Asymmetric Price Transmission: Fact or Artefact? [1]

S. von Cramon-Taubadel and Jochen Meyer

Department of Agricultural Economics, Göttingen, Germany

E-Mail : scramon@gwdg.de and mail@jochenmeyer.de

Abstract :

Asymmetric price transmission, especially between vertically separated markets, has been a subject of considerable attention in agricultural economics. Asymmetric price transmission is not only important because it may point to gaps in economic theory, but also because its presence is often considered for policy purposes to be evidence of market failure.

The focus of our research lies on the methods used to determine whether price transmission is asymmetric or symmetric.

We analyse the behaviour of a variety of common tests for asymmetry in the presence of structural breaks in the underlying data. The hypothesis that we wish to test is that such anomalies in the underlying data can lead to overrejection of the null hypothesis of symmetric transmission. The results of Monte-Carlo experiments demonstrate that in the presence of structural breaks in symmetrically linked price data, tests will tend to reject the null hypothesis of symmetric transmission at the 5% level of significance in considerably more than 5% of a large number of repetitions. In other words, in the presence of structural breaks, it appears that the true size of tests for asymmetric price transmission is considerably larger than the chosen significance level. This implies that what in many studies appears to be asymmetric price transmission may in fact be due to other causes.

Keywords: Asymmetric price transmission, structural breaks, Monte-Carlo analysis

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Asymmetric Price Transmission: Fact or Artefact?

S. von Cramon-Taubadel and Jochen Meyer
Department of Agricultural Economics, Göttingen, Germany

Asymmetric price transmission, especially between vertically separated markets, has been a subject of considerable attention in agricultural economics (see i.e. the literature cited in VON CRAMON-TAUBADEL, 1998, and HARPER & GOODWIN, 1999). Outside of agriculture, gasoline and fuel markets have also been tested for asymmetric price transmission (see BORENSTEIN, CAMERON & GILBERT, 1997) while BALKE & FOMBY (1997) and ENDERS & GRANGER (1998) find evidence of asymmetric adjustment between interest rates of different maturities. Most recently, PELTZMAN (2000) has conducted an exhaustive study of price transmission for several hundred producer and consumer goods in the United States. PELTZMAN finds evidence of asymmetric price transmission in over two -thirds of all the markets he studies, and concludes than since asymmetric transmission appears to be the rule rather than the exception, standard economic theory, which does not account for asymmetric transmission, is "wrong" (p. 493).

Asymmetric price transmission is not only important because it may point to gaps in economic theory, but also because its presence is often considered for policy purposes to be evidence of market failure. Although there are many potential causes of asymmetric price transmission (see the discussions in PELTZMAN, VON CRAMON-TAUBADEL), the empirical methods used to detect this asymmetric price transmission do not allow us to differentiate between different possible causes. In political discussions and debates, asymmetric price transmission is very often considered a result of the abuse of market power. Hence, asymmetric price transmission on pork markets is tied to concentration in the slaughter industry and retail sector, and German politicians argue that reducing gasoline taxes would not lower prices at the pump for consumers because oil multinationals and the OPEC countries would quickly adjust their margins correspondingly. The implication is that asymmetric price transmission is due to imperfect competition which, in turn, implies that markets are not efficient.

Whether we are interested in asymmetric price transmission because of its implications for economic theory, because of its implications for market efficiency, or both, it is clear that we must be certain that the methods employed to detect asymmetric price transmission are reasonably accurate before we jump to far-reaching conclusions. Over the last three decades, most attempts to test for the presence of asymmetric price transmission have been based on a variable splitting technique for detecting irreversible supply reactions developed by WOLFFRAM (1971) and later adapted by HOUCK (1977) and WARD (1982). In 1994, VON CRAMON-TAUBADEL & FAHLBUSCH demonstrated that an asymmetric error correction model (ECM) based on GRANGER & LEE (1989) could be used to test for asymmetric price transmission. VON CRAMON-TAUBADEL & LOY (1999) extended this application of the asymmetric ECM and demonstrated that it is more appropriate than the use of the Houck approach if the price data being studied are cointegrated. Most recently, ABDULAI & RIEDER (1999) and HARPER & GOODWIN (1999) use a threshold autoregressive test for unit roots to test for the presence of asymmetric price transmission and argue that this method has several advantages over that proposed by VON CRAMON-TAUBADEL & FAHLBUSCH.

In the following, we analyse the behaviour of a variety of common tests for asymmetry - ranging from various forms of the Houck and the asymmetric ECM approaches to the threshold autoregressive approach - in the presence of structural breaks in the underlying data. We choose to study structural breaks as one of a number of anomalies (others include, for example, error terms with 'fat tails') that are commonly observed in the price data that is tested for asymmetric transmission and that might be expected to have an impact on the behaviour of the corresponding tests. It is reasonable to expect that phenomenon such as increasing concentration at various levels of the marketing chain and changes in government policy that effect market outcomes in agriculture will lead to structural changes in the relationships linking prices at different levels of the marketing chain. The hypothesis that we wish to test in this paper is that such structural changes in price data create the false impression of asymmetric price transmission.

We use a Monte-Carlo approach to demonstrate that in the presence of structural breaks in symmetrically linked price data, tests tend to reject the null hypothesis of symmetric transmission at the 5% level of significance in considerably more than 5% of a large number of repetitions. In other words, in the presence of structural breaks, it appears that the true size of tests for asymmetric price transmission is considerably larger than the chosen significance level. This implies that what appears to be asymmetric price transmission in empirical studies such as PELZMAN's may in fact be due to other causes.

This paper is structured as follows: We begin in section 1 with an overview of various tests for asymmetric price transmission. In section 2 we than proceed to outline the structure of the Monte Carlo experiments to which these tests are subjected. In section 3 we present the results of these experiments and in section 4 we close the paper with some brief conclusions and suggestions for future research.

1. Tests for asymmetric price transmission

In the following we briefly introduce eight tests for asymmetric price transmission that will be subjected to Monte-Carlo analysis in later sections.

1.1 The Houck approach

Based on HOUCK (1977) many authors have developed a test for asymmetric price transmission based on the segmentation of price variables into increasing and decreasing phases (BOYD & BRORSEN, 1988; KINNUCAN & FORKER, 1987; BAILEY & BRORSEN, 1989; ZHANG, FLETCHER & CARLEY, 1995; MOHANTY, PETERSON & KRUSE, 1995). HOUCK proposed a static asymmetric model that can be written as:

$$\Delta P_{it} = a_0 + a_1 \Delta P_{jt}^{+} + a_2 \Delta P_{jt}^{-} + e_t \qquad (1)$$

where P_i and P_j = prices at different levels of the marketing chain,

t = 1, 2, ..., T (a time index),

D = is the first difference operator, and

$D P_{jt}^{+} = P_{jt} - P_{jt-1}$, if $P_{jt} > P_{jt-1}$ and 0 otherwise, and

$D P_{jt}^{-} = P_{jt} - P_{jt-1}$, if $P_{jt} < P_{jt-1}$ and 0 otherwise.

PELTZMAN considers the following reparameterisation of (1):

$$D P_{it} = a_0 + a_1(D P_{jt}^{+} + D P_{jt}^{-}) + (a_2 - a_1)(D P_{jt}^{-}) + e_t$$

$$= a_0 + a_1 D P_{jt} + a_2^{*} D P_{jt}^{-} + e_t \qquad (2)$$

PELZMAN tests for asymmetry by considering the significance of the coefficient a_2^{*}, whereby he includes k lagged values of the independent variables to account for dynamic responses.

This is equivalent to testing whether $a_1 = a_2$ in (1), which is the first test, refered in the following to as *Houck-I* that we subject to the Monte Carlo experiment belows.

HOUCK himself proposes taking the sum of both sides of equation (1) to derive the following:

$$\sum_{t=1}^{t} \Delta P_{it} = a_0 t + a_1 \sum_{t=1}^{t} \Delta P_{jt}^{+} + a_2 \sum_{t=1}^{t} \Delta P_{jt}^{-} + v_t \qquad (3)$$

which can be rearranged as follows:

$$P_{iT} = P_{i0} + a_0 t + a_1 P_{jt}^{UP} + a_2 P_{jt}^{DOWN} + v_t \qquad (4)$$

where P_{jt}^{UP} is the sum of all positive changes in price j from $t=1$ to t and P_{jt}^{DOWN} is the corresponding sum of all negative changes in price j over the same period. While some authors recognise that the summation of (1) to derive (3) and (4) leads to the introduction of a trend term (see, for example, KINNUCAN & FORKER; ZHANG, FLETCHER & CARLEY) others (such as MOHANTY, PETERSON & KRUSE) do not, estimating the following equation instead:

$$P_{iT} = P_{i0} + a_0^{*} + a_1 P_{jt}^{UP} + a_2 P_{jt}^{DOWN} + v_t \qquad (5)$$

In the following we refer to (5) as *Houck-II* and (3) or (4) as *Houck-III*. Note that in many applications, lags are incorportated into (3), (4) or (5) to allow for dynamic price response. This leads to specifications such as:

$$P_{iT} = a_0^{*} + \sum_{\ell=1}^{k} a_{1\ell} P_{jt-\ell}^{UP} + \sum_{\ell=1}^{k} a_{2\ell} P_{jt-\ell}^{DOWN} + v_t \qquad (6)$$

in which short-run and long-run symmetry are rejected when individual $a_{1\ell}$ and $a_{2\ell}$ terms are unequal and when $\sum_{l=1}^{K} a_{1\ell} \neq \sum_{l=1}^{K} a_{2l}$, respectively.

1.2 The asymmetric error correction model

The asymmetric ECM approach is motivated by the fact that all of the variants of the Houck approach discussed above are not consistent with cointegration between the price series involved (VON CRAMON-TAUBADEL, 1998, and VON CRAMON-TAUBADEL & LOY, 1999). The fundamental problem with specifications derived from the Houck approach is that they are all based on a simple VAR in differences (1). This is not an appropriate specification for cointegrated variables because it does not take advantage of the information that is reflected in their levels. Furthermore, note that the summation applied to (1) to derive (3) through (6) changes the nature of the error term: if e_t in (1) is a stationary random error, then v_t in (3) through (6) will be a random walk.

If P_i and P_j are cointegrated then an error correction representation exists (ENGLE & GRANGER, 1987) which can be depicted as follows:

$$D P_{it} = a_0 + a_1 D P_{jt} + a_2 ECT_{t-1} + a_3(L) D P_{it-1} + a_4(L) D P_{jt-1} + e_t \quad (7)$$

where $ECT_t = P_{it} - b_0 - b_1 P_{jt}$ (deviations from the cointegrating relation between P_i and P_j),

$a_3(L)$ and $a_4(L)$ = lag polynomials.

GRANGER & LEE (1989) propose a modification to (7) that involves segmentation of the error correction term ECT into its positive and negative components:

$$D P_{it} = a_0 + a_1 D P_{jt} + a_2^+ ECT_{t-1}^+ + a_2^- ECT_{t-1}^- + a_3(L) D P_{it-1} + a_4(L) D P_{jt-1} + e_t \quad (8)$$

where $ECT_{t-1}^+ = ECT_{t-1}$ if $ECT_{t-1} > 0$ and 0 otherwise, and

$ECT_{t-1}^- = ECT_{t-1}$ if $ECT_{t-1} < 0$ and 0 otherwise.

An F-test can be used to test whether $a_2^+ = a_2^-$, and, hence, whether price transmission between P_i and P_j is symmetric. We refer to this method, first applied to price transmission by VON CRAMON-TAUBADEL & FAHLBUSCH, as *ECM-I*. VON CRAMON-TAUBADEL & LOY (1999) consider a more general specification, refered to in the following as *ECM-II*, in which both the error correction term and exogenous price change are segmented:[2]

$$\Delta P_{it} = a_0 + a_1^+ \Delta P_{jt}^+ + a_1^- \Delta P_{jt}^- + a_2^+ ECT_{t-1}^+ + a_2^- ECT_{t-1}^- + a_3(L) \Delta P_{it-1} + a_4(L) \Delta P_{jt-1} + e_t \quad (9)$$

and both $a_1^+ = a_1^-$ and $a_2^+ = a_2^-$ can be tested.

Both of these ECM methods involve the estimation of a restricted form of the asymmetric ECM in which the error correction term is first estimated and then segmented. VON CRAMON-TAUBADEL & LOY also propose an unrestricted asymmetric ECM based on an augmented distributed lag (ADL) model with segmented variables (without loss of generality we consider only an ADL(1,1) in the following):

[2] BORENSTEIN ET AL. (1997) estimate an equation that is based on the Houck approach but includes an error correction term to account for the long-run relationship between retail gasoline and crude oil prices. Their model is therefore an ECM intermediate to (8) and (9) in which the contemporaneous and lagged changes of the exogenous price are segmented and the error correction term is not.

$$P_{it} = a_0 + a_1^+ P_{it-1}^{UP} + a_1^- P_{it-1}^{DOWN} + a_2^+ P_{jt}^{UP} + a_2^- P_{jt}^{DOWN} + a_3^+ P_{jt-1}^{UP} + a_3^- P_{jt-1}^{DOWN} + e_t \quad (10)$$

which can be reparametrised to:

$$\Delta P_{it} = a_0 + (a_1^+ - 1) P_{it-1}^{UP} + (a_1^- - 1) P_{it-1}^{DOWN} + (a_2^+ + a_3^+) P_{jt-1}^{UP} + (a_2^- + a_3^-) P_{jt-1}^{DOWN} + a_2^+ \Delta P_{jt}^{UP} + a_2^- \Delta P_{jt}^{DOWN} + e_t \quad (11)$$

Again, an F-test can be used to test for asymmetry. We refer to this method as *ADL* in the following.

1.3 The threshold cointegration approach

While the asymmetric ECM approach may be superior to earlier approaches when the price series in question are cointegrated, BALKE & FOMBY (1997) and ENDERS & GRANGER (1998) demonstrate that tests for cointegration have low power in the presence of asymmetric adjustment. This is because such tests implicitly assume symmetric and linear adjustment. Hence, it is inconsistent to base a test for asymmetric adjustment in a cointegration framework on cointegration tests that are, themselves, based on the assumption of symmetric adjustment. ENDERS & SIKLOS (2000) propose an extension to the standard Engle-Granger testing strategy that is based on the threshold autoregressive (TAR) model. According to this approach the long-run cointegrating relationship between P_i and P_j is estimated:

$$P_{it} = b_0 + b_1 P_{jt} + u_i \quad (12)$$

Rather than testing the residuals u_i from this estimation for stationarity and, by extension, testing for cointegration between P_i and P_j, ENDERS & SIKLOS propose estimating the following equation:

$$D u_t = r_1^+ u_{t-1}^+ + r_1^- u_{t-1}^- + e_t \quad (13)$$

where $u_{t-1}^+ = u_{t-1}$ if $u_{t-1} > 0$ and 0 otherwise, and

$u_{t-1}^- = u_{t-1}$ if $u_{t-1} < 0$ and 0 otherwise.

Necessary and sufficient conditions for the stationarity of u_i (i.e. cointegration between P_i and P_j) are that $r_1^+ < 0$, $r_1^- < 0$ and $(1 + r_1^+)(1 + r_1^-) < 1$. ENDERS & SIKLOS tabulate critical values of an F-test that can be used to test the joint hypothesis that $r_1^+ = r_1^- = 0$. If this hypothesis is rejected we can conclude that P_{it} and P_{jt} are cointegrated and the null hypothesis of symmetric adjustment can be tested using a standard F-test of the null hypothesis that $r_1^+ = r_1^-$. We refer to this method in the following as *TAR*.

1.4 The momentum threshold approach

ENDERS & SIKLOS also suggest the use of a so-called momentum threshold autoregressive model (*M-TAR*) according to which u_{t-1} is segmented into u_{t-1}^+ and u_{t-1}^- depending on whether $\Delta u_{t-1} > / < 0$, respectively:

$$\Delta u_t = r_1^+ u_{t-1}^+ + r_1^- u_{t-1}^- + e_t \qquad (14)$$

where $u_{t-1}^+ = u_{t-1}$ if $\Delta u_{t-1} > 0$ and 0 otherwise, and

$u_{t-1}^- = u_{t-1}$ if $\Delta u_{t-1} < 0$ and 0 otherwise.

M-TAR asymmetry is fundamentally different from the asymmetry that is tested for by the previous seven methods outlined above. According to the M-TAR approach, a correction to the margin between prices at different levels of the marketing chain does not depend on the size of this margin at a given point in time but rather on the magnitude and direction of its change in the previous period. It is in this sense that M-TAR behaviour is said to exhibit 'momentum'.

ENDERS & SIKLOS also suggest modifications of the TAR and M-TAR models that allow the threshold value for the segmentation of u_i to differ from 0. BALKE & FOMBY (1997) point out that the TAR and M-TAR approaches can also be extended to account for multiple thresholds that allow for complex forms of symmetric and asymmetric adjustment. The TAR and M-TAR approaches to testing for asymmetric price transmission are employed by ABDULAI & RIEDER (1999) and HARPER & GOODWIN (1999).

2. A simple Monte Carlo experiment

In the following experiments we generate samples of two price series P_i and P_j as follows:

$$P_{it} = P_{it-1} + v_{1t} \qquad (15)$$

$$P_{jt} = b_0 + b_1 P_{it} + v_{2t}$$

where $v_{1t}, v_{2t} \sim NID(0,1)$.

Without loss of generality, b_0 is set equal to 0 in all cases. b_1 is always equal to 1 for the first half of all the observations in each sample, and then changes to a number on the interval between –1 and +3 for the second half of the observations in this sample. Thus, we assume that P_i is difference stationary and that P_i and P_j are cointegrated throughout but that there is a breakpoint in the middle of each sample where the coefficient linking P_i to P_j changes from 1 to some other value between –1 and +3. To explore the impact of the size of this structural break on the behaviour of test for asymmetric price transmission, we systematically explore the range between –1 and +3 in increments of 0,1.

For each increment, 1.000 samples are generated and tested for asymmetric price transmission using the eight procedures discussed in section 1. Specifically, these are *Houck-I* in equation (1), *Houck-II* in (5), *Houck-III* in (3), *ECM-I* in (8), *ECM-II*[3] in (9), *ADL* in (11), *TAR* in (13) and *M-TAR* in (14). This procedure is repeated for sample lengths of 50, 100 and 500. For each run of 1.000 repetitions we calculate:

a) in what percentage of the 1.000 cases is the (true) null hypothesis of symmetric transmission rejected at the 5% level of significance, and

b) in what percentage of the 1.000 repetitions does a cointegrating augmented Dickey-Fuller-test (CADF, ENGLE & GRANGER, 1987)[4] lead us to reject the (true) null hypothesis of no unique cointegrating relationship between P_i and P_j over the entire sample period.

3. Results

The results of the experiments described in the previous section are summarized in 24 graphs (Figure 1), panels (a) through (x); one for each combination of the three sample sizes and eight tests for asymmetry considered. In each of the graphs, the value that b_1 takes after the structural break in the middle of the sample is depicted on the x-axis. The y-axis measures, for each value of b_1 following the structural break, in what % of the repetitions the null hypothesis of symmetric transmission is rejected at the 5% level of significance (solid line), and in what % of the repetitions the null hypothesis of no cointegration between P_i and P_j is rejected (dashed line).

[3] ECM-I and ECM-II is estimated without lagged variables.

[4] In the case of the TAR and M-TAR approaches, cointegration is tested using the F- and t-tests developed by ENDERS & SIKLOS.

In panel (d), for example, we see that when b_1 also takes on the value of one after the breakpoint (i.e. no structural break) the *Houck-II* test for asymmetric price transmission has the correct size of 5%. As the shift in b_1 increases, however, we see that the test for asymmetric price transmission no longer has the indicated size; instead, the true null hypothesis of symmetric transmission is rejected in far more than 5% of all cases at the 5% level of significance. As the sample size increases to 100 and 500 observations (panels (e) and (f)) this problem is exacerbated; even small structural breaks (i.e. small deviations from $b_1 = 1$ in the second half of the sample) lead to rapid increases in the likelihood of false inference regarding the existence of asymmetric price transmission.

This problem is mitigated somewhat by the fact that as the size of the structural break increase (i.e. the value of b_1 deviates strongly from 1 in the second half of the sample) cointegration tests increasingly indicate that there is no stable cointegrating relationship between P_i and P_j over the entire sample period. For example, in panel (d) we see that if b_1 takes on a value of three following the breakpoint in the middle of the sample, symmetric price transmission is rejected at the 5% level of significance in over 70% of the samples, but in only roughly 30% of the samples would the CADF-test lead us to conclude that P_i and P_j are cointegrated over the entire sample period. There is, therefore, a fairly high probability that a careful researcher would first determine the price series in question are not cointegrated over the entire sample period, and as a result he or she might avoid the trap of applying tests for asymmetric price transmission that do not have the indicated size due to the presence of a structural break in the underlying data.

In each of the 24 panels of figure 1 we have therefore included a third (dotted) line that indicates for each value of b_1 following the breakpoint the probability that the cointegration test rejects the null hypothesis of no unique cointegrating relationship over the entire sample period and that the test for asymmetry in question will reject the null hypothesis of symmetric price transmission. We see in panel (d), for example, that the fundamental problem nonetheless remains: Even if the lack of cointegration in many of the samples with a larger structural break is taken into account, for $b_1 = 3$ following the structural break roughly 15% of the generated samples appear to be cointegrated over the entire sample period and characterised by asymmetric price transmission.

In panels (e) and (f) we see that this problem becomes stronger as the sample size increases. The same pattern can be observed for the other asymmetry tests that we consider. It appears, therefore, that the problem of incorrect inference regarding asymmetric price transmission in the presence of structural breaks becomes worse, rather than better, with increasing sample size. The reason for this phenomenon is, intuitively, that as the length of the sample increases, a given structural break leads to a more pronounced ‘kink’ in the price series. When a single stable relation is estimated over this entire ‘kinked’ sample, the resulting error terms display increasing deviations from white noise behaviour. Essentially, the problem is analogous to the residual autocorrelation that arises as a symptom of fitting the wrong functional form to data.

To see how this distorts the result of tests for asymmetry, consider the asymmetric ECM approach in (8). It can be demonstrated that due to the ‘kink’ the ECT will often appear to be following a trend over protracted portions of the sample. This behaviour is especially pronounced in the case of moderate structural breaks and long sample periods. Depending on whether this trend occurs in a positive or negative phase of the ECT variable, either a_2^+ or a_2^- tends towards 0 while the other one of these coefficients will take on a significant value. The result, when the identity of a_2^+ and a_2^- is used to test for asymmetry, is often the rejection of the null hypothesis of symmetric transmission.

Figure 2 combines the results of all eight methods for testing asymmetry based on 10000 repetitions of samples with 100 observations. Only the results of the corresponding asymmetry tests (i.e. the share of cases in which the (true) null hypothesis of symmetry is rejected at the 5% level of significance) are shown. We see that *Houck-I* displays the ‘best’ behaviour, although this test also leads to ‘too many’ findings of asymmetry. *ECM-I*, *ECM-II* and *TAR* display similar behaviour, as do *Houck-II* and *Houck-III*. The results of the ADL method lie between those of *Houck-II* and *Houck-III* on the one hand, and the *ECM* and *TAR* methods on the other.

Figure 2 and panels (v) to (x) of figure 1 indicate that the *M-TAR* approach behaves in a manner which is most similar to *Houck-I* but with a higher rate of rejection for larger structural breaks. Note that over the range of b_1-values for which the *Houck-I* and *M-TAR* methods lead to inflated shares of rejections of the null hypothesis of symmetric transmission, there is also a high probability that the cointegration tests will indicate that P_i and P_j are not cointegrated. Hence, there appears to be less danger that structural breaks will mislead researchers using either the *Houck-I* or *M-TAR* method. Note, however, that M-TAR-type asymmetry is, as discussed in section 1.4, a specific type of asymmetry.

How can the different susceptibilities of the methods tested above be explained? We do not have all of the answers to this question, but some insight can be gained from figure 3, which presents analogous results to figure 2 for an experiment in which P_{it} is not I(1) but rather I(0), i.e. in which (15) is replaced by:

$$P_{it} = v_{1t} \qquad (16)$$

$$P_{jt} = b_0 + b_1 P_{it} + v_{2t}$$

The fact that tests according to the *Houck-II* and *Houck-III* methods have the correct size in this second experiment confirms that the summation on which they are based does indeed lead to a misspecified I(1) error term in the first experiment. A similar explanation can be proposed for the *ECM-I* and *TAR* method. As mentioned before using these methods in the first experiment leads to explanatory variables with a trend. If this trend is only partial its existence can lead to a rejection of symmetry. In the case of a strong change in the relation there is not only a partial trend but a continuous trend in ECT^+ and ECT^- and therefore the estimated coefficients are $a_2^+ = a_2^- = 0$. Therefore for these methods an increase of structural change leads to fewer rejections of symmetry.

4. Conclusions

The results presented above suggest that the presence of structural breaks in the cointegrating relationship between price series that are symmetrically linked to one another will lead researchers using standard tests for asymmetric price transmission to wrongly reject the null hypothesis of symmetric transmission in many cases.

Of course, these results are very preliminary. The experimental price series that are generated for our tests are very simple, and the various tests for asymmetry are applied in their simplest form, i.e. without the inclusion of trends and lagged variables that might be appropriate in individual cases. The results are also puzzling in some respects. It is perhaps surprising that tests based on flexible specifications and recent advances in the study of price transmission (in particular tests based on the *ECM*, *ADL* and *TAR* methods) should be more likely to produce misleading results than the *Houck-I* method which is based on a simple VAR in differences and, thus, does not take advantage of the information contained in levels.

We are currently working on explanations for the different patterns of behaviour displayed by the different tests. We are also investigating impact of other anomalies in the price data, such as GARCH behaviour. Our work could also be extended to consider the impact of random breakpoints in samples, and regimes that switch not only once but perhaps several times, such as could be the case as a region fluctuates between being a net importer and a net exporter, for example. A further modification would be to analyse the behaviour of tests for asymmetric price transmission in the presence of prices that are, indeed, asymmetrically linked.

The obvious implication of our preliminary analysis is, however, that the results of tests for asymmetric price transmission must be interpreted with great caution if there is reason to suspect that there are structural breaks in the price series being investigated. Since it appears reasonable to assume that there are structural breaks in many real price series, our results imply that the very common finding of asymmetric price transmission in empirical applications in agriculture and elsewhere may be more artefact than fact.

Figure 1: Monte Carlo results

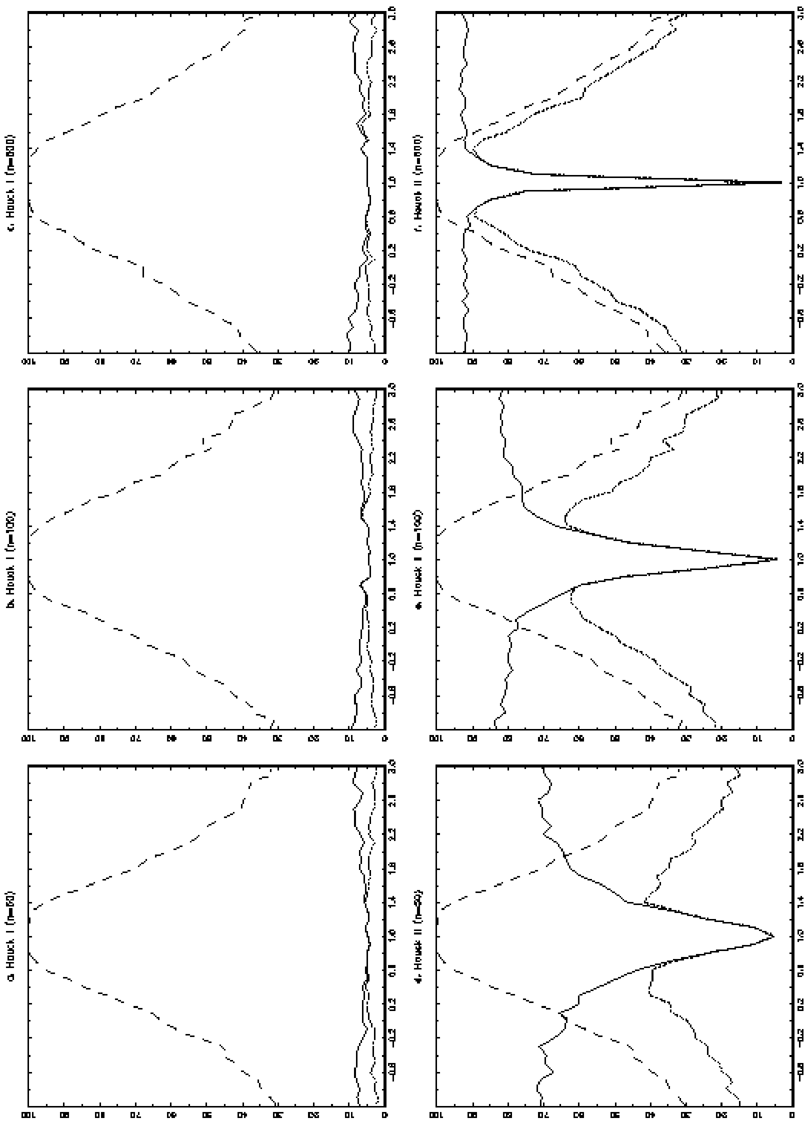
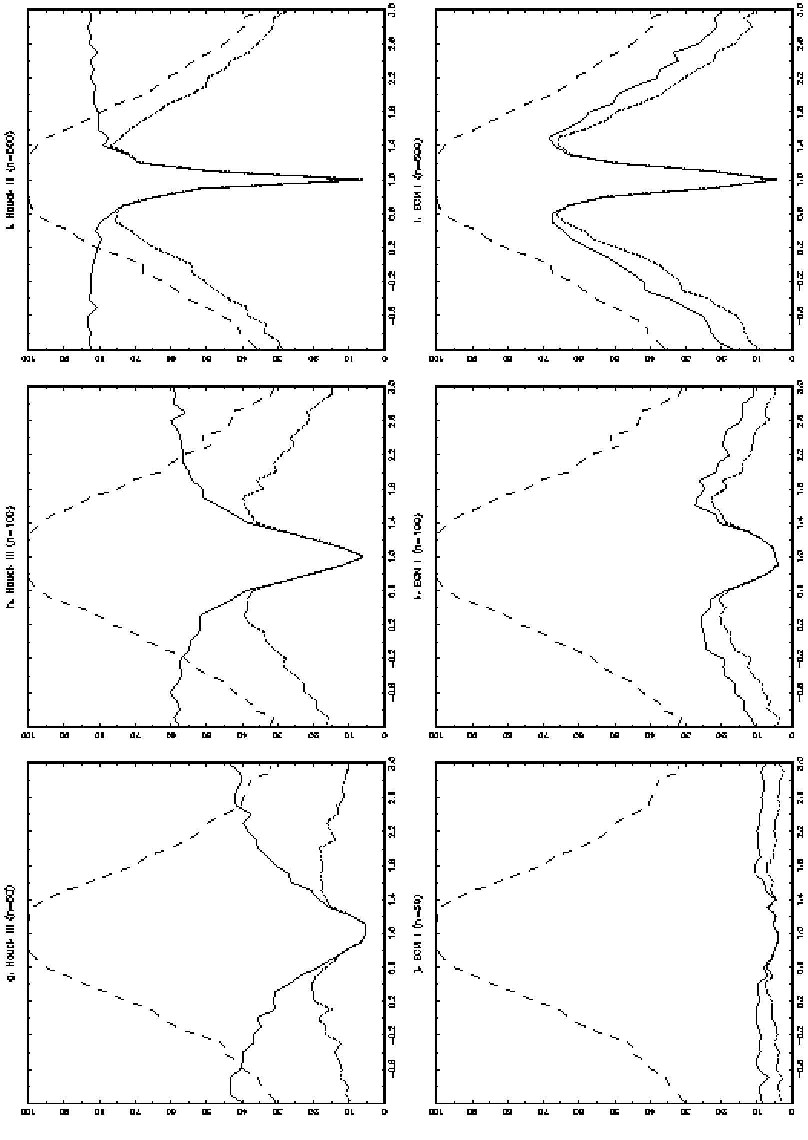


Figure 1 (continued):



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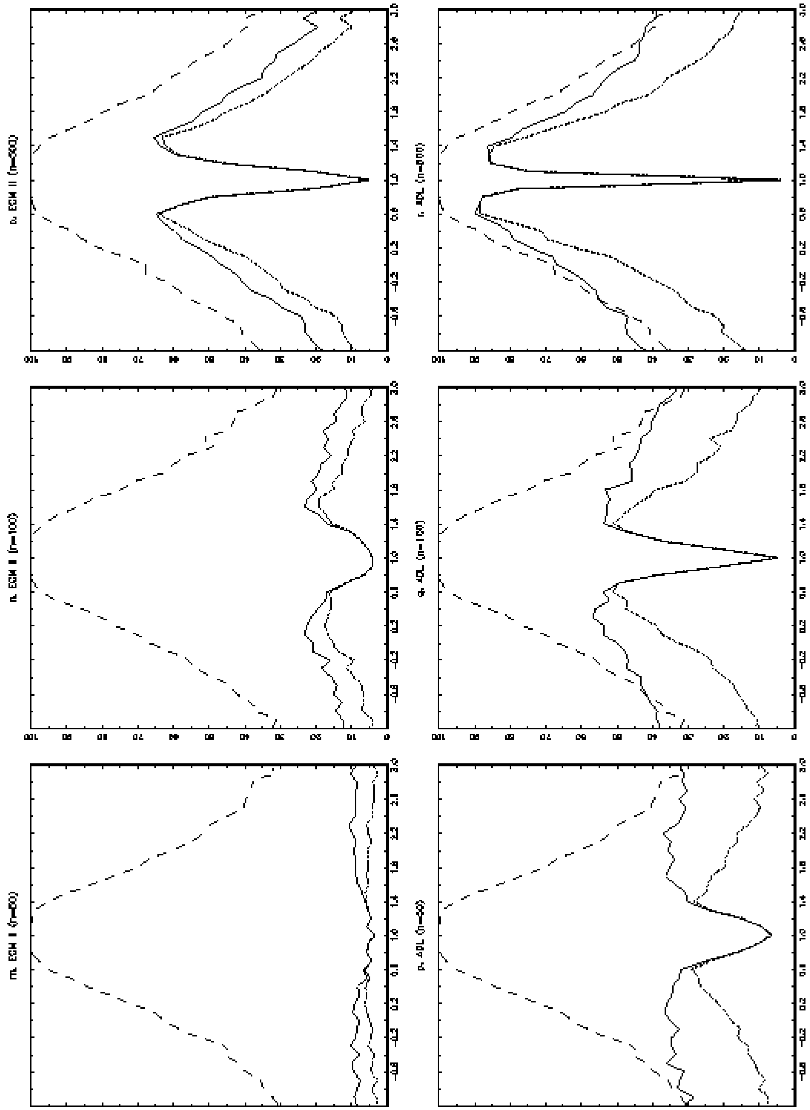

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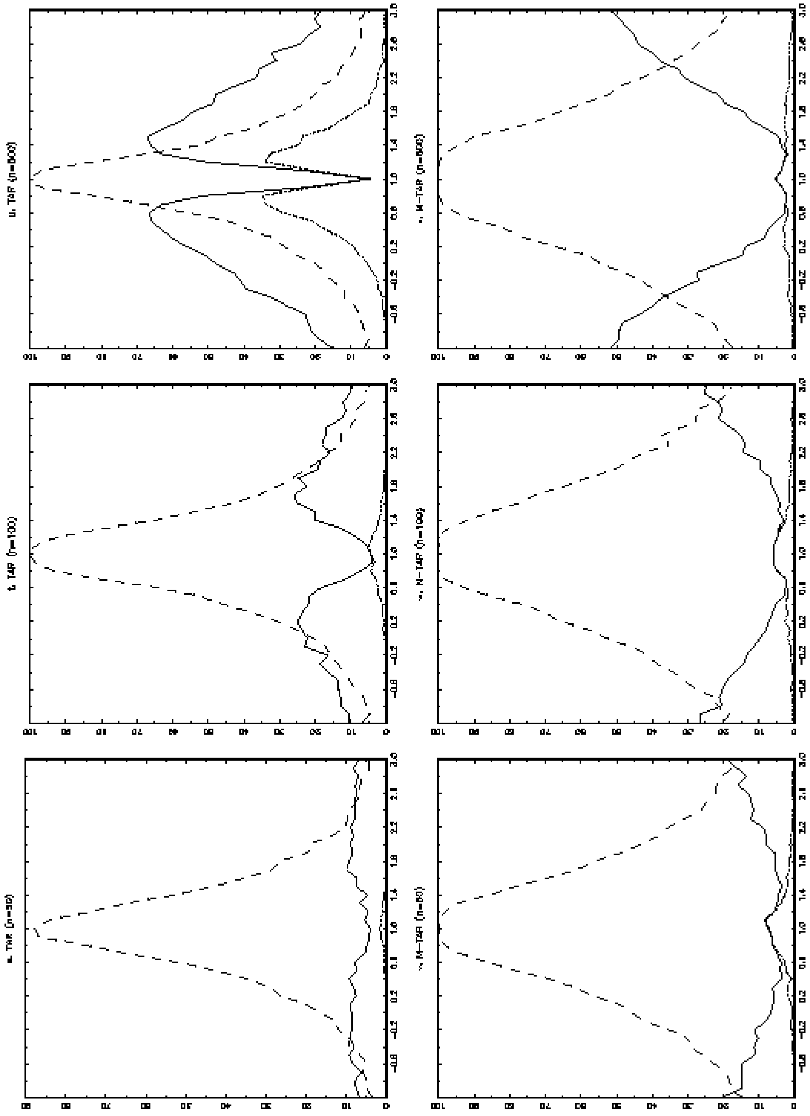


Figure 2:

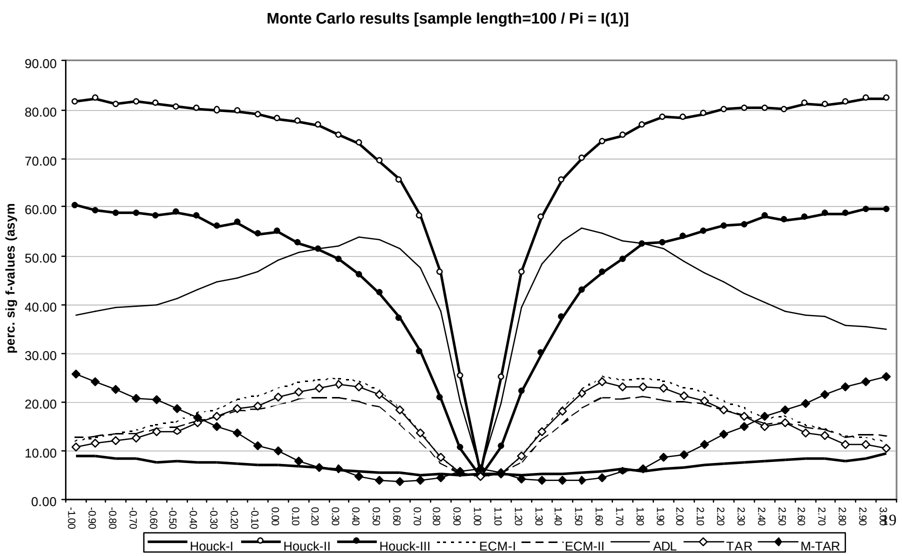
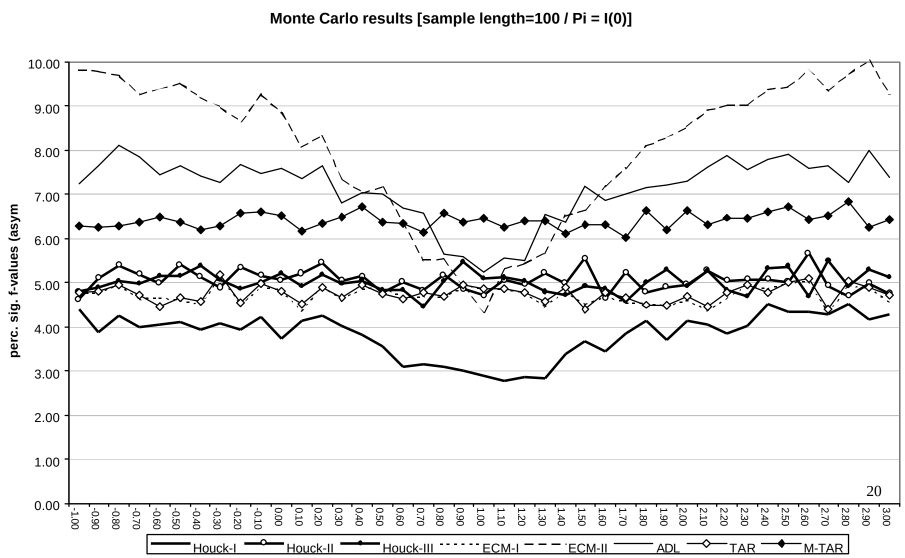


Figure 3:



References

ABDULAI, A. & P. RIEDER: Using threshold cointegration to estimate asymmetric price transmission in the Swiss pork market. Working Paper, ETH, Zürich 1999.

BAILEY, D. & B.W. BRORSEN: Price asymmetry in spatial fed cattle markets. *Western Journal of Agricultural Economics* 14 (1989), pp. 246-252.

BALKE, N.S. & T. FOMBY: Threshold cointegration. *International Economic Review* 38 (1997), pp. 627-643.

BORENSTEIN, S.; CAMERON, A.C. & R. GILBERT: Do gasoline prices respond asymmetrically to crude oil prices changes? *The Quarterly Journal of Economics* 112 (1997), pp. 305-339.

BOYD, S.M. & B.W. BRORSEN: Price asymmetry in U.S. pork marketing channel. *North Central Journal of Agricultural Economics* 10 (1988), pp. 103-110.

VON CRAMON-TAUBADEL, S.: Estimating asymmetric price transmission with the error correction representation: An application to the German pork market. *European Review of Agricultural Economics* 25 (1998), pp. 1-18.

VON CRAMON-TAUBADEL, S. & S. FAHLBUSCH: Identifying asymmetric price transmission with error correction models. Poster Paper: EAAE European Seminar "Food policies and the food chain: Structures and interrelationships". Reading, UK, 1994.

VON CRAMON-TAUBADEL, S. & J.-P. LOY: The identification of asymmetric price transmission processes with integrated time series. *Jahrbücher für Nationalökonomie und Statistik* 218 (1999) 1+2, pp. 85-106.

ENDERS, W. & C.W.J. GRANGER: Unit-root tests and asymmetric adjustment with an example using the term structure of interest rates. *Journal of Business and Economic Statistics* 16 (1998), pp. 304-311.

ENDERS, W. & P.L. SIKLOS: *Cointegration and threshold adjustment.* Iowa State University, Working Paper, Februar 2000.

ENGLE, R.F. & C.W.J. GRANGER: Cointegration and error correction: Representation, estimation and testing. *Econometrica* 49 (1987), pp. 251-276.

GRANGER, C.W.J. & T.-H. LEE: Investigation of production, sales and inventory relationships using multicointegration and non-symmetric error correction models. *Journal of Applied Econometrics* 4 (1989), pp. S145-S159.

HARPER, D.C. & B.K. GOODWIN: *Price transmission, threshold behavior, and asymmetric adjustment in the U.S. Pork Sector*. Paper presented at the 1999 AAEA Meetings in Nashville, May 14, 1999.

HOUCK, P.J.: An approach to specifying and estimating nonreversible functions. *American Journal of Agricultural Economics* 59 (1977), pp. 570-572.

KINNUCAN, W.H. & O.D. FORKER: Asymmetry in farm-retail price transmission for major dairy products. *American Journal of Agricultural Economics* 69 (1987), pp. 285-292.

MOHANTY, S.; PETERSON, E.W.F. & N.C. KRUSE: Price asymmetry in the international wheat market. *Canadian Journal of Agricultural Economics* 43 (1995), pp. 355-366.

PELTZMAN, S.: Prices rise faster than they fall. *Journal of Political Economy* 108 (2000) 3, pp. 466-502.

WARD, R.W.: Asymmetry in retail, wholesale, and shipping point pricing for fresh vegetables. *American Journal of Agricultural Economics* 62 (1982), pp. 205-212.

WOLFFRAM, R.: Positivistic measures of aggregate supply elasticities: Some new approaches – some critical notes. *American Journal of Agricultural Economics* 53 (1971), pp. 356-359.

ZHANG, P.; FLETCHER, S.M. & D.H. CARLEY: Peanut price transmission asymmetry in peanut butter. *Agribusiness* 11 (1995) 1, pp. 13-20.