MEASURING MARKET INTEGRATION IN THE PRESENCE OF TRANSACTION COSTS - A THRESHOLD VECTOR ERROR CORRECTION APPROACH

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ABSTRACT

Applied econometric analyses of market integration based on price data alone have been criticised, because they neglect the role of transaction costs. To meet this objection threshold vector error correction models are used. Threshold models can account for the effects of transaction costs in price transmission without directly relying upon information about these costs, which are often unavailable. Results from threshold models that are based on two thresholds provide results that are economically more intuitive than those obtained from one threshold models. However there is no adequate econometric test for threshold significance in a two-threshold model available so far; such tests are only available for the one threshold model. In this paper a restricted two-threshold model is developed in which the significance of the thresholds can be tested. This model is therefore amenable to economic interpretation and statistical inference. This model is used to estimate market integration on the European pig market.

JEL classification codes: C32, F15
Keywords: Market integration, price transmission, transaction cost, threshold model

INTRODUCTION

Econometric analyses of market integration are becoming increasingly popular. Farmers as well as agricultural economists are interested to what extent price shocks are transmitted between markets. For example, German pig producers use the commodity exchange AEX in Amsterdam for hedging the price risk, assuming that German and Dutch markets are highly integrated. Economists often use market integration, defined as the degree of price transmission between two either vertically or spatially related markets, as a proxy for market efficiency. To answer questions about market integration, adequate empirical methods are necessary. Especially in recent years, these methods have improved considerably. Nevertheless there is still no unified approach to evaluate market integration[2]. Recent studies that rely on price data alone have been criticised by Barrett for their neglecting of transaction costs (Barrett 2001; Barrett & Li 2002). Due to commonly unavailable information on transaction costs, we therefore propose an approach of measuring market integration based on price data alone but also considering effects of transaction costs. Unlike most studies that analyse price adjustment between vertical related stages of the marketing chain we focus on spatial market integration. Hence our analysis is related to the literature on the "Law of one price" (Lo & Zivot 2001; Obstfeld & Taylor 1997). To quantify the price adjustment we use the framework of a vector error correction model (VECM). As an extension and innovation we also take testable threshold effects into account. To illustrate this approach we analyse market integration between pig markets in Germany and the Netherlands.
In the following section of the paper we describe the empirical method. In section 3 the results of our empirical application to German/Dutch pork markets are presented. In section 4 conclusions are drawn and suggestions for further research are given.

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[2] See Meyer & v.Cramon-Taubadel (2002) for an overview.

THRESHOLD VECTOR ERROR CORRECTION MODEL

Price series of agricultural commodities are often non-stationary. Therefore estimating price adjustment as the impact of a change in one price on another price should be based on appropriate methods which allow for non-stationary variables. In market integration models, the error correction model (ECM) specification has gained popularity because of its intuitively appealing interpretation. For example, v. Cramon-Taubadel (1998) analyses vertical price transmission between farm gate and wholesale pig prices in Germany using an ECM. To incorporate also effects of transaction costs into models of price transmission, threshold error correction models (TECM) have been developed. Based on work by Balke and Fomby (1997) many studies have been undertaken so far. Obstfeld and Taylor (1997) for example analyse the "Law of one Price" within such framework. Goodwin and Piggott use a threshold error correction model to quantify spatial integration in US corn and soybeans markets (Goodwin & Piggott 2001). Ben-Kaabia, Gil et al. (2002) estimate price transmission between vertically related stages of the Spanish lamb market using a threshold model. In the following we describe the concept of our analysis dealing with difficulties regarding the economic interpretation of the adjustment process and the econometric testability of threshold parameters. These issues have been frequently ignored in the literature.

On spatially integrated markets such as Germany and the Netherlands, where it is not apparently clear which price causes the other, the use of an vector error correction model (VECM) is appropriate. A specification of a VECM is given is the following equation:

$$\begin{bmatrix} \Delta p_t^{NL} \\ \Delta p_t^{GER} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \sum_{i=1}^{k} \begin{bmatrix} \beta_i^{NL,NL} & \beta_i^{NL,GER} \\ \beta_i^{GER,NL} & \beta_i^{GER,GER} \end{bmatrix} \begin{bmatrix} \Delta p_{t-i}^{NL} \\ \Delta p_{t-i}^{GER} \end{bmatrix} + \begin{bmatrix} \phi^{NL} \\ \phi^{GER} \end{bmatrix} \left[ECT_{t-1} \right] + \begin{bmatrix} \varepsilon_t^{NL} \\ \varepsilon_t^{GER} \end{bmatrix} \quad (1)$$

with $\Delta p_t = p_t - p_{t-1}$. Here changes in the Dutch as well as changes in the German pig price are simultaneously explained by constant terms ($\alpha_{1,2}$), lagged short-term reactions to previous changes in the Dutch and the German pig price (Δp_{t-i}) and by deviations from the long-term equilibrium denoted ECT.

If a VECM such as (1) is used to estimate price adjustment one implicit assumption has to be noted. Adjustment of prices induced by deviations from the long-term equilibrium (ECT) are assumed to be continuous and a linear function of the magnitude of the deviation from long-term equilibrium. So even very small deviations from the long-term equilibrium will always lead to an adjustment process on each market.[3] This assumption might lead to a biased result, because it ignores the impact of transaction costs. In spatial markets, transportation costs will limit the transmission of price shocks below a critical level because potential gains from trade cannot outweigh these costs and hence a perfect price adjustment will not occur.[4] Therefore in the case of significant transaction costs adjustment to the long-term equilibrium should not be continuous.

Taking these implications of transaction costs into consideration provides a justification for the use of models with price adjustment including thresholds, with the error-correction term (ECT) as the threshold variable.[5] Within such models, the extent to which deviations from equilibrium are responsible for a price adjustment depends on the magnitude of these deviations. The price adjustment process may be different if deviations are above or below a specific threshold.

In figure 1, price adjustment (Δp_t), as a function of deviations from the long-term equilibrium (ECT), is represented by a) a linear error-correction model (ECM), b) a one threshold error-correction model (TECM) and c) a two threshold error-correction model (TECM). Because of its discontinuous nature the TECM is often labelled as "non-linear".

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[3] Assuming that ϕ differs from zero, which is a necessary condition for cointegration and the existence of a long-term equilibrium.
[4] Heckscher first pointed out this argument (Heckscher 1916).
[5] Threshold models have been introduced by Tong (1978).

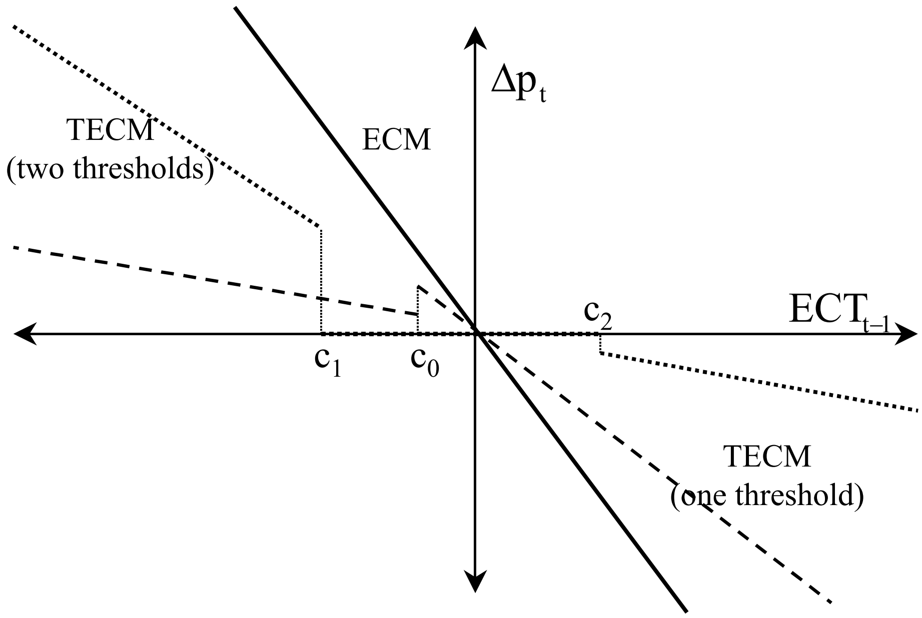

Figure 1. Impact of the error correction term on the price adjustment.

Based on the number of thresholds (c) the model contains c+1 different regimes of price adjustment. Studies on price transmission using threshold error correction models have either used one threshold (c_0) to separate the adjustment process into two regimes (Balke & Fomby 1997; Enders & Granger 1998; Abdulai 2002; Ben-Kaabia, Gil et al. 2002) or two thresholds (c_1 and c_2) to separate the adjustment process into three regimes[6] (Obstfeld & Taylor 1997; Goodwin & Piggott 2001; Serra & Goodwin 2002). We suggest that a price adjustment model with three regimes separated by two thresholds[7] can make more economic sense than a two-regime model with only one threshold. The band between the two thresholds, which are below and above the long-term equilibrium, can be interpreted as those deviations from the long-term equilibrium which are, compared to adjustment costs, so small that they will not lead to a long-term adjustment process of related prices. Results from a TECM with only one threshold cannot be interpreted in such an intuitively appealing way.

The advantage of easy interpretable results from a two-threshold error correction model is unfortunately weakened by the fact that so far no adequate econometric test for the significance of two thresholds has been developed (Hansen & Seo 2001). To overcome this problem, we use a variant of a one threshold vector error correction model (TVECM) proposed by Hansen and Seo (2001):

Regime 1

$$\begin{bmatrix} \Delta p_t^{NL} \\ \Delta p_t^{GER} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \sum_{i=1}^{k} \begin{bmatrix} \beta_i^{NL,NL} & \beta_i^{NL,GER} \\ \beta_i^{GER,NL} & \beta_i^{GER,GER} \end{bmatrix} \begin{bmatrix} \Delta p_{t-i}^{NL} \\ \Delta p_{t-i}^{GER} \end{bmatrix} + \begin{bmatrix} \phi_1^{NL} \\ \phi_1^{GER} \end{bmatrix} \left[ECT_{t-1} \right] + \begin{bmatrix} \varepsilon_t \\ \varepsilon_t \end{bmatrix} \text{ if } ECT_{t-1} \le \gamma$$

Regime 2

$$\begin{bmatrix} \Delta p_t^{NL} \\ \Delta p_t^{GER} \end{bmatrix} = \begin{bmatrix} \alpha_3 \\ \alpha_4 \end{bmatrix} + \sum_{i=1}^{k} \begin{bmatrix} \delta_i^{NL,NL} & \delta_i^{NL,GER} \\ \delta_i^{GER,NL} & \delta_i^{GER,GER} \end{bmatrix} \begin{bmatrix} \Delta p_{t-i}^{NL} \\ \Delta p_{t-i}^{GER} \end{bmatrix} + \begin{bmatrix} \phi_2^{NL} \\ \phi_2^{GER} \end{bmatrix} \left[ECT_{t-1} \right] + \begin{bmatrix} \mu_t \\ \mu_t \end{bmatrix} \text{ if } ECT_{t-1} > \gamma \quad (2)$$

Like the VECM (1) this one threshold model explains the price changes by short-term as well as long-term adjustment, but also conditional on the deviation from the long-term equilibrium. If the deviation from the long-term equilibrium is greater than the threshold γ, the price transmission process is defined by a different regime (regime 2) than in the case of smaller deviations from the long-term equilibrium (regime 1).

[6] Price adjustment defined by those long-term deviations between c_1 and c_2 must not necessarily equal to zero.
[7] One above the long-term equilibrium level and the other below the long-term equilibrium level.

As a variant and in the line with approaches by Balke and Fomby we propose the following specification of a TVECM (3):

Regime 1

$$\begin{bmatrix} \Delta p_t^{NL} \\ \Delta p_t^{GER} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \sum_{i=1}^{k} \begin{bmatrix} \beta_i^{NL,NL} & \beta_i^{NL,GER} \\ \beta_i^{GER,NL} & \beta_i^{GER,GER} \end{bmatrix} \begin{bmatrix} \Delta p_{t-i}^{NL} \\ \Delta p_{t-i}^{GER} \end{bmatrix} + \begin{bmatrix} \phi_1^{NL} \\ \phi_1^{GER} \end{bmatrix} \left[ECT_{t-1} \right] + \begin{bmatrix} \varepsilon_t \\ \varepsilon_t \end{bmatrix} \text{ if } \left| ECT_{t-1} \right| \le \gamma$$

Regime 2

$$\begin{bmatrix} \Delta p_t^{NL} \\ \Delta p_t^{GER} \end{bmatrix} = \begin{bmatrix} \alpha_3 \\ \alpha_4 \end{bmatrix} + \sum_{i=1}^{k} \begin{bmatrix} \delta_i^{NL,NL} & \delta_i^{NL,GER} \\ \delta_i^{GER,NL} & \delta_i^{GER,GER} \end{bmatrix} \begin{bmatrix} \Delta p_{t-i}^{NL} \\ \Delta p_{t-i}^{GER} \end{bmatrix} + \begin{bmatrix} \phi_2^{NL} \\ \phi_2^{GER} \end{bmatrix} \left[ECT_{t-1} \right] + \begin{bmatrix} \mu_t \\ \mu_t \end{bmatrix} \text{ if } \left| ECT_{t-1} \right| > \gamma$$

The difference between (2) and (3) is the regime definition. In specification (2) one price adjustment process applies if the deviations from the long-term equilibrium are below a threshold (regime 1) and another applies if the deviations are above a threshold (regime 2)[8]. This specification excludes the possibility of a "band of non-adjustment"[9] of smaller deviations from a long-term equilibrium inside a regime of adjustment to bigger deviations (figure 2). Specification (3) allows this and is therefore economically more meaningful. Using TVECM (3) we assume one regime of price adjustment defined by absolute deviations from the long-term equilibrium that are below the threshold γ (regime 1) and another defined by deviations that exceed the threshold γ in absolute values (regime 2). Because of this regime definition we yield a TVECM that is based on only one threshold (γ) and therefore is testable regarding threshold significance, but that also potentially allows for the economically meaningful "band of non-adjustment" (regime 1) inside a regime of price adjustment to greater deviations from the long-term equilibrium (regime 2). Note that TVECM (3) is essentially a restricted version of the general two threshold model depicted in figure 1; restricted in the sense that $c_1 = c_2 = |\gamma|$ in (3) and in the sense that no asymmetric price transmission is possible in (3) as the same price reaction occurs regardless of whether ECT_{t-1}.is larger than γ or smaller than $-\gamma$. The simple linear ECM in figure 1, in turn, is a restricted form of (3) in which γ=0.

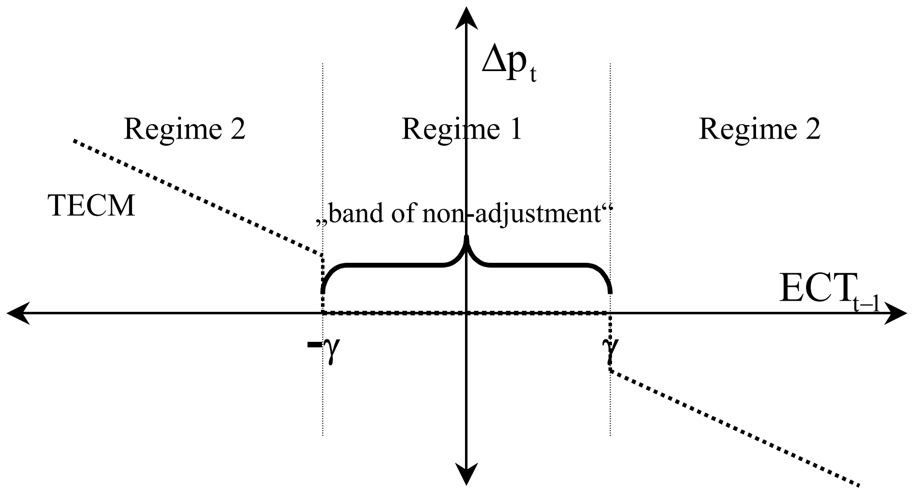

Figure 2. Impact of the error correction term on the price adjustment.

We propose a three-step procedure to estimate the restricted TVECM (3). In a first step the two series of prices to be analysed for integration are tested for stationarity, using the augmented Dickey-Fuller (ADF) unit root test. After the confirmation of non-stationarity the price series are tested for cointegration using the Johansen method.

For comparison reasons and if non-stationarity as well as cointegration can be concluded, a linear vector error correction model (1) is estimated in a second step using the error correction term generated by the

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8 Compare with figure 1 (One threshold model).

9 Goodwin and Piggott (2001) denote these deviations as a "neutral band".

Johansen method. The number of included lags (k) is determined by the Akaike information criterion (AIC). To estimate the more general threshold vector error correction model (3) we have to determine the threshold γ. For this we use a variant of the Hansen and Seo (2001) search procedure[10] that relies on the log determinant of the estimated error covariance matrix of (3) as the selection criteria. The selection criteria has the following form:

$$\zeta(\hat{\gamma})=\min\left(\log\left|\frac{1}{n}\sum_{t=1}^{n}\hat{\varepsilon}_t(\gamma)\hat{\varepsilon}_t(\gamma)'\right|\right) \tag{4}$$

Goodwin and Piggott (2001) use a different selection criterion that is based on the trace of the variance-covariance matrix of the residuals. This selection criterion ignores the potential cross correlation between the two equations of (3). In a paper Serra and Goodwin (2002) focus on the issues of choosing selection criteria.

Using a Monte Carlo experiment they found no empirical support that ignoring the cross-equation correlation leads to incorrect estimates of the threshold.

The value of γ that minimises (4) is chosen. Imposed on this search procedure is the restriction that both regimes should contain at least a pre-specified fraction (π_0) of the total sample.[11] Hence the following expression should always be satisfied:

$$\pi_0 \leq P\left(\left|ECT_{t-1}\right| \leq \gamma\right) \leq 1-\pi_0 \tag{5}$$

After determining the threshold parameter γ, the statistical significance of the threshold is calculated in a third step. Because of the unidentified nuisance parameter (γ) that is not present in the non-linear model (1), conventional tests statistics have non-standard distributions. Therefore, Hansen and Seo propose the use of a SupLM test and bootstrapping techniques to calculate p-values.

RESULTS OF AN EMPIRICAL APPLICATION

For our analysis we have chosen pig prices in Germany and the Netherlands, both major pig markets in Europe. The share of German pig production in total EU production was 21% in 1995, and the share of Dutch pig production was 13% (ZMP 1999). In our analysis we use weekly price data for pigs (€/100kg slaughterweight). The price data is collected in the Netherlands and Germany at the farm gate level and provided by the ZMP (Zentrale Markt- und Preisberichtstelle). Our price series starts in June 1989 and ends in March 2001. 14 weeks with missing data in one or both countries have been omitted from the sample. Therefore our total sample for this period contains 600 observations. For further analysis we use the logarithmic form of the price data.

The augmented Dickey-Fuller (ADF) test confirms a unit-root in the pig price series for the Netherlands and also in the series of pig prices in Germany (see table 1). Johansen's maximum eigenvalue statistic as well as the Johansen trace statistic reject the null hypothesis of no cointegrating vector at a significance level of 99% (see table 1) [12]. After normalization with respect to the Dutch pig prices[13], we calculate the cointegration relationship (table 1) and obtain residuals, which can be interpreted as deviations from a long-term equilibrium.

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[10] We only search over the threshold parameter γ and not also over the cointegration parameter(s).
[11] For the empirical application we set the trimming parameter to 0.05. Therefore each regime is restricted to contain at least 5% of all observations. Hansen & Seo 2002; Ben-Kaabia & Gil et al. 2002 and Goodwin & Piggott 2001 choose the same value.
[12] The constant is suppressed from the fitted regression and included in the cointegration regression.
[13] Normalisation with respect to the German pig prices leads to very similar results.

Table 1: Unit-root, cointegration and threshold testing results

Test	Test Statistic	Critical Value[a]
Augmented Dickey-Fuller (ADF)		
- constant term in the fitted regression / two lagges		
German pig price	-2.547	-2.871
Dutch pig price	-2.494	-2.871
Johansen method		
maximum eigenvalue test statistic	63.95	19.83
trace test statistic	73.21	24.99
- cointegration relationship		
ln p(Netherland) = -1.01 + 1.18 ln p(Germany) + ε		
Hansen's threshold test		
SupLM test	28.41	27.05

[a] ADF-Test 5% sig. / Johansen 99% sig./ Hansen fixed regressor bootstrap 5% sig.
Source: own calculation

After determining the deviations from the long-term equilibrium we define the appropriate lag-length of a VECM using the Akaike information criterion. The AIC suggest to include two lags (k=2) into the model. To compare results from a VECM (1) with those of a TVECM (3) the estimated coefficients of the VECM as well as heteroskedasticity-robust Eicker-White standard errors (in italics) for these coefficients are presented below:

$$\begin{bmatrix}\Delta p_t^{NL}\\ \Delta p_t^{GER}\end{bmatrix}=\begin{bmatrix}0.000\\ (\mathit{0.002})\\ 0.000\\ (\mathit{0.001})\end{bmatrix}+\begin{bmatrix}-0.062 & 0.581\\ (\mathit{0.121}) & (\mathit{0.119})\\ 0.046 & 0.296\\ (\mathit{0.049}) & (\mathit{0.078})\end{bmatrix}\begin{bmatrix}\Delta p_{t-1}^{NL}\\ \Delta p_{t-1}^{GER}\end{bmatrix}+\begin{bmatrix}-0.121 & -0.164\\ (\mathit{0.075}) & (\mathit{0.109})\\ 0.050 & -0.166\\ (\mathit{0.038}) & (\mathit{0.059})\end{bmatrix}\begin{bmatrix}\Delta p_{t-2}^{NL}\\ \Delta p_{t-2}^{GER}\end{bmatrix}+\begin{bmatrix}-0.114\\ (\mathit{0.054})\\ 0.068\\ (\mathit{0.031})\end{bmatrix}\left[ECT_{t-1}\right]+\begin{bmatrix}\varepsilon_t^{NL}\\ \varepsilon_t^{GER}\end{bmatrix}$$

The Breusch-Godfrey test indicates the presence of autocorrelation at the 5% significance level. Autocorrelation may be due to a misspecified functional form. As we will see below the TVECM does not suffer from autocorrelation. Hence the results of autocorrelation might be interpreted as evidence in favour of the TVECM. Due to the autocorrelated residuals of the VECM, the results can only be interpreted with caution. Lagged price changes in the Netherlands ($\Delta p_{t-1}^{NL};\Delta p_{t-2}^{NL}$) have no significant effect on the price adjustment in Germany or the Netherlands, whereas lagged price changes in Germany seem to have a short-term effect on price adjustment (except Δp_{t-2}^{GER} on Δp_t^{NL}). The estimated coefficients for the adjustment to deviations from the long-term equilibrium indicate a stronger reaction of pig prices in the Netherlands to such deviations ($\phi^{NL}=-0.114$) than in Germany ($\phi^{GER}=0.068$).

Applying the described search procedure yields a threshold parameter of γ=0.095. Based on this parameter the TVECM (3) is divided into two regimes. Regime 1 is defined by those weekly prices where the absolute deviation from the long-term equilibrium is below 9.5%. Calculated at average prices this deviation represent roughly 14 €/100kg slaughterweight. Thus if the deviation from the long-term equilibrium is below 14 €/100kg slaughterweight, no adjustment will occur. For every observation in regime 2 the absolute deviation from the long-term equilibrium is above 9.5%. The adjustment regime 1 (the "band of non-adjustment") contains 94,6% of all observations. This adjustment regime can therefore be denoted as the "general" regime whereas regime 2, containing only 5,4% of all observations, is referred as an "extreme" regime, containing bigger deviations from the long-term equilibrium. Using Hansen's fixed regressor bootstrap technique with 10.000 replications we find the critical threshold to be significant at 5% (p-value = 0.032). Results for the SupLM tests can be found in Table 1.

Estimated coefficients of the general threshold vector error correction model and also Eicker-White standard errors of these coefficients (in italics) are as follows:

Regime 1

$$\begin{bmatrix}\Delta p_t^{NL}\\ \Delta p_t^{GER}\end{bmatrix}=\begin{bmatrix}0.001\\ (\mathit{0.002})\\ 0.000\\ (\mathit{0.001})\end{bmatrix}+\begin{bmatrix}0.082 & 0.469\\ (\mathit{0.068}) & (\mathit{0.085})\\ 0.050 & 0.319\\ (\mathit{0.046}) & (\mathit{0.064})\end{bmatrix}\begin{bmatrix}\Delta p_{t-1}^{NL}\\ \Delta p_{t-1}^{GER}\end{bmatrix}+\begin{bmatrix}-0.073 & -0.243\\ (\mathit{0.061}) & (0.093)\\ 0.059 & -0.189\\ (\mathit{0.038}) & (\mathit{0.061})\end{bmatrix}\begin{bmatrix}\Delta p_{t-2}^{NL}\\ \Delta p_{t-2}^{GER}\end{bmatrix}+\begin{bmatrix}-0.084\\ (\mathit{0.047})\\ 0.045\\ (\mathit{0.032})\end{bmatrix}\left[ECT_{t-1}\right]+\begin{bmatrix}\varepsilon_t\\ \varepsilon_t\end{bmatrix}\text{ if }\left|ECT_{t-1}\right|\leq 0.095$$

Regime 2

$$\begin{bmatrix}\Delta p_t^{NL}\\ \Delta p_t^{GER}\end{bmatrix}=\begin{bmatrix}-0.019\\ (\mathit{0.013})\\ -0.027\\ (\mathit{0.012})\end{bmatrix}+\begin{bmatrix}-0.935 & 0.709\\ (\mathit{0.221}) & (\mathit{0.273})\\ -0.210 & 0.100\\ (\mathit{0.127}) & (\mathit{0.301})\end{bmatrix}\begin{bmatrix}\Delta p_{t-1}^{NL}\\ \Delta p_{t-1}^{GER}\end{bmatrix}+\begin{bmatrix}-0.525 & 0.711\\ (\mathit{0.334}) & (\mathit{0.395})\\ -0.496 & 0.766\\ (\mathit{0.239}) & (\mathit{0.385})\end{bmatrix}\begin{bmatrix}\Delta p_{t-2}^{NL}\\ \Delta p_{t-2}^{GER}\end{bmatrix}+\begin{bmatrix}0.249\\ (\mathit{0.143})\\ 0.417\\ (\mathit{0.120})\end{bmatrix}\left[ECT_{t-1}\right]+\begin{bmatrix}\mu_t\\ \mu_t\end{bmatrix}\text{ if }\left|ECT_{t-1}\right|>0.095$$

Estimated coefficients in regime 1 are similar to the estimates from the linear VECM. As in the VECM, only short-term reactions to lagged price changes in Germany have a significant effect on the German or Dutch pig price changes in the TVECM. But unlike the VECM, the threshold model shows no significant adjustment to deviations from the long-term equilibrium, if these deviations are below the critical threshold (regime 1). These results are in line with assumed transaction costs that prohibit a perfect price adjustment. Only if the absolute deviations from the long-term equilibrium are above the critical threshold (regime 2) adjustment does take place. These expected results can be found in the strong adjustment of the German pig price to deviations from the long-term equilibrium contained in regime 2 ($\phi_2^{GER}=0.417$). The Dutch price shows no significant adjustment to deviations from the long-term equilibrium in both regimes.

Price adjustment according to the estimated VECM differs considerably from adjustment according to the TVECM. The VECM suggest that the Dutch pig price as well as the German price react to deviations from the long-term equilibrium. The potentially more meaningful TVECM indicates no significant reaction of the Dutch price to such deviations. Price leadership analyses that are based on estimated reactions to deviations from the long-term equilibrium (eg. Kuiper & Meulenberg 2002) will be sensitive to those differences.

CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

Analyses of market integration based on price data alone have been criticised, because they often neglect the role of transaction costs. To overcome this critique we suggest the use of threshold vector error correction models. These models can account for the effects of transaction costs in price transmission, without directly relying on transaction cost data. A three regime TVECM would be most suitable to fit the economic requirements for the analysis of price adjustment, but unfortunately so far no consistent statistical test for the significance of two thresholds is available. Therefore we propose a testable two-regime threshold model that includes a “band of non-adjustment”. Our results show that ignoring threshold effects lead to misleading results.

Clearly the use of TVECM for analysing price adjustment is at its beginning. Tests for a three regime TVECM could be developed. Such models would have the advantage of capturing potential asymmetric price adjustment processes. A generalization to a multivariate model considering adjustment of more than two prices is also of interest, as are models that explicitly account for transaction costs.

The TVECM is based on the assumption of constant transaction costs through the analysed period. If market integration is expected to increase over time e.g. due to decreasing transaction costs, the TVECM could be extended to variable thresholds.

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