Integration of Biodiesel and Crude Oil Prices

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Abstract – We investigate the development of biodiesel prices in Germany in relationship to international crude oil prices between 2002 and 2009 using a Markov-switching vector error correction model. We find a low influence of crude oil prices during the period of strong biodiesel market growth. However, the biodiesel prices show strong reactions to crude oil prices from 2008 on, when the biodiesel market was challenged by high raw material costs, overcapacity in biodiesel production and increasing import competition. The price relationship between biodiesel and crude oil remained unchanged. While the market seems to have developed mainly insulated during the first years, a much stronger influence of the world market is found since 2008.

Introduction

The development of prices has been of interest for researches for a long time. Several authors analysed vertical (along the processing chain) and horizontal (between separated markets) price transmission. The basic idea is that if markets are linked by e.g. trade flows, price changes in one market should lead to changes in the other market(s) as well.

With the increasing use of agricultural commodities for energy production, changes in energy prices should have an influence on the development of agricultural commodity prices. The integration between both markets could be shown by several authors (for an overview see e.g. Busse, 2010). We add to this literature by analysing the influence of crude oil on the biodiesel price development in Germany during the past eight years with a focus on the effects of changing promotion policies, rising food prices and increasing import pressure.

Market Overview

In Germany, the growth of the biodiesel industry was mainly encouraged by investment assistance and tax exemptions granted since 2004. Until 2003, the use of vegetable oil as fuel was unregulated and, therefore, tax free. As excess profits in the biodiesel industry, resulting from this tax exemption, rose, the tax credit was reduced. An energy tax of 103 €/t of biodiesel sold as B100 (pure biodiesel), and a full taxation (541 €/t) for biodiesel used in blends was implemented in August 2006. Since 2007, diesel must be blended with 5% biodiesel (B5), which requires about 1.5 million tons of biodiesel per year. While mainly B100 was sold until 2005, the sales of B5 gained importance since 2006 when the market was challenged with taxation and increasing raw material costs.

Highest growth rates in production capacity occurred between 2004 and 2006 (Fig. 1) which resulted in a large gap between domestic production and capacity. Biodiesel imports did not play an important role until 2007 but the import pressure from subsidized US B99 became in particular problematic in 2008 before penalty tariffs were raised (COM, 2009). These imports reached their maximum in June 2008 at 250,000 tons per month (Eurostat, 2010). Given the excess capacity in combination with increased import pressure, the capacity growth slowed down in 2007 and a decline was observed in 2008.

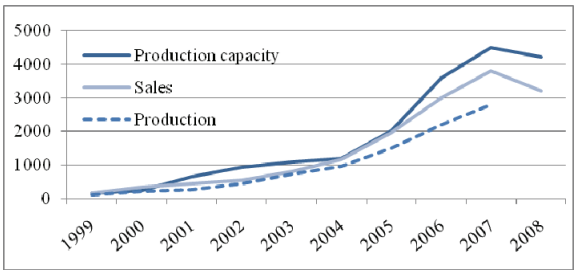

Figure 1. Production, production capacity and sales of biodiesel in Germany (1,000 tones)

Methods and Data

For the analysis, weekly prices for biodiesel and crude oil are used over a sample period form July 2002 until July 2009 (358 observations). The crude oil prices are Brent future prices one month forward (The Public Ledger, 2010). The biodiesel prices are German consumer prices at the petrol station including energy tax (UFOP, 2010). The prices are used in €/t net of VAT (Fig. 2).

We use a Markov-switching vector error correction model (MS-VECM) since the linearity assumption of the standard VECM is rejected. The MS-VECM is a regime-dependent time series model and was initially developed by Hamilton (1989). Krolzig (1997) gives a detailed account of the usage of the model in economic analysis. Regime-dependent models allow for a non-linear data generating process which is characterized by non-constant parameters. For a detailed review of the existing literature see Ihle (2010), and for an application of this framework to the European biodiesel complex see Busse (2010).

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Empirical Results

Statistical tests indicate unit roots in all price series as well as cointegration between biodiesel and crude oil. We estimate a MSIAH(3)-VECM which allows for Markov-switching in the error-correction coefficients, the intercept (I), the autoregressive parameters (A), and in the standard errors of the equations (heteroskedasticity, H) between the three regimes (3). The model is estimated using two lags, based on exclusion tests for higher order lag coefficients. The diagnostic tests indicate normally distributed residuals, and the absence of autocorrelation and heteroskedasticity; hence, the model seems appropriate for the data. The parameter estimates of the two most important regimes are presented in Table 1.

Table 1. Estimated coefficients of the MSIAH(3)-VECM for crude oil and biodiesel.

	Regime1		Regime2	
	Δp^{BD}	Δp^{CO}	Δp^{BD}	Δp^{CO}
Δp^{BD}_{t-1}	-0.1734**	-0.0372	-0.2885**	-0.1206
Δp^{BD}_{t-2}	0.0037	-0.0548	-0.3940***	-0.0691
Δp^{CO}_{t-1}	0.4512***	0.4201***	0.0932	0.0761
Δp^{CO}_{t-2}	0.0521	0.1446	0.1189*	-0.0146
α	-0.1052***	0.0116	-0.0214**	0.0037

Note: Standard deviation in parentheses; asterisks denote significance at the 1%(***), 5%(**) and 10%(*) level

The third regime is not presented here since it consists of only 8 observations and is characterized by an average duration of 1.3 weeks. Due to the very small number of observations, this regime should be interpreted with caution. The first two regimes show the expected behavior that crude oil prices do not react to past changes in biodiesel prices and do not display significant error-correction behavior.

These two regimes can be discriminated with respect to the biodiesel price behavior. Regime 1 shows a substantially stronger error-correction than regime 2. When ignoring any short-run adjustment, half of a deviation from equilibrium is corrected in regime 2 within 33 weeks while regime 1 needs less than 7 weeks. Furthermore, while the largest short-run impact comes from past crude oil price changes in regime 1, regime 2 shows strong reactions to past own price changes.

Discussion

The regime classification in the relationship between crude oil and biodiesel prices is plotted in Fig. 2. The classification is based on the highest probability of regime occurrence among the three regimes. It can be seen that regime 1, which is characterized by the strong influence of crude oil prices on the development of biodiesel prices, was mainly present in the beginning and the end of the sample period. In the phase of strong production growth, regime 2 was dominating.

From 2008 on, when the agricultural food price crisis occurred and the prices of both commodities were markedly increased, regime 3 occurs and frequent regime switches are observed. This can be seen as one aspect of the increased uncertainty in the markets during this period, likely caused by the strong changes in the support framework. However, also the increasing import pressure and rising raw material costs are likely explanatory factors. While the long-run equilibrium is unchanged, the dominance of regime 1 indicates a more crude oil oriented biodiesel price development.

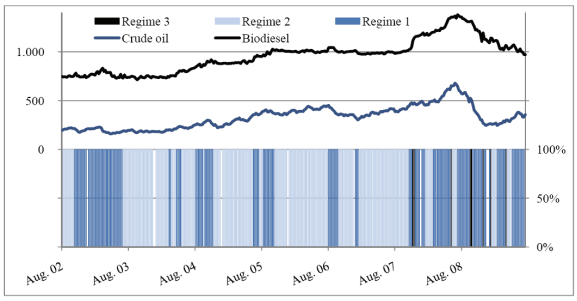

Figure 2. Biodiesel and crude oil prices (left scale) and regime occurrence (right scale).

Conclusions

In our analysis we found strong evidence for cointegration between German biodiesel and international crude oil prices. However, the price adjustment behavior is found to be regime dependent. While the biodiesel market developed mainly insulated until 2007, a stronger orientation to crude oil prices is observed in the past years. This rising international influence is caused by switches in the promotion framework, increasing import pressure from foreign biodiesel producers and temporarily increased raw material costs. The frequent regime switches reflect the high uncertainty present in the market today.

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