A new econometric test for asymmetric price adjustment by cointegrating vector restrictions with an application to the U.S. and Dutch pork chains

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Abstract

A new test of asymmetric price adjustment is proposed on the basis of the super-consistent cointegrating vector estimator in the Johansen (1995) cointegration procedure. The super-consistency makes the test robust to misspecifications in the short-run model. Application of the test to the price spreads in the Dutch and U.S. pork chains reveals that in the Netherlands wholesalers might obtain extra price margin as a consequence of asymmetric price adjustment vis-à-vis the farmers.

1. Introduction

The economic literature has presented extensive research on asymmetric price transmission in production and marketing chains for agricultural and horticultural products. Overview articles on this literature are those of Frey and Manera (2007) and Meyer and Von Cramon-Taubadel (2004). The problem in this research so far, and in many other economic studies, is the indirectness of the method. Often a model is specified in which rejection of certain coefficient restrictions is indicative of asymmetric price transmission. It is therefore these restrictions that are tested by using empirical data and econometric estimation methods. If the restrictions are not rejected, then the question remains whether there really is no asymmetric price trans-mission. Indeed, it might as well be that the restrictions are not rejected because the under-lying model does not provide a good fit of the empirical data resulting in a low power of the coefficient test. And vice versa, if the restrictions are to be rejected in favor of asymmetric price transmission, one may be suspicious whether the model has probably become too flexible in fitting the data as a result of which it is describing noise instead of economic laws. In that case the asymmetry found might well be a consequence of a few outliers rather than capturing the representative pattern for the price transmission behaviour of the vertical chain participants. Additional research using a more direct approach like a case study or a question-naire survey, seems therefore desirable. Such research, however, takes time and effort, because now the data has to be collected instead of being already available as the time series data on prices in the chain which are frequently used in the indirect approach.

The aim of this study is to introduce a method for detecting asymmetric price transmission in agricultural marketing channels that does use the secondary time-series observations on chain prices, but now in conjunction with the super-consistent cointegrating vector estimator of the Johansen (1995) cointegration procedure. Since the cointegrating vector estimator is super-consistent, it is quite robust for (mild) misspecifications of the short-run model. Consequently, if the cointegrating vector estimator could be used to test for coefficient restrictions indicative for the absence of asymmetric price adjustment, then the outcome of this test is expected to be much less sensitive to the short-run model than is the commonly used test on asymmetry of the speed-of-adjustment parameters, as this test concerns the error-correction term whose stationarity prevents the speed-of-adjustment-coefficient estimator from being super-consistent. In this study we present a test on asymmetry of price transmission that is based on testing for the absence of restrictions on the cointegrating vector in spite of the fact that asymmetric price adjustment, being triggered by asymmetry in the short-run coefficients, is an inherently short-run phenomenon. The basis idea of the test is to generate a new output price series that does not exhibit asymmetric adjustment behaviour

vis-à-vis the input price. As the asymmetric speed-of-adjustment behaviour concerns short-run dynamics, the new and actual output prices must be cointegrated. Nevertheless, if excessive price margins vis-à-vis the average price margin are dominantly positive (negative) as a consequence of asymmetric price transmission, then the new output price will be lower (higher) than the actual output price so that the cointegrating coefficient of the actual output price will be smaller (greater) than one when normalising the long-run relationship to the new output price (i.e., having a cointegrating coefficient equal to minus one). The fact that the cointegrating coefficient of the actual output price deviates from one is needed to make the error-correction term to become stationary around zero as ought to be for stationary processes which always have an unconditional expectation equal to the mean to which the process is reverting. This also implies that in the long-run the cointegrating residuals do not reveal the profits or losses of asymmetric price transmission even though the error-correction behaviour (= short run!) is asymmetric.

The remainder of this study is organized as follows: First, in Section 2, an outline is given of the price correction model, the testable coefficient restrictions on the absence of asymmetric price transmission in the agricultural marketing channel and the econometric estimation and testing method. Then, in Section 3, an empirical application is presented regarding the time-series observations on the farm, wholesale and retail prices of pork in the Netherlands and, for purpose of cross-country comparison, in the U.S. In Section 4, the study is concluded with a summary of the main results.

2. Method

Consider two price at time t ($t = 1, \dots, T$), the input price p_{it} and the output price p_{ot}. The absolute price margin m_t is defined as $m_t \equiv p_{ot} - p_{it}$. To correct the output price for asymmetric price transmission, an output price change at a relatively high or low margin is replaced by the input price change that occurs at the same time. In contrast, output prices at and close to average margin levels are left unchanged. This leads to the following corrected output price, denoted as p_{ct}, generating formula:

(1) $p_{ct} = I(|m_t - \mu_m| \leq \tau\sigma_m)p_{ot} + I(|m_t - \mu_m| > \tau\sigma_m)(p_{c,t-1} + \Delta p_{it})$ ($t = 2, \dots, T$)

where $I(a)$ is an indicator function that is equal to one if a is true and equal to zero if a is false, μ_m and σ_m denote the mean and standard deviation of m_t, respectively, τ is the threshold parameter which might be set equal to, for example, 0.5 (we shall come back on the choice of τ shortly), and $p_{c1} = p_{o1}$. Note that $I(|m_t - \mu_m| \leq \tau\sigma_m)$ is orthogonal to $I(|m_t - \mu_m| > \tau\sigma_m)$ and $I(|m_t - \mu_m| \leq \tau\sigma_m) + I(|m_t - \mu_m| > \tau\sigma_m) = 1$. Suppose that t indicates, for example, months, then we may allow μ_m or both μ_m and σ_m to vary over years in order to let the process $\{m_t - \mu_m\}$ become stationary so that μ_m and σ_m really make sense.

We can illustrate the functioning of (1) by using the three cases of asymmetric price transmission distinguished by Meyer and Von Cramon-Taubadel (2004) in their Figure 1. These three cases are asymmetry with respect to the magnitude, the speed and both the magnitude and speed of price transmission. The three cases are depicted in Figure 1, panel a, c and e. The blue graph shows the actual output price, the red one is the corrected output price as obtained by (1), and the green line is the input price. Panels b, d and f show the activation by the excessive values of the margin.
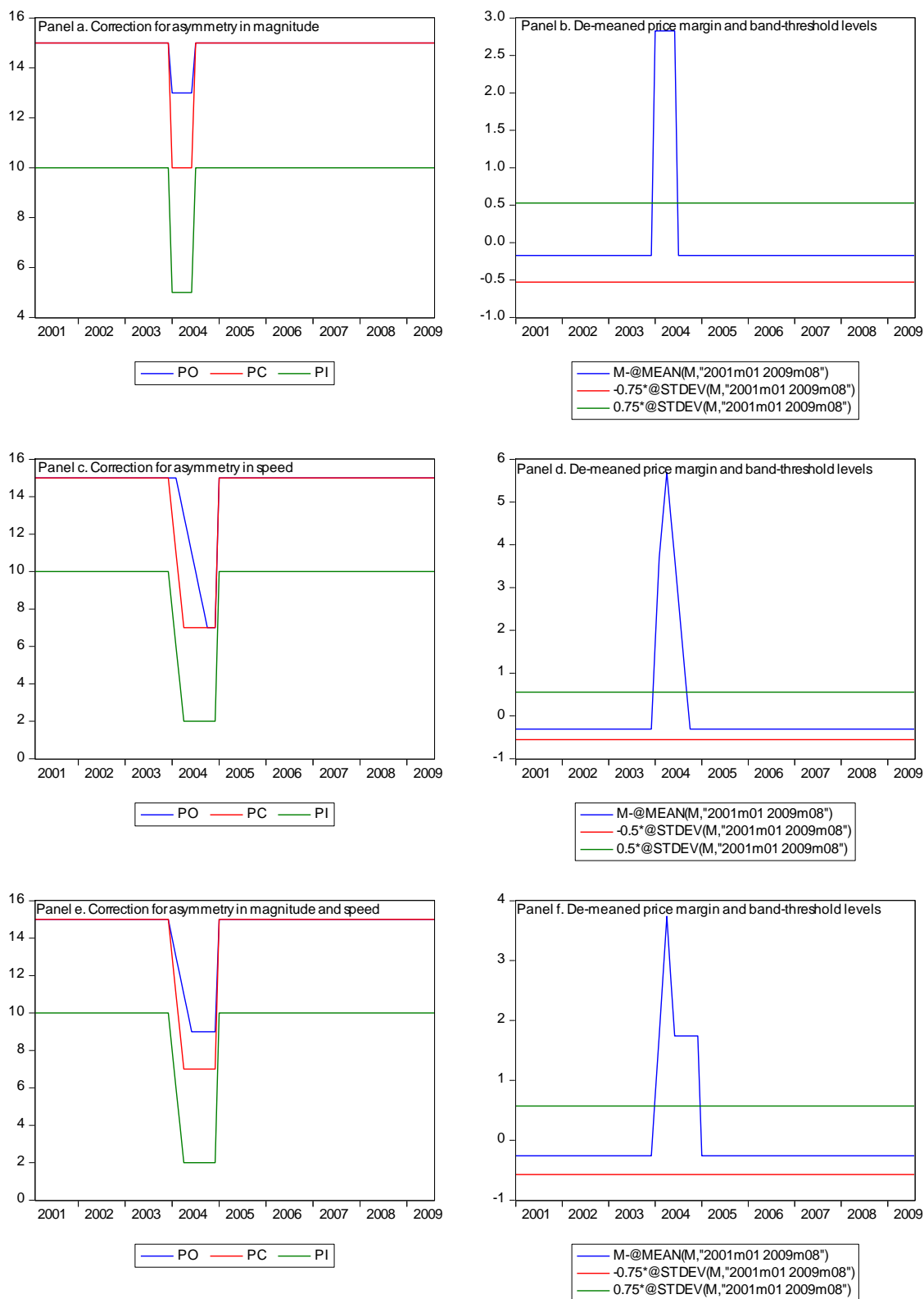
Figure 1.   Asymmetric price transmission

As aymmetric price adjustment is a matter of short-run dynamics, the actual and corrected output prices must be cointegrated. Consequently, we employ a bi-variate Vector Error-Correction Model (VECM) to perform the Johansen (1995) procedure to test for cointegration and to test for the absence of deterministic terms and perfect transmission in the long-run price relationship. The VECM is given by

(2) $\Delta \mathbf{X}_t = \alpha \beta' \mathbf{X}_{t-1} + \Gamma \mathbf{Z}_t + \varepsilon_t$

where $\Delta \mathbf{X}_t = \mathbf{X}_t - \mathbf{X}_{t-1}$, $\mathbf{X}_t = [p_{ct}, p_{ot}]'$ is the bi-variate price vector, $\alpha = [\alpha_1, \alpha_2]'$ are the speed-of-adjustment parameters, $\beta = [-1, \beta_2]'$ is the cointegrating vector, $\mathbf{Z}_t$ may collect lags of $\Delta \mathbf{X}_t$, centred seasonal dummies and the deterministic terms that cannot be restricted to be only included in the cointegrating space, Γ is a $(2 \times n)$ coefficient matrix given that vector $\mathbf{Z}_t$ contains n terms, and ε_t is Gaussian white noise with covariance matrix Σ. The test procedure starts with a Vector Auto-Regression of upper limit order k, denoted VAR(k), for $\mathbf{X}_t$ (i.e., in levels). Then, with the help of the Schwarz information criterion the order of the VAR is selected. Next, Johansen's Trace statistic is used to see whether or not the prices are cointegrated and to test for the absence of any deterministic terms in the cointegrating relationship. Finally, the restriction $\beta_2 = 1$ is tested. If this restriction must be rejected in favour of $\beta_2 < 1$ ($\beta_2 > 1$), then we conclude that there is positive (negative) asymmetry, where 'positive' ('negative') asymmetry refers to the situation in which the output price reacts more fully or rapidly to an increase (decrease) in the input price than to a decrease (increase), cf. Peltzman (2000) and Meyer and Von Cramon-Taubadel (2004).

3. Empirical application
We apply our test method to the pork chains in the Netherlands (source: LEI) and in the U.S. (for an explanation of the U.S. data see: http://www.ers.usda.gov/publications/ldp/ APR04/ldpm11801/). For each country we have monthly observations on the farm, wholesale and retail prices for the sample period January 2001 up to and including August 2009 (so $T = 104$). In Figure 2a,b the time series for these prices are displayed. The price peaks in December reveal a seasonal pattern. Excessive high or low price margins as a consequence of seasonality are allowed to do their job in (1). In contrast, as we wish to ignore the stochastic trend in the absolute price margin – that would be object of a study to find out whether or not price transmission in the long run is perfect – we allow μ_m to vary over years by regressing m_t on year dummies. We run (1) for ten different values of τ such that $\tau = 0.1, 0.2, \dots , 1.0$ and for each of the resulting ten corrected output prices we perform our test on asymmetry. A selection of the outcomes of this procedure for each pair of subsequent input-output prices is presented in Table 1.

The results in Table 1 are for the value of τ that leads to the lowest p-value in the test of $\beta_2 = 1$. At the ten percent significance level the restriction $\beta_2 = 1$ is rejected in favour of $\beta_2 < 1$ in the price relationship between the wholesale and retail sector in the U.S. and between the farm and wholesale sector in the Netherlands. The actual and corrected output prices for these two cases are presented in Figure 3 and Figure 4.
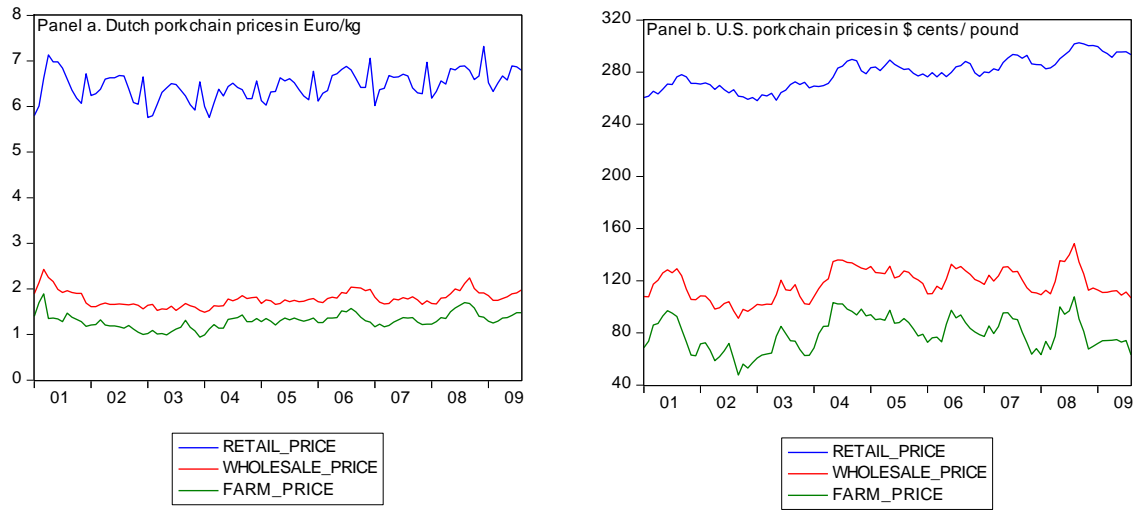
**Figure 2.** **Prices in the Dutch (panel a) and U.S. (panel b) pork chain**

Comparison of the U.S. retail price of pork with its correction clearly reveals a pattern not only of positive, but also of negative asymmetry. Consequently, the fact that $\beta_2 = 1$ can be rejected at the ten percent level in favour of $\beta_2 < 1$ when $\tau = 0.2$ may not be just interpreted as retailers profiting from wholesalers by asymmetric price adjustment. In contrast, compared to positive asymmetry we see that negative asymmetry is less pronounced for the Dutch case (see Figure 3). Therefore, the test result in favour of positive asymmetry in the Dutch farm-wholesale price relationship may lead to the somewhat worrying conclusion that the wholesalers succeed to obtain extra price margin by asymmetric price adjustment behaviour.

Table 1. **Testing for asymmetric price adjustment**

Input price	Output price	Estimate of β_2		p-value of test $\beta_2 = 1$	
		NL	US	NL	US
Wholesale	Retail	0.988398 (0.00857)	0.994332 (0.00334)	0.18	0.08
Farm	Wholesale	0.985524 (0.00753)	0.998083 (0.00294)	0.06	0.49
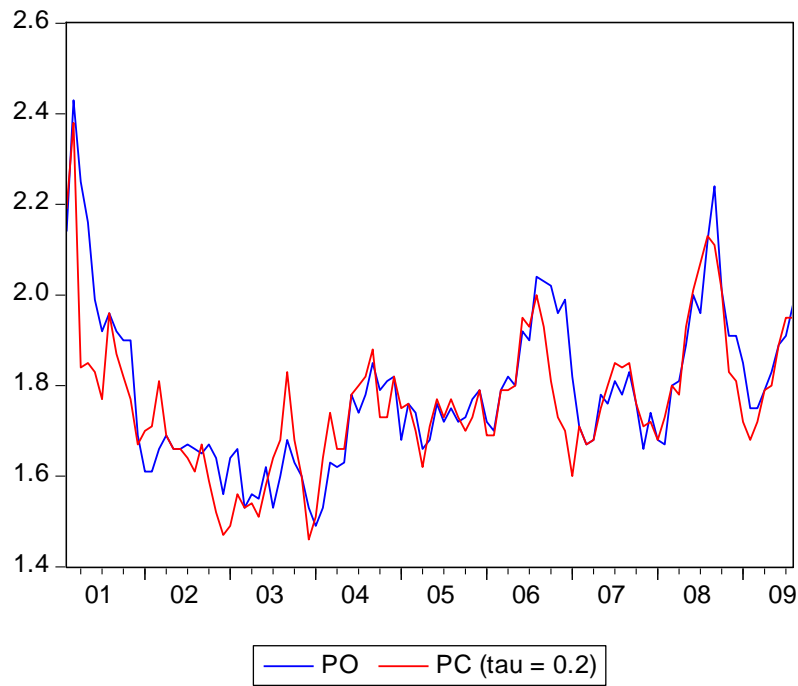
Figure 3. Wholesale price (PO) and at $\tau = 0.2$ corrected wholesale price (PC) for the Dutch pork chain (Euro/kg)
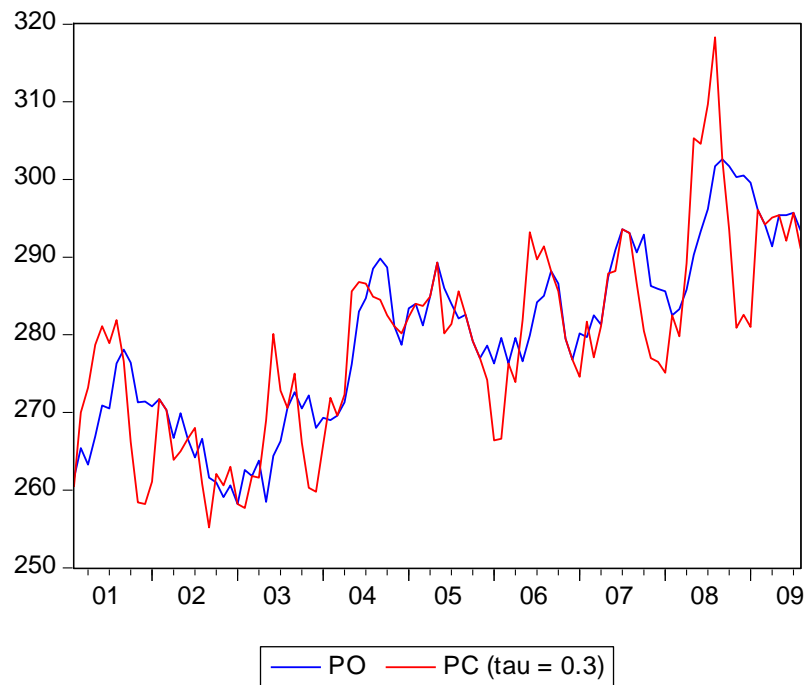
Figure 4. Retail price (PO) and at $\tau = 0.3$ corrected retail price (PC) for the U.S. pork chain ($ cents/pound)

4. Conclusion

A new test of asymmetric price adjustment is proposed of which it is argued that it may profit from the super-consistency property of the cointegrating vector estimator in the Johansen (1995) cointegration test procedure. Common test of asymmetric price transmission are testing for the absence of asymmetry in the short-run coefficients and/or the speed-of-adjustment parameters. The estimator of these coefficients, however, is not super-consistent and may therefore be expected to be much more sensitive to mis-specifications in the short-run model which invalidates the test on asymmetry. Application of our test to the price relationships in the Dutch and U.S. pork chain reveals that in the Netherlands wholesalers might obtain extra price margin as a consequence of asymmetric price adjustment vis-à-vis the farmers. In contrast, asymmetric price adjustment is not found in the short-run dynamics of the wholesale-retail price spread in the Netherlands and the farm-wholesale price spread in the U.S. Although asymmetry is found in the U.S. retail price of pork, it does not appear to be always positive, but is also frequently negative so that retailers do not really seem to enforce asymmetry profits.

Evaluation of the size and power properties of the test procedure by a Monte Carlo simulation study will be the next step in our research on testing for asymmetric price adjustment.

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