, German agricultural markets, agricultural policy

JEL classification: Q11, Q13, Q18.

1. INTRODUCTION

During the last decades the Common Agricultural Policy (CAP) was repeatedly amended. The main goal over time was the alignment i) of the administrated system to the size of the Community, ii) to the costs of the CAP and iii) to international constraints faced during the multilateral negotiation at the GATT/WTO. This paper wants to adress two questions. 1) The first is to which extend price volatility levels on the main German markets changed over the last four decades? Therefore, we fist have to identify if price volatility has an impact at all. The second question is whether changes in the volatility levels have any relationship to the process of the reform of the CAP. For this we briefly present the method to determine price volatility. Then we perform a descriptive and graphical analysis of core German agricultural markets. Finally, we use t-tests to identify the relationship of volatility level changes and the reform process of the CAP, taking major reform steps as milestones.

2. MEASURING VOLATILITY

Volatility describes the magnitude of the movements of a particular variable. The different approaches to measure and to describe the temporal development of volatility are targeted to specific applications. These range from the assessment of options in financial markets, forecasts of future volatility rates form historical (past) volatility. This paper includes a description of the development of the price volatility on the German agricultural markets. For this purpose, the determination of the historical volatility is useful. It can be far easily calculated and by the nature of the dimension a direct comparison of the price volatility of different products is allowed.

The underlying dimension is the standard deviation of price returns. Price returns (R) correspond to the difference of the logarithms of prices and reflect the percentage deviation of prices for a time t at the price of the previous period t-1.

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right) = \ln(P_t) - \ln(P_{t-1})$$

Based on monthly returns, the historical price volatility (s) for a given year can be determined.

$$s = \sqrt{\frac{1}{12-1}\sum_{t=1}^{12}\left(\ln\left(\frac{P_t}{P_{t-1}}\right) - \overline{R}\right)^2}$$

This volatility measurement, however, refers only to the observed period length. To facilitate comparison, these values are annualized. Based on the price returns of several months the annualized volatility (as_j) of product j can be determined. It corresponds to the standard deviation of logarithmic price changes in the returns of a year.

$as_j = \sqrt{\frac{1}{m-1}\sum_{t=1}^{12}\left(\ln\left(\frac{P_{j,t}}{p_{j,t-1}}\right) - \overline{R}_j\right)^2} * \sqrt{12}$, since m equals the number of months of a year (in the case of monthly data) the following formula results for the annualized volatility

$$as_j = \sqrt{\frac{1}{11}\sum_{t=1}^{12}\left(\ln\left(\frac{P_{j,t}}{p_{j,t-1}}\right) - \overline{R}_j\right)^2} * \sqrt{12}$$

where $\overline{R}$ is the arithmetic mean of the returns in the year and $\sqrt{12}$ is a term used to scale the standard deviation of the twelve months of the year. The variable t is a counting index of monthly data runs at 1 to 12

For a graphical analysis of several years, it is useful to depict the historical volatility similarly to a moving average. For this a modification of the above formula is necessary. The goal is always to regard for the proximate month in the equation and in return exclude the most distant month. The above formula then changes as follows into

$$s_k = \sqrt{\frac{1}{11}\sum_{t=k}^{k+11}\left(R_t - \overline{R}\right)^2} \quad ; \ \forall k = 1,\ldots Nobs - 12$$

For the initial descriptive analysis the graphical presentation of the volatility calculated as moving historical volatility is chosen. This approach is used for different products. In a further step we apply a simple t-test to evaluate if the observed volatility levels during different phases of the CAP can be associated to the overall setting of the European agricultural policy. For this comparison however a standardization of the volatility indicator is needed, so the annualized volatility is used here.

The outcome of the stepwise procedure to determine the volatility measure applied for this paper is shown graphically in Figure 1. The price level is shown in the upper left graph

based on the average monthly nominal product prices (P_t). The price returns (R_t), in the upper right graph correspond to the percentage changes to the previous months. The lower left graph shows the historical volatility. The historical volatility is depicted as moving average with a window width of 12 months. The annualized historical volatility (as_j) is obtained as the scaled standard deviation of returns for 12 months, and is shown in the lower right graph of Figure 1. By doing so the information of twelve monthly observations is reduced to a single year figure.

In the following Chapter we discuss the overall development of nominal prices, and the historical volatility of selected German vegetable and animal products markets. The range of the available data series is not always the same, so the data series depiction is not uniform. Even the shorter series nevertheless provide an insight into the temporal course of price volatility.

In Chapter 3, price volatility (reproduced as a moving average of historical volatility relative to 12 months) for products is depicted graphically. To facilitate the evaluation of price development over time and avoid distortion of results by the national currency change from Deutsche Mark to Euro, all prices are given in ECU (European Currency Unit) or EURO. We assume a constant exchange rate to the Deutsche Mark before the implementation of the ECU. In the descriptive analysis of the developments of the price volatility for the different products we focus on the identification of cycles. This is facilitated by the availability of monthly data in conjunction with the concept of historical volatility. In the course of the analysis we also discuss some market specific aspects that drive price and volatility patterns as well as the role of the CAP in that particular pattern.

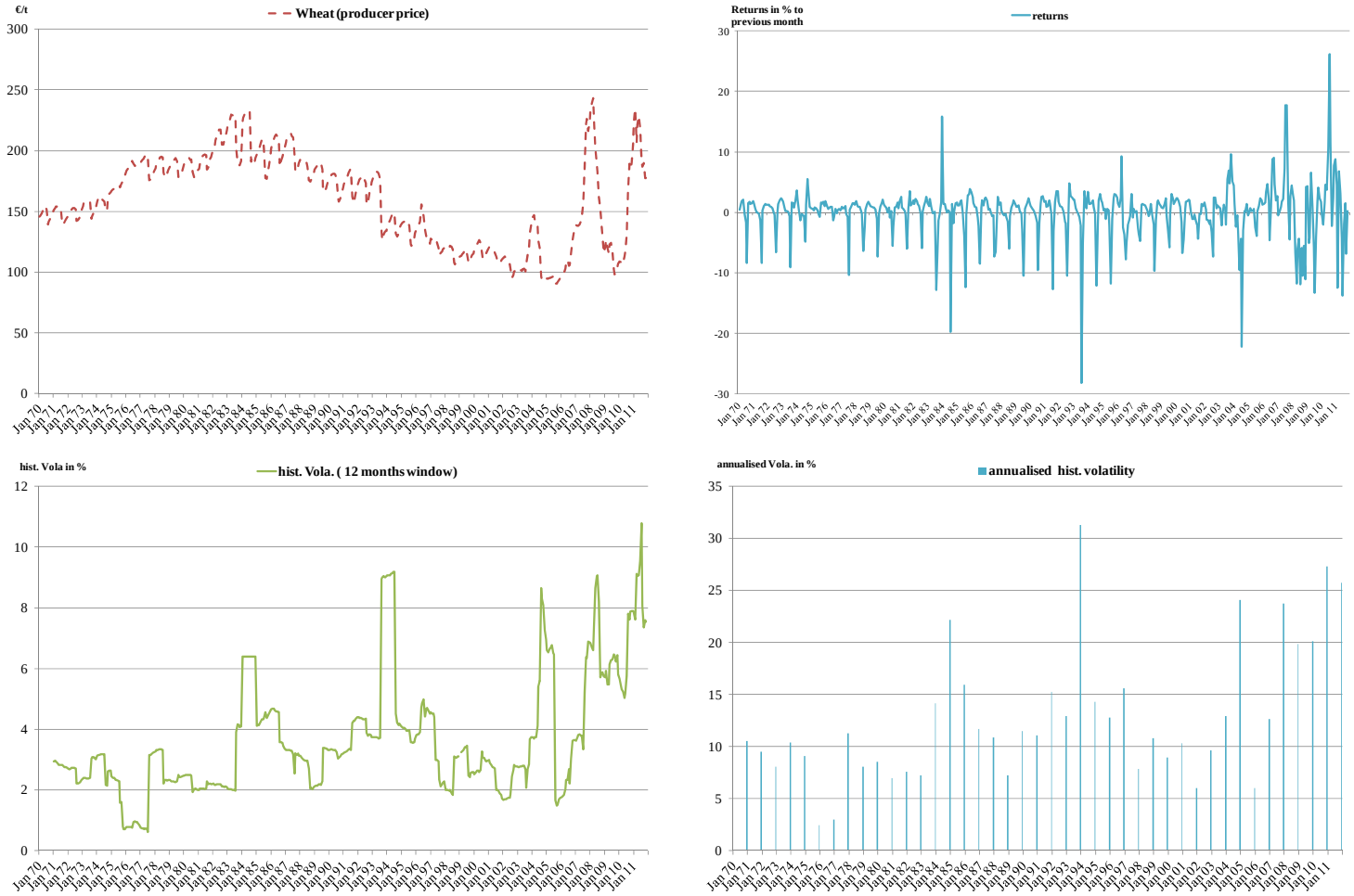
In Chapter 4 we use t-tests to verify whether the average volatility of selected time periods has changed significantly or not. These statistical tests are based on the annualized volatility. We aim to clarify whether an increase in price volatility in the German agricultural markets is noticeable or not. Furthermore, the use of annualized volatilities allows a comparison with results of other studies (Gilbert, 2006, Gilbert and Morgan, 2010, OECD, 2010).

3. DESCRIPTIVE ANALYSIS OF THE HISTORICAL VOLATILITY

Analyses are based on the information provided by the Federal Ministry of Nutrition, Agriculture and Consumer Protection (BMELV), and the data available at the Institute of Market Analysis and Agricultural Trade Policy of the vTI, which partially start in the 70s of last century.

To generate a broad picture of the development of the volatility in the German agricultural markets, data series have been used for several product groups of different markets.

Figure 1: Monthly German wheat producer price, returns, historical volatility (12 months window) and annualized historical volatility, 1970-2011



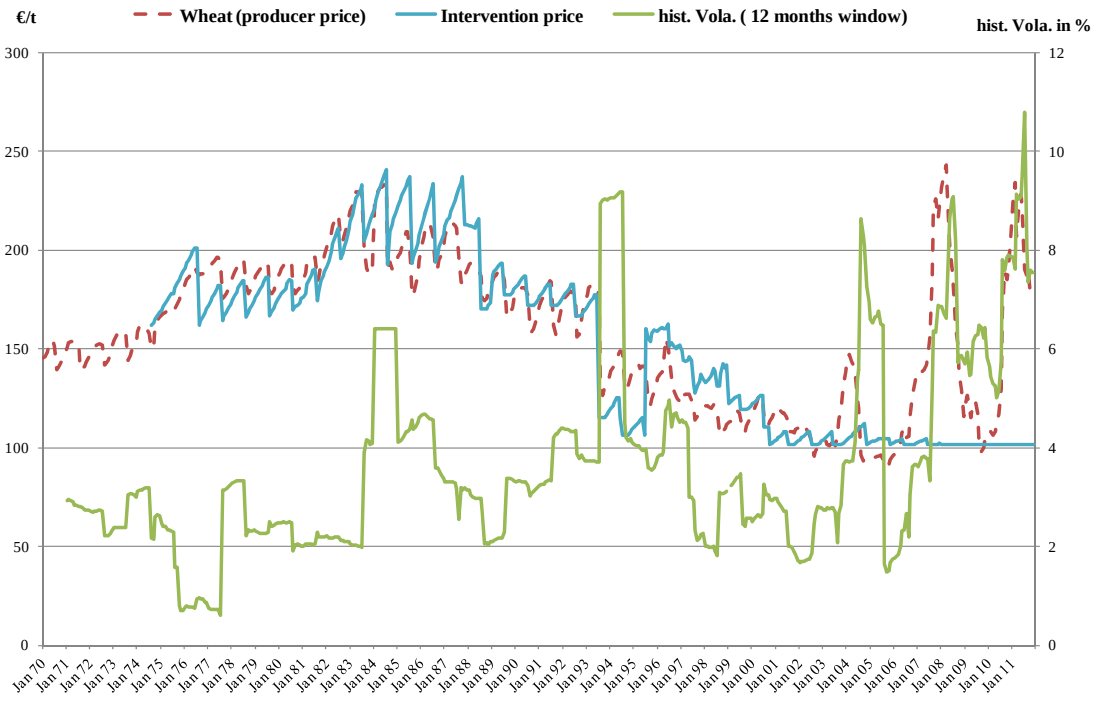
Source: own calculations based on BMELV – Monthly reports (several issues).

From the grain sector price series since 1970 are available at producer level for wheat and rye. At the wholesale level prices for milling wheat, milling rye, feed barley, feed oats and barley are also available since 1970. From the meat production sector, wholesale prices for bulls and cows from 1984 onwards, pigs from 1975 and broilers since 1982 are available. From the milk and milk products sectors producer prices for whole milk (real fat content) from 1970 are available. Wholesale prices for butter and Gouda cheese are available since 1980 and consumer prices for milk, butter and Gouda since 1983.

3.1. Cereal markets

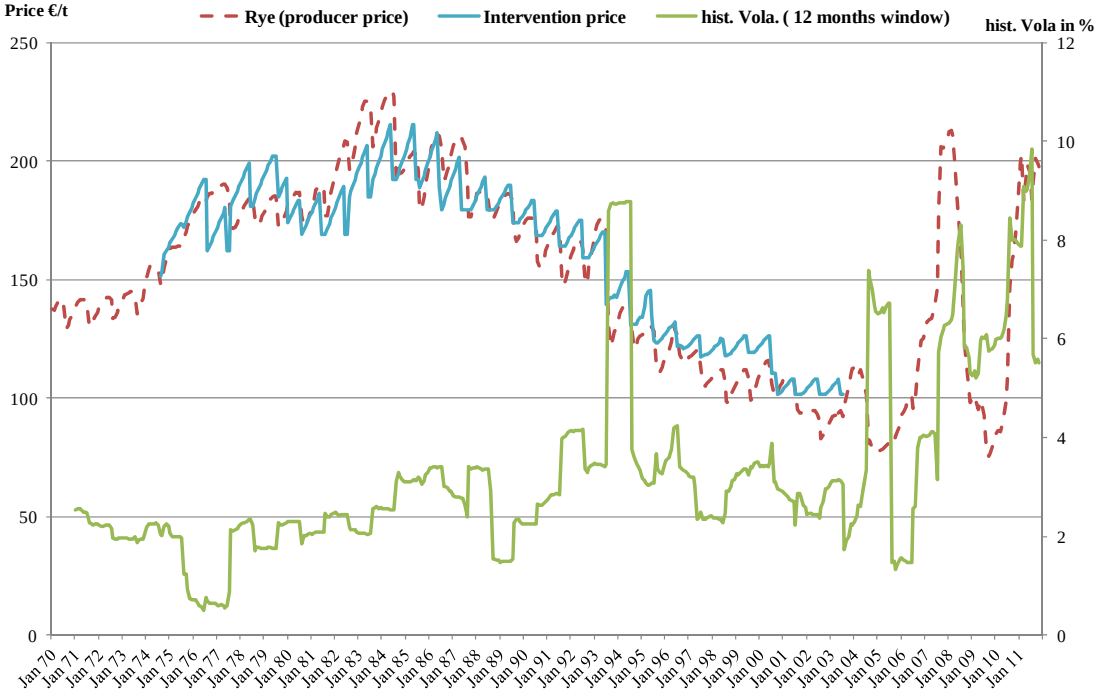
Figure 2 and 3 depict the price for wheat and rye at producer level. The course of wheat and rye prices has a strong regular sawtooth pattern until 1993. In this phase the price follows the development of the intervention price, namely the monthly reports of the intervention system. From 1993 onward a disruption of this pattern is visible. This interruption is due to the fact that the McSharry reform of the CAP came to bear in 1992. It was a transition from price support to direct payments to farmers. This new system was basically implemented with the reduction of the existing intervention prices and the introduction of compensatory payments. It was transferred to the market by reduced the market prices. The implementation of the McSharry reform in the grain sector was the beginning of a continuous reduction of intervention prices for cereals., In the course of the subsequent Agenda 2000 and the Mid-term-Review the present level of the safety net of 101 €/t was achieved. One can observe that during the first decade of the century the ‘trends’ of the market price and the administered intervention price diverge. Figure 4 shows that the lowering of intervention (and the producer) prices caused a reduction of the domestic price level and an approximation to the world market price.

Figure 2: Wheat, monthly German producer, EU-intervention price and historical volatility, 1970-2011



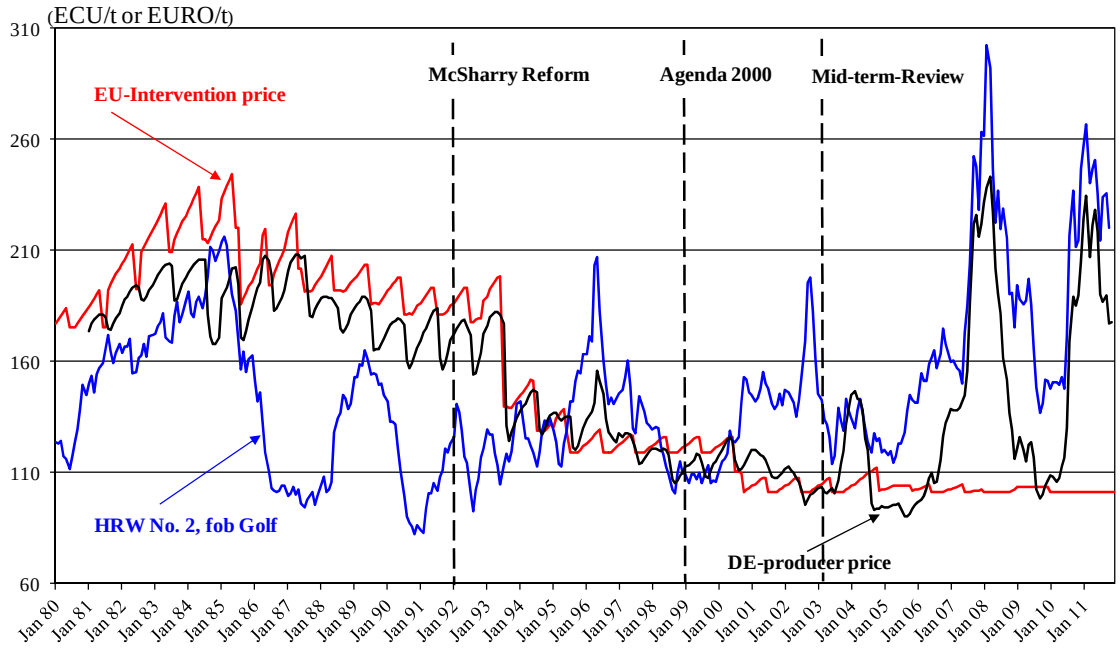
Source: own calculations based on BMELV – Monthly reports (several issues), Toepfer International (several issues).

Figure 3: Rye, monthly German producer, EU-intervention price, historical volatility, 1970-2011



Source: own calculations based on BMELV – Monthly reports (several issues), Toepfer International (several issues).

Figure 4: Wheat, monthly German producer, EU-intervention and World market price (US HRW*), 1970-2011



*US Hard Red Winter, fob Gulf of Mexico.
Source: own calculations based on BMELV – Monthly reports (several issues), Toepfer International (several issues).

With the McSharry reform the EU set the stage for the Blair House accord and the final Marrakesh Agreement (the conclusion of the Uruguay Round of the GATT that also established the WTO) in April 1994. The previous Figures 2, 3 and, 4 show that if not an integration, at least an approximation of the German (and European) cereal market to the world market took place.

From the graphs in the previous Figures 2 and 3 and the following Figures 5 and 6 it is apparent that the underlying price process follows a different pattern. The closer connection of the German market to the world market interrupted the price movements induced by the administration of the intervention price levels and leads to a transfer of volatility of world markets on the German (and also th European) market. Noticeable is the peak (see graphs in Figures 5 and 6) in the historical volatility values that accompanied the reform in 1993 when the intervention price was strongly reduced, immediately causing a decrease in the domestic price level. The consequence of the reform can be determined referring to the correlation coefficient of wheat and intervention prices. During the period of August 1974 and July 1994, a correlation coefficient of 0.89 was determined, indicating a high coherence of the two price series. For the period between August 1994 and August 2010, however, a correlation coefficient of -0.21 was determined, which does not indicates a significant correlation of the data series anymore.

Similar results were obtained for the development of wheat and rye prices and volatility again at the wholesale level (Figure 5). Similarly to the outcome at producer level the graph

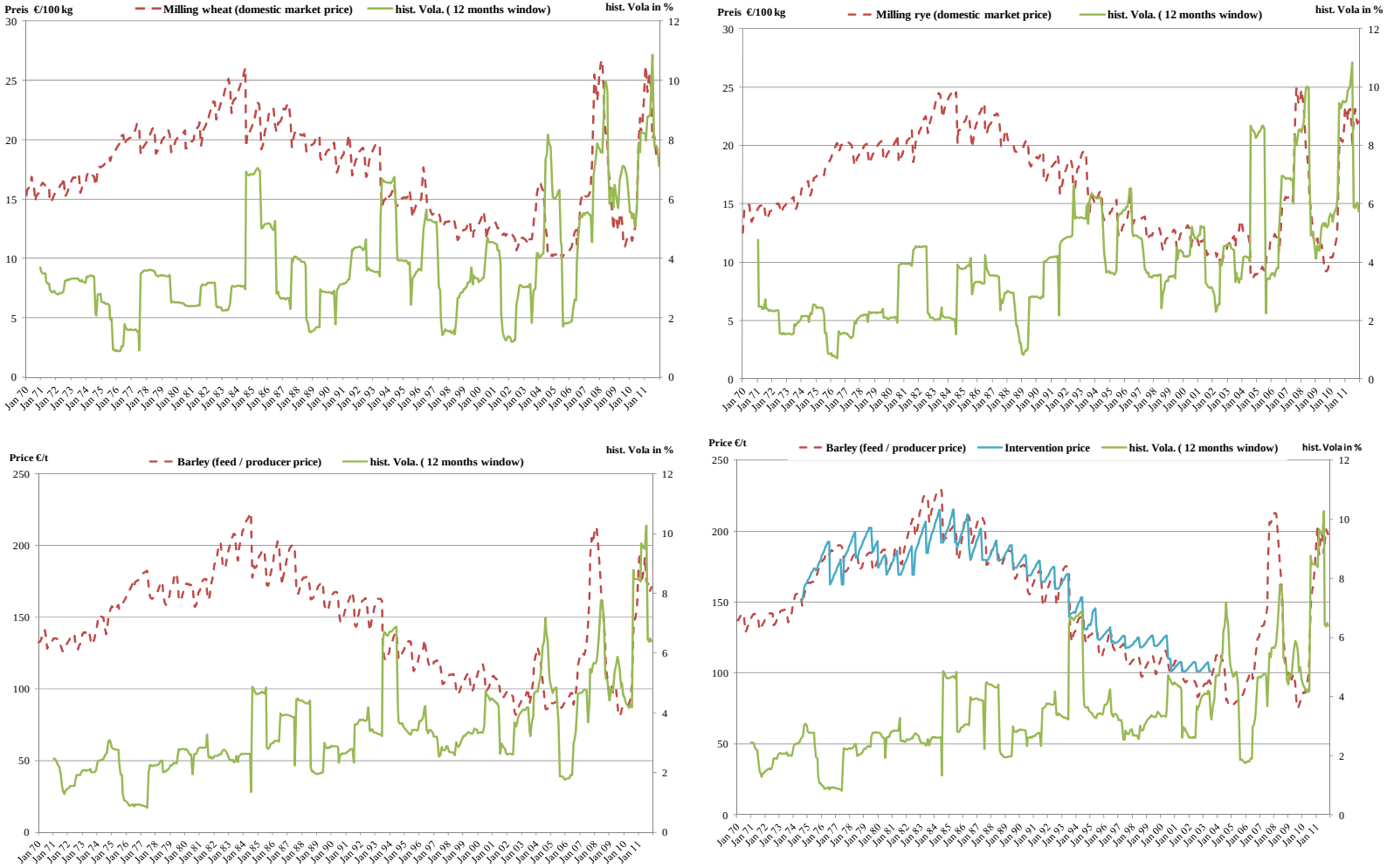
depicts a change in the development of price and price volatility at the wholesale level from 1993 onward.

In contradiction the graphs for malting barley and oats (Figure 6) did not follow the pattern of the intervention system. For the oats market no particularly striking results are visible as prices follows the price decrease in the main feeding cereals indicating that substitution at lower prices was possible. The malting barley data show remarkably low and constant levels of volatility in the period leading up to the implementation of the McShary reform.

The Figures for the grains markets (Figures 2-6) also show that rising prices are not always in line with increasing volatility, or vice versa. During the period of August 1974 to January-May 1977 prices rose by about 20% for wheat, and 30% for rye and oats. During that period, the historical volatility decreased about half of all observed markets and trading levels. On the other hand the rise in prices for different types of grain in 1983-84 was, as well as the latter reform-induced decrease in market prices in 1993, accompanied by a rise in historic volatility.

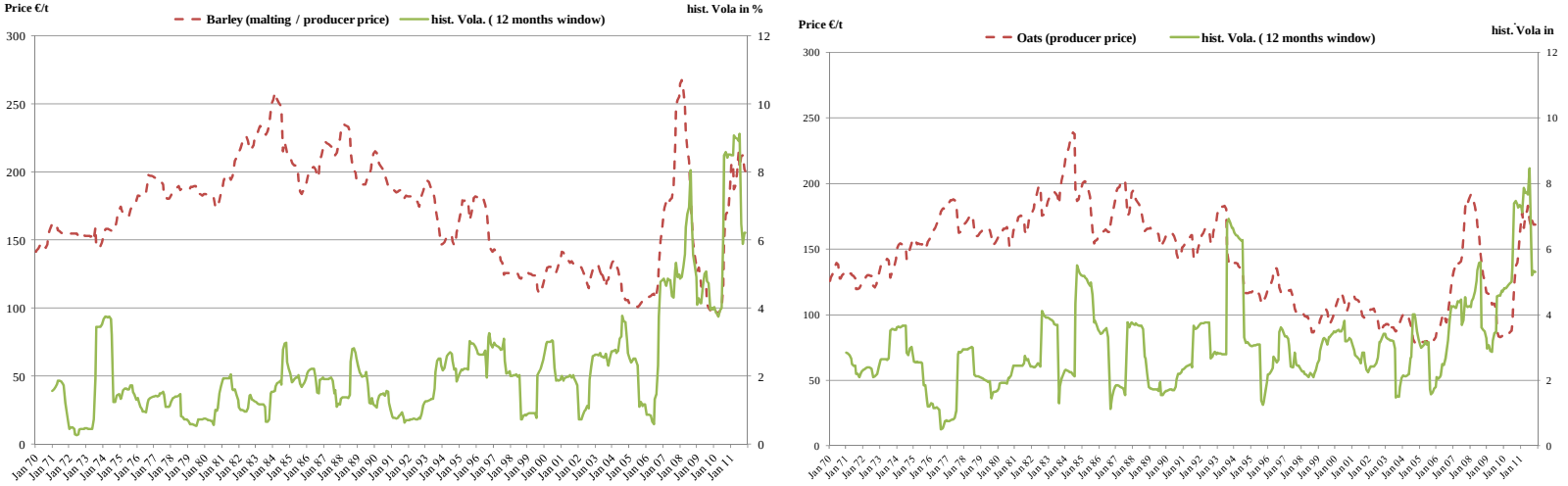
Between 1970 and 1990, no clear pattern in the trend of the historical volatility can be identified. The volatility seems to move around a more or less stable mean and the price development went up and down . The changes from the end of the 90s (1997) from where on the magnitude of the peaks of the historical volatility increase, seem to follow a positive trend. In this phase prices developed from something like a base level to a peak and then return back to the base level from which the cycle restarts. These cycles could be observed in the period 2003, 2008 and 2010. The current data indicate that with each new cycle there is an increase in the price volatility level, something the previous research could not foresee.

Figure 5: Cereals in Germany, monthly prices and historical volatility (12 months window), 1970-2011



Source: own calculations based on BMELV – Monthly reports (several issues), Toepfer International (several issues).

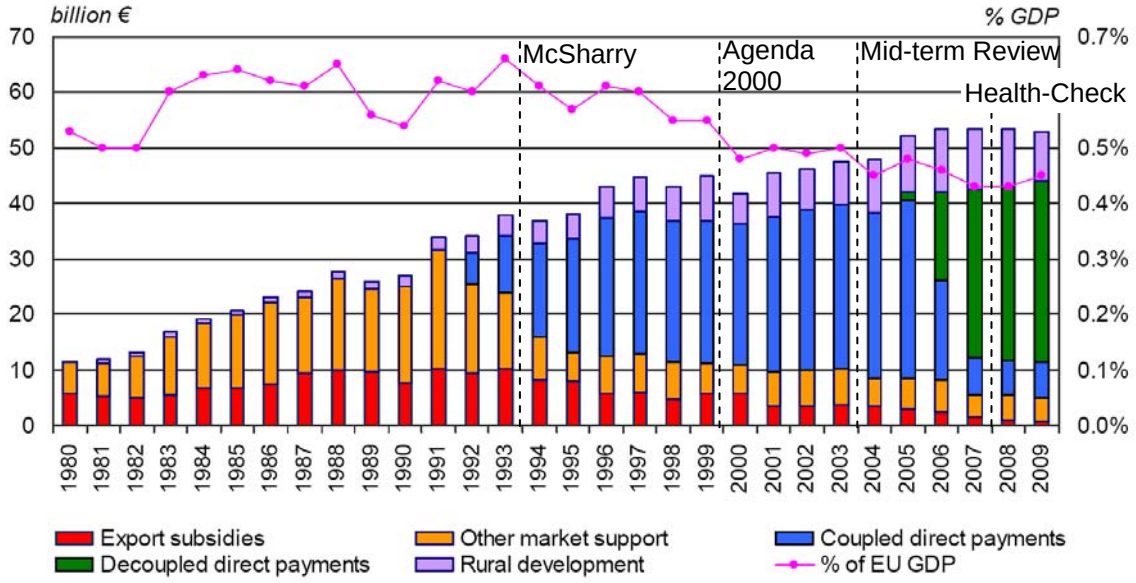
Figure 6: Cereals in Germany, monthly prices and historical volatility (12 months window), 1970-2011



Source: own calculations based on BMELV – Monthly reports (several issues).

In the course of this paper the reduction of the support of agricultural markets in the EU can be well illustrate based on the following Figure 7. Here, the various components of expenditures of the EU-budget are shown. In the course of time the rate and the importance of direct payments and support instruments decreases and is replaced by decoupled payments. This process was also described and documented at various points by the OECD, for example during the development of the PSE (producer subsidy estimate). As highlighted above milestones in this process are the McSharry reform (1992), the Agenda 2000 (1999) the Mid-term-Review (2003) and the Health-Check (2007).

Figure 7: The path of CAP expenditure (1980 – 2009, billion current €)



Source: European Commission (2010).

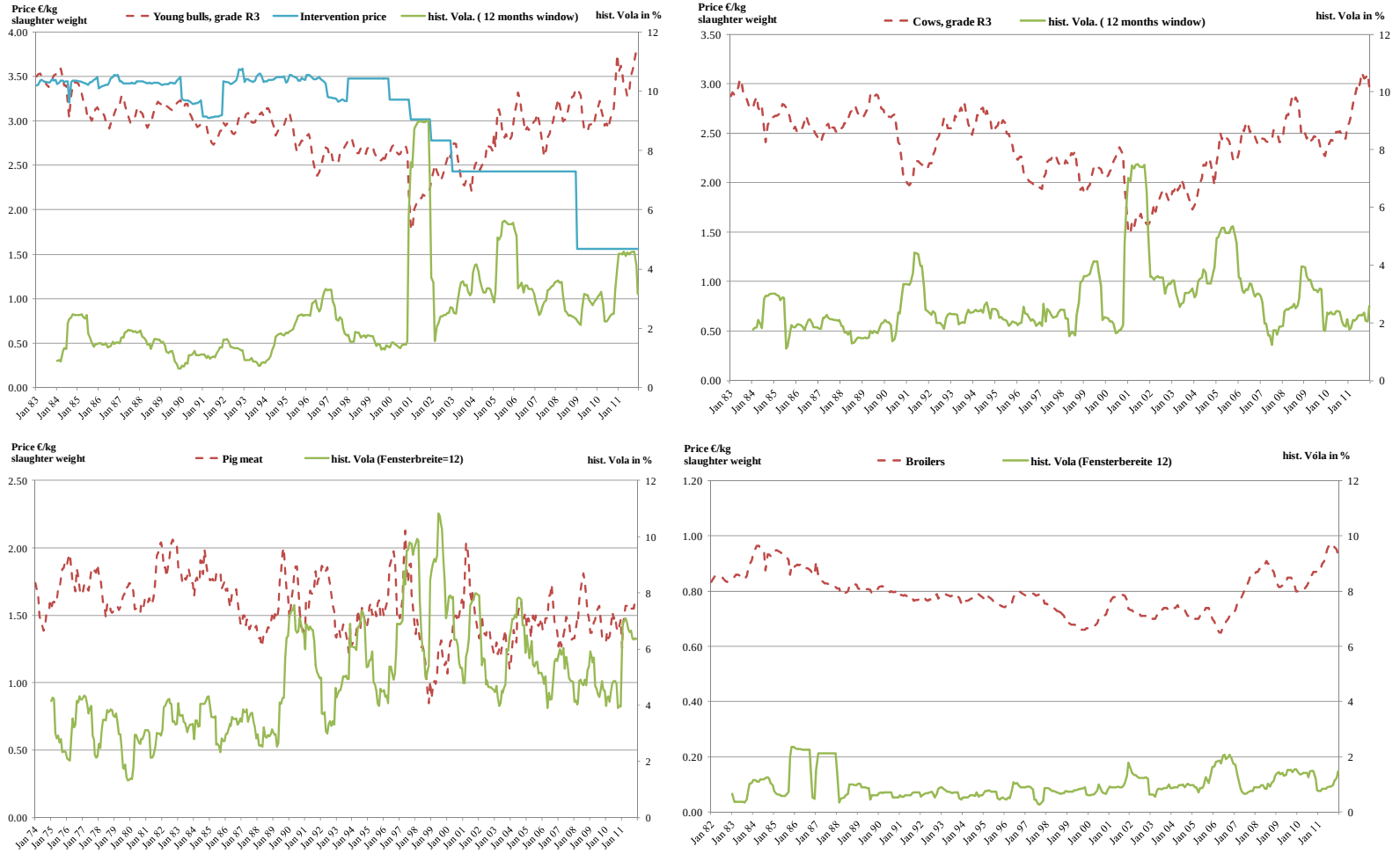
3.2. Meat markets

The price and volatility trend in meat markets (see Figure 8) is largely a reflection of the EU price support policy for the relevant product markets. Unlike the grain markets, where the market regulations were relatively steady over long periods, the Market Organization for various meat markets was quite diverse.

Among all markets the European beef market was for long time the one with the highest intensity of regulation. There was the intervention price system with minimum purchases and storage, and an underlying safety net. There were also variable levies, in 1995 these were converted into tariffs, import quotas and export refunds in accordance with the agreements of the Uruguay Round of the GATT.

Until the end of the eighties cattle meat prices follow the development of market support prices combined with the degradation of the various payments (upper left graph in Figure 8).

Figure 8: Meat in Germany, monthly prices and historical volatility (12 months window), 1970-2011



Source: own calculations based on BMELV – Monthly reports (several issues), CAP-Monitor (several issues).

The upper left graph in Figure 8 shows that after a period of stable prices and small volatility levels the bovine meat market is impacted in 1990 by decreasing prices due to the increased number of slaughtered animals. This happened in the course of the disruption of the bovine husbandry in the newly-formed German states after the German reunion (see upper right graph in Figure 8). This process did not cause a noticeable change in the volatility levels. By March 1999, as part of the Agenda 2000 reform the Market Organization for beef was changed. The reform caused in particular a decline in market support, direct payments to producers and aid to private and public storage. Due to the reforms of the CAP, the role of intervention storage was reduced. The EU should only buy beef if prices in a Member State or region fell under 1560 € per tonne (deadweight). In practice the intervention was reduced to a safety net. The last time the EU bought beef into the intervention was during the European BSE crisis in 2001. The intervened amounts were finally resolved in the summer of 2004 (AID ZMP, 1997, p.183-191, CAP Monitor, 2010 Chapter 7 a, Probst, 2003, 2000, 1990).

During the Nineties however the prices on the bovine meat market in Germany remained below the administrated prices after the BSE outbreaks in UK. Consumer fears regarding the healthiness of European beef lead to a prolonged demand contraction. Outstanding is the 2000/2001 period, the climax of the BSE crisis, during which the historical volatility more than quadrupled in the short term. After that crisis prices on the German beef market reshaped and since then follow a fairly different pattern. This is partially explained by the contraction of production caused by the abolition of the CAP payments for young bulls. This price development is enforced by an international shortage of bovine meat. Regarding the average volatility the graphs in Figure 8 show that the level in recent years is higher although no clear trend can be recognized. The pork meat series seem to reproduce the classical pork-cycle. Recently German beef prices and volatility increase due to the sudden additional demand on European markets caused by the Turkish beef imports in the period from the autumn 2010 to summer 2011. Although on a higher average level, no clear trend can be recognized in the peaks of the volatility cycles since then.

Compared to the beef market, the regulation intensity on the pork and poultry markets was traditionally much lower. Not the direct market price supports, through the use of intervention prices and storage, but border protection measures were applied. Until 1995 variable levies and imports quotas were applied for pork meat. They were then converted into fixed tariffs import or tariff quotas. The EU support for pig farmers and pork meat market is limited to the occasional use of private storage aid (AID ZMP, 1997, p.141-146, CAP-Monitor, 2010, Chapter.7b).

The system of Market Organizations did not provide specific measures to intervene in the poultry meat market. The unified system for eggs and poultry meat included import duties, export refunds and additional safeguards that allow for the adjustment of supply to market requirements. Since 1990 regulations apply to standards in marketing. These are periodically revised (AID-ZMP, 1997, p.157-159, CAP-MONITOR, 2010, chapter 8).

The average level of volatility in the pig meat market, by about 6 % is, as shown in the lower left graph in Figure 8, almost twice as high as in all the previously considered markets, where the average levels are about 2 or 3 %. The EU market is, traditionally linked to the world market, it is characterized by the absence of administered price support and reports a higher 'basic-risk' in the prices. This risk is reflected in higher price volatility levels reflected by the sharp swings in prices and volatility in end of the Nineties in the lower left graph of Figure 8.

From the middle of the Nineties on a conjunction of events on the European pig husbandry caused a demand contraction. In 1997 the Dutch pork sector was hit by a swine fever outbreak. Initially the Dutch shortfall in production and increased prices stimulated the German market. In the sequence however the recovery of the Dutch production depressed heavily the oversupplied German market. Additionally, a Dioxin-scandal in Belgium in 1999 lead to consumer fears and strong demand reduction and an extreme price decrease, accompanied by an increase in volatility. In the course of the BSE crisis the strong short-term increase in demand for pork meat increased prices and volatility until the peak in spring 2001.

For the broiler market the price volatility remains practically unchanged during the entire observation period at a low level (see lower right graph of Figure 8). This is due to the price stability that is typical for this market. This results from the structural characteristics of the broiler market, where few marketers operating with a highly integrated production chain, in combination with very short turnover periods. They can promptly adjust their output to short-term changes in demand conditions. This is done under the protection of tariffs without any accompanying domestic price support.

3.3. Milk and dairy products

The price and volatility development of markets for milk and milk products reflects the price and quantity control of the respective EU agricultural markets though the CAP. This can be illustrated by the example of the butter market (graph in Figure 9). The price and volatility swings at the end of the observation period are caused by the tight supply situation on the world market combined with the decline in intervention stocks of dairy products in the EU. After adjustments in production structure and changes in the regulatory framework prices reshape.

It should be noted that the international market for dairy products (butter and milk powder) is a thin, or residual market. Compared to consumption amounts only relatively small amounts are internationally traded. Due to the concentration on few large providers relatively small changes in the volume of supplied milk (such as weather-related supply lack in Oceania or South America) can cause relatively strong price reactions (Kurzweil and Salamon, 2003; Wohlfahrt, 2010).

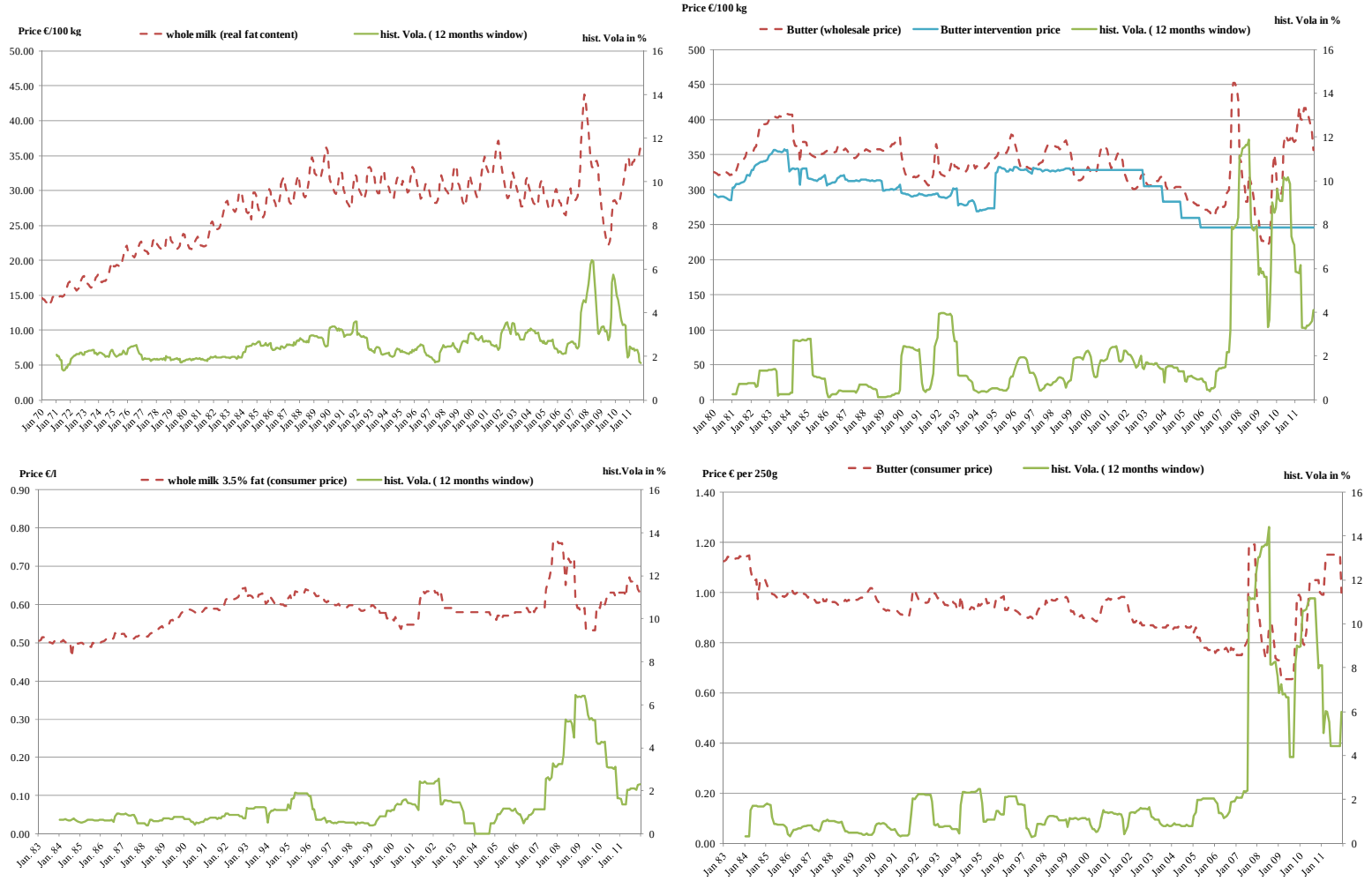
The graphs in Figure 9 and 10 show that after high domestic prices caused by substantial scarcity on the world dairy markets in 2007/2008/2009 the production was increased which reduced prices. The subsequent price swing 2010/2011 although indicates that a stabilization of supply could not be achieved.

The price spike in the autumn of 2007 was followed a dramatic price fall between October 2007 and September 2008. During this period, a similar high historical price volatility is recorded for producer and consumer prices. This poses in so far an unexpected result. We expected that an increasing degree of processing and an decrease of the relative shares of raw material in the final product price volatility of the processed product would decrease (Weber, 2009). The butter price spikes at the wholesale level and retail level in 2007/08 (right hand graphs in Figure 9) are examples of such a dramatic market reaction. In this time period, the volatility almost quintupled.

The historical volatility of cheese prices (see graphs in Figure 10) generally follows the course described above, but does not reach the same levels as butter. Reasons for this difference may be the substitutive nature of protein and fat as well as different marketing strategies for mass products such as butter, fresh or UHT milk and higher-value products such as cheese.

Unlike the markets for grain and meat the European market for milk and milk products is still in the midst of the reform process. The EU Commission took advantage of periods of high world market prices (2006-08) in order to propel further reforms in the regime and deplete remaining intervention stocks without having to rely on export refunds. The abolition of export refunds was on the agenda of the negotiations of the Doha-Round of the WTO. The simultaneous reduction of the stocks in the EU, the relatively high prices on the world and in the internal market, as a result of the supply lacks in major producing regions are therefore not accidental. This situation favored the decisions by the European Commission. After the world market for dairy products returned to a ‘normal’ the European and German dairy markets were confronted with the altered inventory levels. Similar to the classical swine cycle following a high-price phase is followed by an expansion of the offer, which is faced to a downturn of the global economy in 2008/09 and a sluggish demand. Subsequent prices increase in 2010 and 2011. Reactions to this development are not only the public protests of producers (Handelsblatt, 17.04.2009), the following price volatility swings and again the backdrop of a stalled Doha-Round of WTO resumed intervention purchases (Milchindustrieverband, 2010).

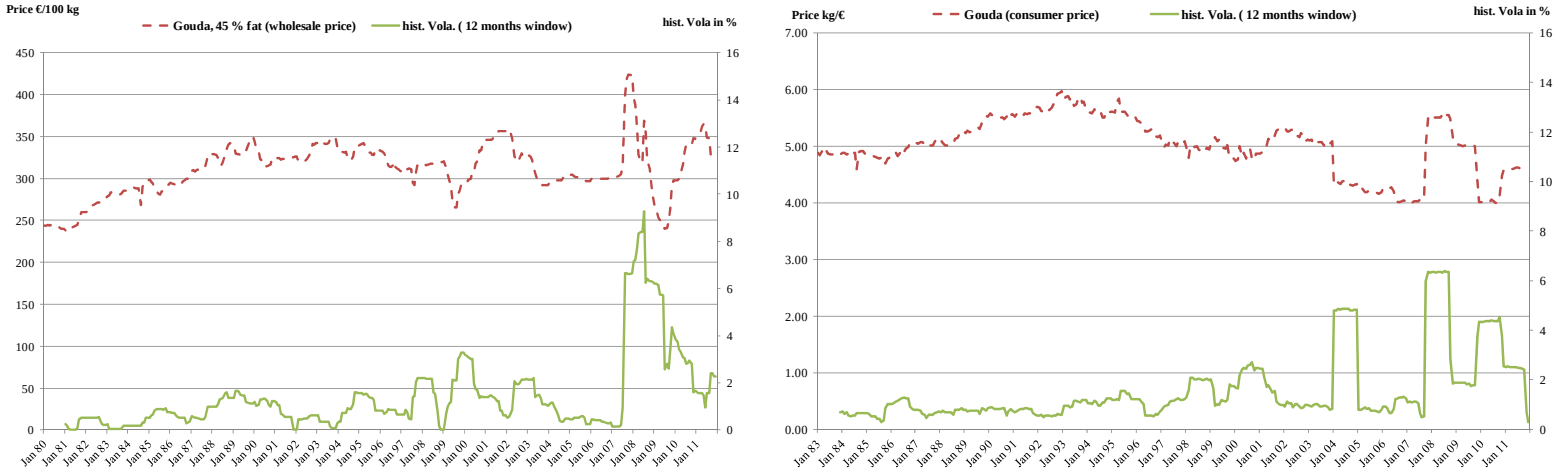
Figure 9: Dairy markets in Germany, monthly prices and historical volatility (12 months window), 1970*-2011



* not all series start in 1970.

Source: own calculations based on BMELV – Monthly reports (several issues) , CAP-Monitor (several issues).

Figure 10: Dairy markets in Germany, monthly prices and historical volatility (12 months window), 1980-2011



Source: own calculations based on BMELV – Monthly reports (several issues).

4. DIFFERENCES IN VOLATILITY OVER TIME

Statistical tests are applied to support the conclusions of the graphical analysis of historical volatility. These tests are used to determine whether a significant change in price volatility is recognisable, and whether the price volatility increased in the course of the reforms of the CAP. Therefore, three time intervals were selected, which are separated by significant events in the reform process of the CAP. The time intervals separate phases of different support schemes to European agriculture. Thus, an overriding framework is supplied for the analysis of the development of volatility (measured now by the annualized historical volatility) of the German market prices.

Phase I encompasses the period that starts with the beginning of the available time series and end with the McSharry reform in 1992: this corresponds to the period of price support in the CAP. Phase II, encompasses the period from the McSharry reform and ends with the Mid-Term review (of the Agenda 2000). During this period the process of decoupling support from prices was initiated and replaced by area or animal related payments. Phase III starts with the introduction of the Single Farm Payments a system of decoupled payments..

A two-sample test (t-test) was performed to verify whether the average volatilities calculated for each time interval are statistically different from each other. Specifically, we analyse whether the average price volatility in phase III differs from the immediately preceding phase II. Phase III, commonly perceived as more volatile, is also compared with the temporally distant Phase I to determine whether a change in the observed price volatility in the long-term view is detectable. Finally, we tested for a difference between phase II and I. The test sequences and the associated hypotheses are schematically described in Table 1. Thereby we characterize phase III> phase I (*); Phase II> Phase I (+) and Phase III> Phase II (#). The symbols *, +, # (**, + +, # #) indicate that the difference is significant at the 5% (10%) level.

Table 1: Schematic representation of the test sequences

Indicator	Hypothesis	Phase I (1970-1992)	Phase II (1993-2003)	Phase III (2004-2011)
#	III > II			# (5%) ## (10%)
+	II > I		+ (5%) ++ (10%)	
*	III > I			* (5%) ** (10%)

The comparison of the phase III to phase II (indicator: #) shows that the average price volatility of the phase III for milling wheat and rye at the wholesale level are significantly higher than in phase II. This can be explained by the changes in the competitive environment and marketing structures at the wholesale level - especially for the international wheat trade. We found comparable results for the cereals prices at the producer level. The volatility level in phase III was higher than in phase II at a significance level of 10% for barley and oats. This

nevertheless clearly demonstrates that the changes of the volatility levels in the cereal sector (see Table 2) are in line with the implementation of the single farm payment system after the Mid-term review of the CAP. These seem to have impacted the crop sector more heavily, as the results for the dairy markets indicate. Due to lack in data a comparable analysis for the beef market could not be done.

Table 2: Historic annualized price volatility, Selected markets for Germany and World or US, 1970 - 2011

		(1970 – 2011)	Phase I (1970-1992)	Phase II (1993-2003)	Phase III (2004-2011)
German	Milling wheat (market)	13.3%	11.0%	12.7%	21.0%**##
	Milling rye (market)	13.8%	10.1%	15.0%	22.7%**##
	Wheat (producer price)	12.7%	10.2%	12.8%	19.9%**##
	Rye (producer price)	11.2%	8.2%	12.1%++	18.5%**##
	Barley (producer price)	11.9%	9.2%	13.3%++	17.7%**#
	Brewing barley (producer price)	7.8%	4.9%	7.7%++	16.0%**##
	Oats (producer price)	10.6%	9.1%	10.8%	14.5%**#
	Pigs-E class. (Wholesale)[2]	16.6%	12.7%	22.8%++	18.0%**
	Milk at farm gate real fat and protein content	8.7%	7.9%	8.9%+	10.7%*
World/US	Wheat (HRW fob Gulf)	17.8%	16.0%	17.9%	23.2%**#
	Pigs-US[3]	36.6%	40.0%	38.8%	28.2%

Note: Volatility was calculated as the annualized standard deviation of monthly (nominal) price returns calculated. Significant differences between periods are analyzed using two-sample tests of significance (t-test).
Here we characterize phase III> phase I (*); Phase II> Phase I (+) and Phase III> Phase II (#).
*, +, # (**, + +, # #) indicates that the difference is significant at the 5% (10%) level.
Source: own calculations

Regarding the volatility of the prices of animal production the test does not indicate an increase of average volatility from Phase II to Phase III. For the pig meat market the previous discussion already highlighted the openness (lack of regulation and administrative guidance) of this market. Furthermore, the calculated averages simply do not provide indication for an substantial increase of volatility. Somewhat different is the development of the milk prices

volatility. Here the values show an increase of the average volatility, which however is not enough significant.

The comparison of the phase II with phase I (indicator: +) shows no significant increase of volatility after the McSharry reform at the wholesale level – although the average volatilities in phase II increased. At producer price level, apart from wheat the increase in price volatility was significant for all analysed markets. One possible explanation is that the decrease in market prices after the introduction of compensatory payments leads to an adjustment of the relative competitiveness among the main cereals impacting more heavily rye and feed barley. The malting barley result can be explained by developments in the German brewery sector. The outcome of the test for these two early periods for the pig meat price volatility is clear and is not explainable by changes in the CAP. As discussed above the pig meat market was nearly completely unregulated. The price swings and the derived volatility have its origin in developments (swine fewer outbreaks and demand shifts due to the BSE crisis) that affected not only the German but the European meat markets.

The final test sequence (phase III> phase I, Indicator: *) shows a very clear picture compared to previous test sequences. Apart from oats all products show significantly higher price volatilities in the period 2004-2011 when compared to 1970-1992. The lower significance of the test result for milk is again caused by the relative low increase of volatility over the period.

The results of the test series confirms that phase II represents a transitional phase towards a more liberalized regime. This certainly was the purpose, of the implementation of the MacSharry and Agenda 2000 reforms. While McSharry was a preparatory exercise for the Uruguay Round of the GATT the Agenda 2000 deepened the process of decoupling support from production. Due to further reforms implemented through the Mid-term review of Agenda 2000 the German agricultural sector is closer connected to the more volatile world market.

For comparison we performed the tests with data for the US hard red winter, the world key cereal market, prices and the US pig meat prices (see bottom of Table 2). The test results indicate that the overall development on the wheat markets can be compared. It must be highlighted that the volatility levels in Germany (and presumably in the rest of the EU) are fairly lower than the observed on the world market. The development on the pig markets on the other side does not show real parallels indicating the differences of these regional meat markets.

5. CONCLUDING REMARKS

The results obtained from our analysis show that the volatility on German (and presumably the European) markets increased during the last four decades. The t-test analysis indicates that this evolution is framed by the reform process of the CAP. The highest degree of correlation between the reform process of the CAP and the increase in price volatility was identified for the cereal markets, which is in line with the path of reform of the Market Organisation. Our results differ from studies of the development of volatility in world markets for these crops (Gilbert, 2008, Gilbert and Morgan, 2010, OECD-FAO, 2010), as these studies

did not identified (at that time) an increase of volatility. On the other hand, our results are consistent with the analysis of Artavia et al. (2009) and the theoretical considerations with regard to expected reactions to the opening of foreclosed markets to the world market.

Our results indicate that the German producers (cereal in particular) are currently facing a more raw market environment. Formerly only farmers engaged in the pork and potato production faced similar price cycles and levels of volatility. The ongoing adjustment process in the German agriculture however indicates that the challenge is being managed.

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REFERENCES

AID-ZMP – Auswertungs- und Informationsdienst für Ernährung, Landwirtschaft und Forsten und Zentrale Markt- und Preisberichtcctelle für Erzeugnisse der Land-, Forst- und Ernährunswirtschaft (1997) *Agrarmarktordnungen in der Europäischen Union und Agrarmärkte in Deutschland*. aid-ZMP, Bonn.

Artavia M, Deppermann A, Filler G, Grethe H, Häger A, Kirschke D, Odening M (2009) Ertrags- und Preisinstabilität auf Agrarmärkten in Deutschland und der EU – Betriebswirtschaftliche und agrarpolitische Implikationen. In: *Auswirkungen der Finanzkrise - und volatiler Märkte auf die Agrarwirtschaft.* Rentenbank. Frankfurt am Main, Edmund Rehwinkel-Stiftung - Rentenbank. 26: 90

CAP-MONITOR (several issues) Agra-Informa, Kent (UK), www.agra-net.com

BMELV (Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz) (sever issues) Monatsbericht (Montly Report). Berlin/Bonn. Web: http://www.bmelv-statistik.de/

European Commission (2010) Situation and Prospects for EU Agriculture and Rural Areas - December 2010. Brussels: European Commission – DG-Agri, Brussels.

Gilbert, C.L. (2006) Trends and Volatility in Agricultural Commodity Prices. In Sarris, A. And Hallam, D. (eds) *Agricultural Commodity Markets and Trade New Approaches to Analyzing Market Structute and Instability*, ed. U. N. FAO - Food and Agriculture Organization of the United Nations and Edward Elgar Publishing

Gilbert, C.L. and Morgan, C.W. (2010) Trends in Food Price Volatility " In Piot-Lepetit Isabelle, M'barek Robert (eds) *Methods to Analyse Price Volatilily*, ed. IPTS. Sevilla: IPTS.

Kurzweil M, Salamon P (2003) Der Markt für Milch. *Agrarwirtschaft*, 52 (1)

Handelsblatt (2009) *Bauern protestieren für höhere Milchpreise*. Online issue from the 17. April 2009. Web: http://www.handelsblatt.com/politik/deutschland/bauern-protestieren-fuer-hoehere-milchpreise/3158960.html

OECD-FAO (2010) *The OECD-FAO Agricultural Outlook, 2010-2019*. OECD-FAO. Paris, Roma OECD-FAO

Milchindustrieverband E.V. (2010) Jahresrückblick 2009: *Rekordmilchanlieferung und Intervention*. In Web:

Probst, F.W. (2003) Die Märkte für Schlachtvieh und Fleisch. *Agrarwirtschaft*, 52 (1)

Probst, F.W. (2001) Die Märkte für Schlachtvieh und Fleisch. *Agrarwirtschaft*, 50 (12)

Probst, F.W. (1990) Die Märkte für Schlachtvieh und Fleisch. *Agrarwirtschaft*, 39 (12)

Toepfer (several issues) Marktberichte. Hamburg, Toepfer International.

Weber SA (2009) Ausmaß und Determinanten von Preisrigiditäten im deutschen Lebensmitteleinzelhandel - Eine empirische Analyse mit Scannerdaten. Gießen: Univ, (Thesis).

Wohlfahrth, M. (2010) *Betrachtung zur aktuellen Marktlage*. Speech during the annual traders union, 08. October 2010, Hamburg.