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# **The Integration of the Conventional and Organic Wheat Market**

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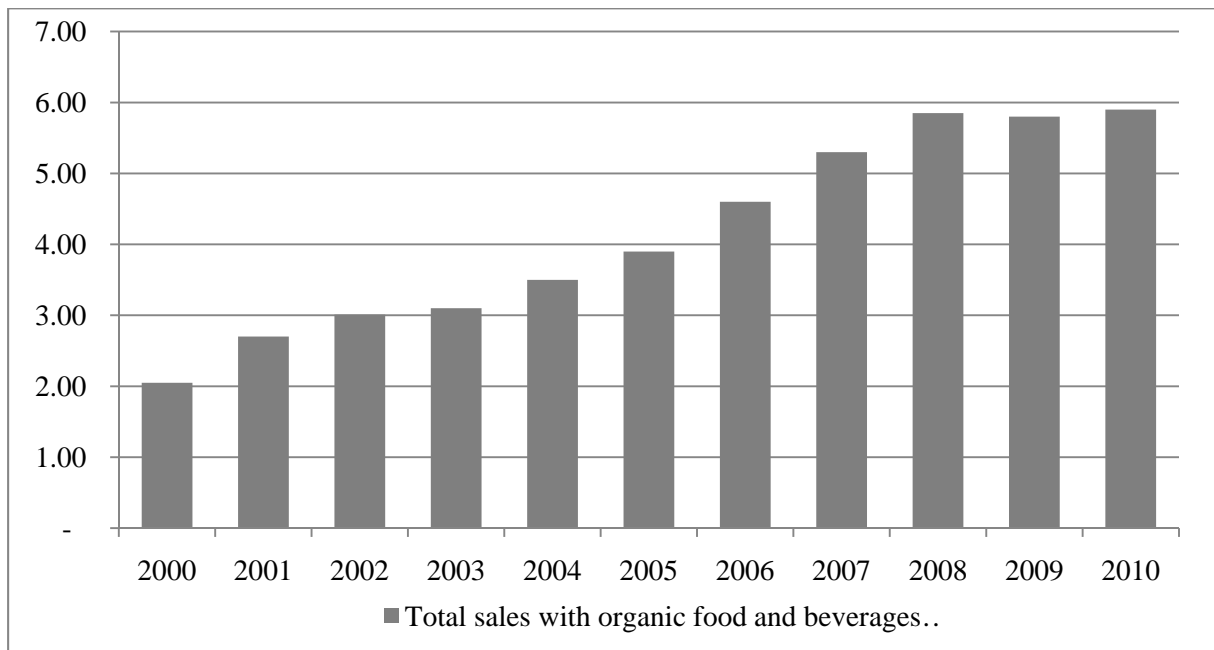
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# 1 Introduction

A number of severe recent food scandals led to an increasing awareness of consumers of health and the environment during the last two decades (BRUHN 2001, NIESSEN and HAMM 2006). The per capita purchases of organic food have been increasing on average from 42.4 €/person in 2004 to 70.70 €/person in 2009 (AMI 2010b). Consequently, the sector for organic food has experienced a strong growth in many European countries. The organic sector in Germany has experienced constantly high growth rates (see Figure 1) and is the second largest worldwide in 2007 (SAHOTA 2009: 59). The number of organic producers has grown moderately by 5.3 % on average per year between 2004 and 2009. Supermarkets and discount retailers have especially increased their market shares, whereas farm-shops and direct-marketing-channels have lost market share during recent years. Specialized organic food stores, the main market actors during the 1990s, are still growing in absolute figures, but the largest part of the overall growth is due to conventional food traders (supermarkets and discounters), who are offering organic food in their stores (RIPPIN and HAMM 2007).

**Figure 1: Total Sales with Organic Food and Beverages (in Billion €)**



Source: Data from AMI 2010b and BÖLW 2011.

Since market actors have substantially changed during the last 20 years, it is appropriate to ask if the price setting behavior has also changed. There are a number of factors which point to altered price interdependencies.

First, the EU has reduced its intervention prices for many markets since 1992. The degree of protection has been decreasing (OECD 2010) and since 2005 intervention in the grain sector has partly been abolished. This leads to higher price volatility on the conventional grain markets (see Figure 2). Furthermore, the financial crisis has increased price volatility; therefore, this uncertainty also gains importance in the agricultural sector (RENTENBANK 2010: 5). Other studies have found that price volatility has increased, particularly for wheat in Germany (ARTAVIA et al. 2010: 64). This might also be the case for the organic sector and might increase the tendency for prices in these markets to be oriented with conventional prices.

The organic sector used to be quite autonomous during the 1990s, as there were only small linkages between the conventional and the organic markets. Consumers purchased organic products mostly in organic food stores, farmers' markets and farm shops where consumers did not have the choice between different qualities and price levels. Moreover, supermarkets and discounters offer both organic and conventional food so that consumers can choose between them. Since consumers tend to be price sensitive, prices for organic products can be assumed not to exceed a certain 'top-up' margin for the organic production scheme. This top-up is likely being calculated in relation to the conventional prices, since consumer can use the conventional price as a point of comparison. Therefore, an increasing share of supermarkets and discounters in the organic sector is likely to lead to a closer link between organic and conventional prices.

If seeds and feed stuff are not available, farmers can, due to the organic producer regulations<sup>1</sup>, use conventional products if the farmer's production association agrees to such an exception. Hence, this link might exist in cases where the supply for organic seeds and feed stuff is low. If the price for organic grain is low, organic farmers can sell their organic grain as conventional grain or as input for biogas plants.

This paper is dealing exactly with these linkages. It is concerned with interdependencies between organic and conventional wheat prices at the producer level. The analysis is carried out by means of cointegration analysis, that is, the estimation of a vector error correction model considering the two price series. With such a model, empirical evidence on the integration of both markets and the speed of transmission of price signals between them can be obtained. We first present some theory of price transmission analysis; present the data, the model and estimation results. Finally, we draw conclusions.

## **2 The Economic Concept of Market Integration**

The study of relationships between markets of one commodity in space, or of various stages of a commodity along the processing chain (e.g. wheat grain – wheat flour – bread), has attracted the interest of agricultural economists for many decades (MEYER 2004). This issue is measured by assessing market integration. The concept of market integration is not agreed upon in the literature (FACKLER and GOODWIN 2001: 976 f.). Admittedly there is a general agreement that market integration is related to the flow of goods and information over space, time and form; however, the determination of an accepted definition with testable components is a challenging task (GONZÁLEZ- RIVERA and HELFAND 2001). It is therefore necessary to clearly define the concept for this paper.

We understand markets as integrated if their prices share stable long-run price equilibrium. The attainment of such an equilibrium can only be reached if either trade flows occur between spatially separated markets of a homogenous commodity or if information flows ensure that price information of one product plays a key role in the price formation of the other. This distinction appears to be relevant in the context of this study insofar as the focus lies on the markets of conventional and organic wheat. The varying production processes yield two types of wheat which cannot be regarded as one homogenous commodity (which is a necessary condition for horizontal price transmission analysis).

On the other hand, the given setting corresponds neither to vertical price transmission analysis which analyses the transmission of price signals between various processing stages of one

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<sup>1</sup> The organic production is defined by the EU regulation EU-VO 2092/91 and EU-VO 1804/99, and since 2007 EU-VO 834/2007. The purchase of conventional inputs such as e.g. seeds and feed-stuff are limited and in some cases only allowed by permission of the controlling body or producer-association such as Bioland, Neuland or Demeter. But this option might still be possible in cases of low supply of organically produced inputs.

agricultural product. The focus of this study lies on interdependencies of the price formation processes of qualitatively differentiated varieties of one commodity (here: organic vs. conventional), which emerge as a result of the transmission of information between both markets. While the varieties of the commodity are usually traded on separate markets, a certain degree of substitutability exists between them concerning marketing and processing. In the framework of organic vs. conventional agricultural products, this substitutability is considered asymmetric since organic wheat might be used or marketed without the label as the conventional variety, whereas the opposite is not possible. Hence, we are presented with a very interesting economic setting of which we try to explore empirically. To our knowledge, this is the first study to assess price relationships for a qualitatively differentiated commodity.

If markets are found to be integrated, the speed and magnitude of the transmission of price signals and price shocks between the markets, i.e., price transmission, is of interest. This form of price transmission analysis is criticized by some authors because it is only based on price series while transaction costs are ignored. Nevertheless, it should be mentioned that price series often represents the only sufficient quality of information for specific markets (MEYER 2004).

While market integration can be assessed by cointegration testing, price transmission can be estimated using cointegration models, in particular the vector error correction model (VECM) which typically takes the form:

$$\begin{bmatrix} \Delta x_t \\ \Delta y_t \end{bmatrix} = \begin{bmatrix} \alpha^x \\ \alpha^y \end{bmatrix} [\beta_0 \quad 1 \quad \beta_1] \begin{bmatrix} 1 \\ x_{t-1} \\ y_{t-1} \end{bmatrix} + \sum_{i=1}^k \begin{bmatrix} a_i & b_i \\ c_i & d_i \end{bmatrix} \begin{bmatrix} \Delta x_{t-i} \\ \Delta y_{t-i} \end{bmatrix} + \begin{bmatrix} u_t^x \\ u_t^y \end{bmatrix}. \quad (1)$$

The variables  $x_t$  and  $y_t$  denote price series in markets  $x$  and  $y$  and  $\Delta$  is the first difference operator. The coefficients  $\beta_0$  and  $\beta_1$  quantify the long-run price equilibrium, so that the product of the vector containing them with the following vector of prices of the previous period measures the *equilibrium error* (the deviation from equilibrium).  $\alpha^x$  and  $\alpha^y$  are the *loading parameters* which quantify the magnitude of the price response in the current period to the equilibrium deviations in the past period. The parameters  $a_i, b_i, c_i$  and  $d_i$  measure the partial influence of past price changes on the current changes and  $u_t^j, j = \{x, y\}$  are Gaussian white noise errors. As mentioned in HACKL (2005: 368), not explicit assumptions on structural characteristics have to be made in this context while Granger causality testing represents a way to evaluate this issue.

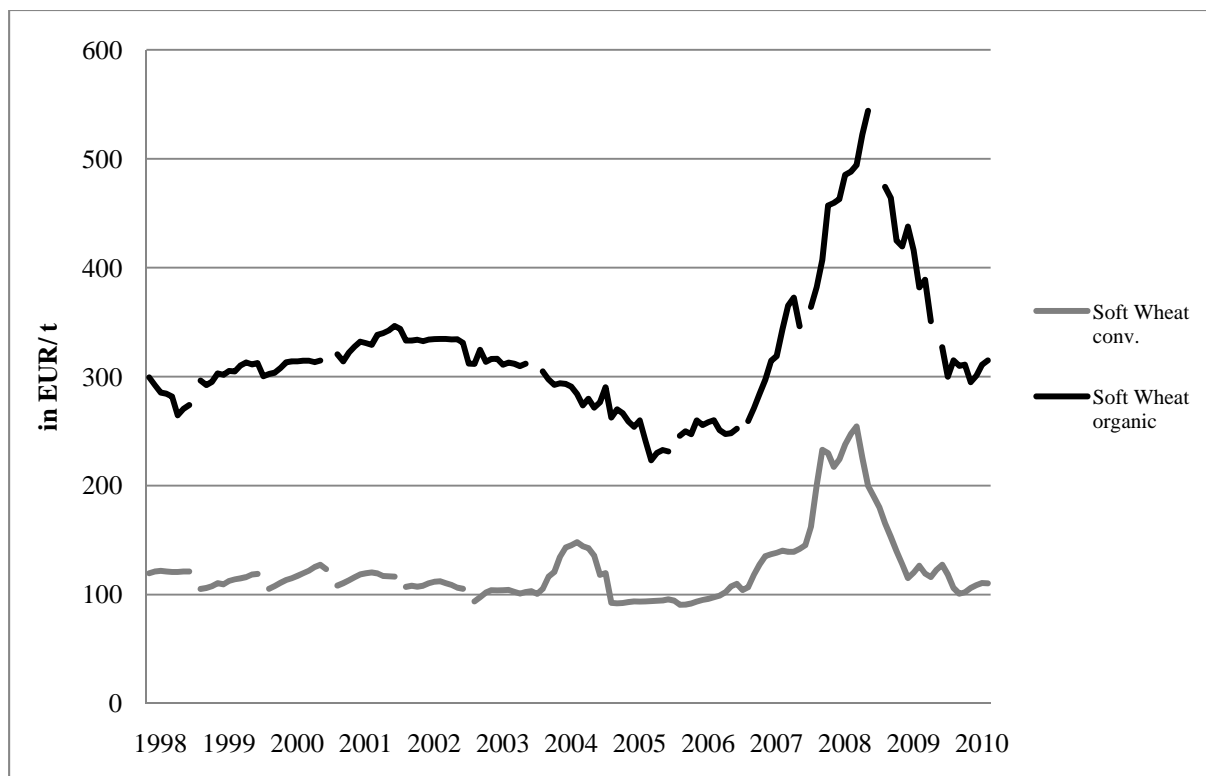
### 3 Data

We analyze monthly producer prices of conventional and organic soft wheat used to make bread. This data was obtained from the German Agricultural Data Service (ZMP/ AMI). The prices are monthly averages for traded quantities of at least two tons. The time frame of the analysis, between November 1997 and February 2010, was determined by the availability of data for organic wheat. As is visible in Figure 2, both price series possess a number of missing observations. These missing values often are present during the time before harvest, i.e., from May to July, because little or no trade took place during this period for some years. Following the WORLD BANK (2009: 87), we impute the missing values. The imputations are carried out using an adapted version of the algorithm of KING et al. (2001) and the R-package AMELIA II (HONAKER et al., 2009). For each missing value 1000 estimates were generated and the most probable value was chosen using the mode estimator of Parzan (1962). In the remainder of this section, we elaborate on the developments of the markets of both products.

## Price developments in the conventional wheat market

For conventional wheat, we present details for the years of the international food crisis between 2006 and 2008, as prices experienced a notable increase during this period in comparison with the average price level between 1997 and 2010. This was followed by a price decrease of the same magnitude (Figure 2).

**Figure 2: Producer Prices of Conventional and Organic Soft Wheat**



Sources: ZMP [a]; ZMP [b]; ZMP [c]; AMI (2010a, 2010b).

In February 2006 it was speculated that the price of wheat would face an upswing. This mainly had to do with the fact that, for six years, a decline in stocks was recorded, with the sole exception of the fiscal year 2004/05. At the same time it was expected that demand would increase due to growing import demand from Asia, and especially China. Already in May 2006, the first increases of wheat prices could be seen. The suspected reasons were market assessments, which were too optimistic, and bare inventories, which were confronted with an increase in consumption and bad weather conditions. In September 2006, wheat prices rapidly increased as the situation was exacerbated by a fast deterioration of the Australian wheat crop. Market analysts expressed doubts of whether the role of these shortages was given enough attention and whether these determinants adequately reflected reality<sup>2</sup>. In 2007, prices rose even more sharply and wheat prices reached the highest level in twenty years in Germany<sup>3</sup>. The inexorable rise in wheat prices highlighted that the most important cereal in

<sup>2</sup> A low relation between international grain-stocks and actual grain-consumption, bad weather conditions in the major producing regions and dubious predictions.

<sup>3</sup> In December 1988, the German wheat prices remained on a level of more than 200.00 EUR / t for more than 6 months. In August 2008, the price rose again to 200.41 EUR / t and remained on that level above 200 Euro / t until May 2008 (Data by ZMP [a], different years and AMI 2010: 156).

terms of nutrition had become scarce. The estimations of the United States Department of Agriculture also forecasted that stocks would reach their lowest level in thirty years. This presumption was also reflected in the EU cereal stocks. In the fiscal year 2007/08, the stocks of wheat held in intervention fell to just 600 t (AMI 2010a: 212). At the beginning of 2008, world cereal stocks were only sufficient to meet a demand of roughly 50 days. The consequence was the observed high volatility of grain prices as low stock levels were only to a very limited extent capable to buffer price movements. Supply and demand information obtained a much greater impact on prices than for example in the 1980s (BRÜMMER 2008:18).

### **Price developments in the organic wheat market**

For organic soft wheat, we summarize the developments over the last two decades because this covers the period of when the organic market obtained an economic importance and experienced a strong and steady growth in relation to the conventional wheat market. During the 1990s, the total area devoted to organic wheat farming increased just as strongly as the expansion of the total area under organic farming did. The strong rise in national demand, as well as additional favorable foreign imported organic wheat pressured the market price significantly. In contrast, conventionally produced wheat did not experience this development (ZMP, b, 1997). This has been seen as evidence that the conventional market does not affect the organic market and vice versa (ZMP, b, 1997). This suggests that the organic market, in its early years, was a niche market and hence could develop relatively independently of the conventional market. Due to weather related yield and quality losses in 1997/98, producers had the opportunity to market their grain at higher prices (ZMP, d, 2001). A balanced market situation also led to the organic boom in some of Germany's neighboring countries. In the harvest year of 2002, bad weather conditions in Germany led to a meager supply of high quality grain. However, this did not lead to a rise in prices as harvests in other countries had been sufficient and grain could be imported. Another factor that impacted the organic grain market was the fall in the prices of the conventional grain market (ZMP, d, 2003). In March 2005, the price for organic wheat fell again due to a large excess of supply (ZMP, a, 2007). In addition, conventional farmers experienced a bumper crop, so that the producer price for conventional bread wheat collapsed. In the fiscal year 2003/04, the price of conventional wheat had increased, while organic wheat prices did not benefit from this period of high prices and had even fallen steadily. On the other hand, the price collapse in August 2004 was transmitted to the organic market (ZMP, d, 2006).

The years 2006/07 were once again characterized by a demand for organically produced grain which had grown more than production (ZMP, a, 2007). However, the short supply at this time led to a rise in prices, as harvests across Europe had turned out badly. Similar to the conventional wheat market, prices for organic wheat reached hitherto unprecedented high levels in 2007/08. The maximum was reached in May 2008 at 544 EUR / t (AMI 2010a: 161). Similar to the conventional market, this was due to the poor harvests of previous years, to a growing demand and almost depleted stocks (ZMP, a, 2007).

## **4 Results**

Firstly, we test for the time series properties of wheat price series and subsequently estimate a VECM. The variable *org* is for producer prices of organic wheat and the variable *conv* is for producer prices of conventional wheat in EUR/t. We expect the producer price of conventional wheat to not be influenced by the price for organic wheat due to the relative importance of both markets. If prices adjust to existing disequilibria then only the organic

prices are likely to show this behavior since the market for organic wheat is considerably smaller than that of conventional wheat<sup>4</sup>.

Table 1 includes the results of the two employed unit root tests, the Augmented Dickey-Fuller (ADF) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. The tests on levels suggest that both time series are nonstationary; therefore, both tests are applied to the first differences of the series and suggest that these can be regarded as stationary. Hence, both price series are I(1), i.e., integrated of degree one.

**Table 1: ADF and KPSS Stationarity Tests**

Time series	ADF			KPSS		
		Optimal lags	Test statistic		Optimal lags	Test statistic
<b>org (level)</b>	No time trend, intercept	0	-1.461	Level stationarity	4	0.576**
	Time trend, intercept	0	-1.520	Trend stationarity	4	0.260***
<b>org (first difference)</b>	No time trend, intercept	0	-12.496***	Level stationarity	4	0.096
	Time trend, intercept	0	-12.461***	Trend stationarity	4	0.098 <sup>†</sup>
<b>conv (level)</b>	No time trend, intercept	1	-2.431	Level stationarity	4	0.548**
	Time trend, intercept	1	-2.535	Trend stationarity	4	0.163**
<b>conv (first difference)</b>	No time trend, intercept	0	-7.357***	Level stationarity	4	0.064
	Time trend, intercept	0	-7.333***	Trend stationarity	4	0.064

Source: Authors' calculations.

Note: Lag length selection according to Schwarz information criterion. One, two and three asterisks denote significance at the 10%, 5 and 1 % level, respectively.

Subsequently, cointegration of the two series is assessed using the Johansen Trace Test. Table 2 provides strong evidence that organic and conventional wheat prices are cointegrated at the 5% level of significance, that is, the both markets share a long-run price equilibrium relationship. Hence, we find the two markets to be integrated.

**Table 2: Johansen Cointegration Test**

Lags	Cointegration relations	p-value
2	0	<0.001
	1	0.403

Source: Authors' calculations. Lag length selection according to Schwarz information criterion.

Based on the robust Schwarz model selection criterion, we estimate a VECM with one lag. This choice is also economically reasonable since it is connected with the question of which price the farmer takes in his buying and selling decisions. The price of the previous month is likely to play a stronger role in the price formation of the current period than a price various months ago. We obtain the following estimates<sup>5</sup>:

$$\begin{aligned}
 \begin{bmatrix} \Delta org_t \\ \Delta conv_t \end{bmatrix} &= \begin{bmatrix} -0.153*** \\ 0.024^* \end{bmatrix} \begin{bmatrix} 1 & -2.236*** \end{bmatrix} \begin{bmatrix} org_{t-1} \\ conv_{t-1} \end{bmatrix} - 47.409^* \\
 &+ \begin{bmatrix} -0.111 & 0.046 \\ 0.018 & 0.508*** \end{bmatrix} \begin{bmatrix} \Delta org_{t-1} \\ \Delta conv_{t-1} \end{bmatrix} + \begin{bmatrix} u_t^{org} \\ u_t^{conv} \end{bmatrix} \quad (2)
 \end{aligned}$$

<sup>4</sup> In 2008, the total grain production in Germany amounted to 50 Mio t. The organic segment contributed 0.61 Mio t, which is a share of 1.1 % respective (AMI 2010b).

<sup>5</sup> One, two and three asterisks denote significance at the 10%, 5% and 1% level, respectively.

$\Delta$  denotes the first difference operator and hence quantifies the absolute change of the current to the previous period. Furthermore, the loading matrix gives information about how quickly the adjustment takes place. For organic soft wheat, the adjustment parameter is negative and significant at the 1% level. In contrast, producer prices of conventional soft wheat do not show significant error-correction at the 5% level, that is, they appear to be weakly exogenous. Comparing the adjustment behavior of the two prices, it is only the organic price which corrects disequilibria. For the producer price for organic soft wheat, the following equation is obtained:

$$\begin{aligned} \Delta org_t = & -0.153^{***}[org_{t-1} - 2.236^{***}conv_{t-1} - 47.409^*] \\ & -0.111\Delta org_{t-1} + 0.046\Delta conv_{t-1} + u_t^{org}. \end{aligned} \quad (3)$$

For the producer price for conventional soft wheat, the following equation is obtained:

$$\begin{aligned} \Delta conv_t = & 0.024^*[org_{t-1} - 2.236^{***}conv_{t-1} - 47.409^*] \\ & -0.018\Delta org_{t-1} + 0.508^{***}\Delta conv_{t-1} + u_t^{conv} \end{aligned} \quad (4)$$

The square brackets of the two equations contain the long-term price relationship, i.e., the expected equilibrium prices. This long-term relationship is the following:

$$org_t = 47.409 + 2.236 conv_t. \quad (5)$$

The equation shows that the producer price of organic soft wheat has a constant value of 47.41 €t and more than a two-fold of the respective producer price for conventional wheat. Above, it was mentioned that no explicit assumptions about the structural dependencies have to be made when using VEC models (HACKL 2005: 368). Therefore, the question on the nature of the relationship between the price time series for conventional and organic soft wheat arises. For this purpose, the Granger causality test will be employed. First, we check the null hypothesis that the conventional wheat price does not Granger-cause the organic wheat price. This means that future producer prices for organic soft wheat cannot be forecasted based on current output prices for conventional wheat. This hypothesis is rejected with a test statistic of 18.5164 corresponding to a p-value of <0.001. Second, we accept the null hypothesis that the organic wheat price does not Granger-cause the conventional wheat price. This hypothesis cannot be rejected since the p-value amounts to 0.379. Hence, the finding of the VECM is confirmed because only the producer price for organic wheat is Granger-caused by the output price for conventional wheat. This conclusion appears to be very plausible as the conventional wheat market is much larger than the organic wheat market. Therefore, it can be concluded that the conventional producer price is not affected by the organic production price.

## 5 Discussion and Conclusions

The importance of organic production in the agricultural sector has increased considerably during the last two decades. Hence, the economic analysis of this area of production is attracting growing interest. One issue not well examined is the linkages and interdependencies between the markets of organically and conventionally produced, that is, varieties of one commodity which differ by quality. We approach this question by assessing the integration between producer prices of organic and conventional wheat since it represents an important

product in both spheres. We analyze monthly price series data between 1997 and 2010 for Germany which boasts one of the largest organic sectors within the European Union.

This paper deals with the questions of how organic wheat prices behave in relation to conventional wheat prices. I aims at aswering whether markets for organic and conventional wheat are integrated. We estimate a long- run price equilibrium between the two producer prices. We confirm the expectation that only the organic price reacts to price disequilibria – a reasonable result since organic grain production is minute and the organic market does not influence the trading behavior of conventional traders.

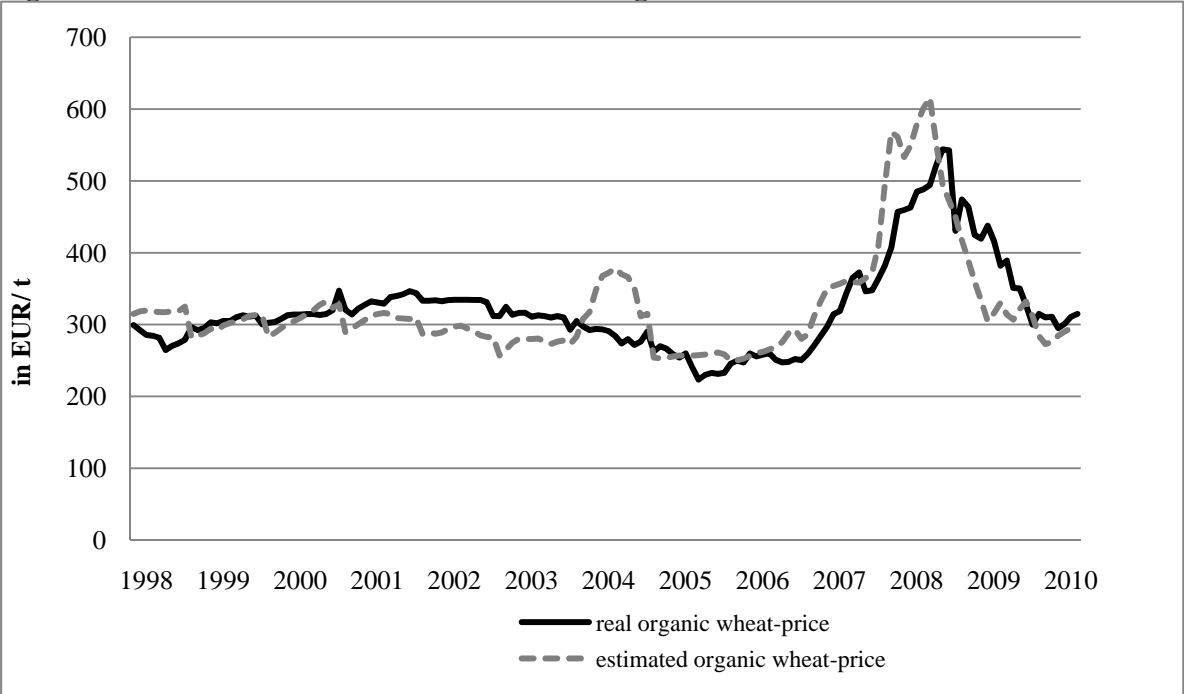
We find the two series to possess unit roots and obtain strong evidence that they are cointegrated. Hence, we conclude that both markets are integrated. This finding is economically very plausible because the two varieties of wheat share a certain degree of substitutability mainly due to linkages in marketing and usage. We estimate a vector error correction model of the two price series. As expected, it is the organic price which adjusts to price disequilibria while the conventional price does not respond to disequilibria. This finding is plausible in consideration of the size of the organic wheat market relative to the conventional one.

Furthermore, we estimate the following long-run equilibrium relationship:

$$org_t = 47.409 + 2.236 conv_t \tag{6}$$

We predict the expected organic equilibrium price based on the price series for conventional wheat according to equation (6) and compare it with the observed prices for organic wheat as shown in Figure 3.

**Figure 3: Observed vs. Predicted Prices for Organic Soft Wheat**



Source: authors' calculation based on ZMP [a, 2007: 242]; ZMP [c, 2008]; AMI (2010a: 161).

The predictions obviously fit the observed prices quite well, but the observed price deviated considerably from the expected equilibrium price during periods of extreme price increases and decreases of the conventional wheat price (as e.g. in 2004 and 2006/07).

In 2006/2007 the prices for conventional and organic wheat were reached an all time price peak followed by a harsh price decrease in 2008. BRÜMMER et al. (2008) analyzed the fundamental factors which caused the price peak. The demand for raw materials used for bio-energy was identified by MITCHELL (2008) as one of the factors that might have caused the price peak. According to BRÜMMER et al. (2008), bio-ethanol has an influence on world grain prices, and was not an underlying factor of the extreme price peak in 2007.

Nevertheless, the future the bio-energy market will have an influence on agricultural commodity prices, since a lot of industrial and transforming countries have decided to increase the use of bio-energy by means of supporting policies. In Germany fuel must be mixed with biodiesel and bio-ethanol and energy produced by biogas-plants is supported due to the Renewable Energy Act<sup>6</sup> (BRÜMMER et al. 2008). Other EU countries have similar policies, which are summarized and coordinated by the EU 'Biomass Action Plan' (EUROPEAN COMMISSION 2005). These policies will increase the production of bio-energy and the use of grains, and thereby also increase the demand for grains on national and EU markets (ISERMAYER and ZIMMER 2006).

We conclude that the current bio-energy market can be regarded as a new safety net of the domestic EU agricultural market, which is also the case for organic production. If prices for organic wheat are low and there does not seem to be demand for organic grain, organic farmers tend to sell their grain to conventional traders for conventional prices.

In periods of increasing prices on conventional markets as observed in 2006/07, traders of organic agricultural commodities tend to follow the general market trend and increase prices for organic products too. This might happen in order to avoid an increased demand for organic products due to a decreasing price gap between both sectors or to benefit from general market developments. In the opposite case, when conventional prices fall and organic prices do not, as observed in 2008, there is no incentive for organic traders to decrease prices. Organic farmers tend to sell then their grain to traders in the market of conventional product. Alternatively, they might sell to bio-energy producers, who are interested in buying commodities regardless of their quality. It might be interesting to include such factors into the analysis of price transmission between organic and conventional wheat in future research. Therefore, we suspect that asymmetric price behavior might be a crucial issue in price formation and price interdependencies. The analysis of the transmission of price signals and further information between organic and conventional markets is thus an area in which research efforts might advance the understanding of the linkages between both markets.

Therefore, prices of the conventional market play a considerable role in the price formation of organic products. However, due to the asymmetric substitutability between the organic and conventional wheat varieties, we suspect that the price interdependencies might also show asymmetric behaviour. Hence, more sophisticated cointegration models might be an area for further research. Suitable model classes for capturing these characteristics might encompass asymmetric price transmission models as in MEYER and VON CRAMON-TAUBADEL (2004). They discuss economic reasons for the asymmetric transmission of price signals. Among the main reasons for price dynamics are market power and adjustment costs. In the case of organic and conventional grains there might be a mixture of market power and missing links between the two markets. Furthermore, regime switching models as in BRÜMMER et al. (2009) or BUSSE et al. (2010) might be an interesting approach since they relax the implicit assumption of constant parameters over the observation range and instead are capable to model the price transmission as alternating regimes.

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<sup>6</sup> The renewable energy act ('Erneuerbares Energien Gesetz (EEG)') supports the biogas by means of an increased electricity price, which has to be paid by the energy companies, who run the regional electricity grid.

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