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Welfare implications of intertemporal marketing margin manipulation

Thomas Kopp, Bernhard Brümmer, Zulkifli Alamsyah, Raja Sharah Fatricia,

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Abstract

Purpose

In Indonesia rubber is the most valuable export crop produced by small scale agriculture and plays a key role for inclusive economic development. This potential is likely to be not fully exploited. The observed concentration in the crumb rubber processing industry raises concerns about the distribution of export earnings along the value chain. Asymmetric price transmission is observed.

Design/methodology/approach

This study investigates the price transmission between international prices and the factories' purchasing prices on a daily basis. An Auto-Regressive Asymmetric Error Correction Model is estimated to find evidence for asymmetric price transmission. In a subsequent step the rents that are redistributed from factories to farmers are calculated. The study then provides estimations of the size of this redistribution under different scenarios.

Findings

The results suggest that factories do indeed transmit prices asymmetrically, which has substantial welfare implications: around three million U.S. Dollars are annually redistributed from farmers to factories. If the price transmission was only half as asymmetric as it is observed, the majority of this redistribution was re-diverted.

Originality

This study combines the approaches of non-parametric and parametric estimation techniques of estimating asymmetric price transmission processes with a welfare perspective to quantify the distributional consequences of this intertemporal marketing margin manipulation. Especially the calculation of different scenarios of alternative price transmissions is a novelty. The dataset of prices on such a disaggregated level and high frequency as required by this approach is also unique.

Plain language summary

Indonesian rubber factories capture rents by transmitting positive price shocks slower to their suppliers than negative ones. This leads to a loss of income for small scale rubber farmers.

Keywords: Asymmetric Price Transmission; Error Correction Model; Intertemporal Marketing Margin Manipulation; Rubber; Indonesia.

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Welfare Implications of Intertemporal Marketing Margin Manipulation

1. Introduction

The agricultural sector is of great importance in Indonesia. In 2011 it contributed 15% to the GDP and employed 36% of the workforce.[1] More than 15 million people generate their main income from rubber cultivation, the most valuable export crop. With an annual output of three million metric tons, Indonesia is the second largest producer of natural rubber in the world, accounting for 27% of global production[2] (Fathoni, 2009).

It is likely that the importance of rubber will increase in Indonesia for two reasons. First, economic growth in emerging economies; and secondly the rising price of crude oil, which will make synthetic rubber more expensive thus increasing the demand for its substitute, natural rubber on the margin.

The Jambi province (Sumatra) depends crucially on its agricultural sector and also represents a typical rubber production area. 52% of the workforce is employed in the agricultural sector and 0.6 million ha (of 1.4 million ha) are dedicated to rubber production, of which 99.6% are cultivated by smallholders (Regional Account and Statistical Analysis Division, 2012). Although Jambi is on average not an exceptionally poor province, the rural population is still disadvantaged compared to populations in other parts of Indonesia. The average income is 17.5 million Indonesian Rupiah (1 600 USD)[3] per year (Arifin, 2005; Regional Account and Statistical Analysis Division, 2012), far below the national average of 26.8 million Rupiah (2 450 USD) per year.[4] Other development indicators show a similar picture; life expectancy at birth is 71 years in Jambi, compared to 76 years in Jakarta (Regional Account and Statistical Analysis Division, 2012).

As rubber is predominantly cultivated by smallholders, it does have the potential for economic and social development in rural areas. In total, 252 000 Jambinese households (out of 619 000) depend on rubber cultivation (Regional Account and Statistical Analysis Division, 2012).

Therefore, malfunctions in this market can have a tremendous effect on the livelihoods of small scale farmers and their families. It should therefore be a primary policy target to ensure that these markets function properly.

However, this does not seem to be the case. The Jambinese rubber sector is charac-

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terized by strong oligopsonistic market power. On the processing side we observe a strong concentration of demand for farmer produce, as there are only nine crumb rubber factories in Jambi, vis-à-vis 252 000 farmers. These factories, far from being in tight competition, are collaborating rather closely and are organized in the association of the rubber processing sector, Gapkindo. A report prepared for USAID (Peramune and Budiman, 2007) found that Gapkindo is an efficiently organized and powerful lobbying-institution representing the interests of rubber processors. There are strong indications that some individual firms exploit their network in a way reminiscent of a cartel or oligopsony (ibid.). The link between the evidence for asymmetric price transmission and the occurrence of market power is based on Meyer and von Cramon-Taubadel (2004).

In order to shed light on the price formation process in the rubber value chain, we employ a price transmission approach. As Ahmadi-Esfahani (2009) shows, market power has the potential to affect price transmission. We study the vertical transmission between the output and input prices of the five crumb rubber factories in Jambi City from 1 January 2009 to 31 December 2012 via an Asymmetric Error Correction Model (AECM), as done so by von Cramon-Taubadel (1998). Previous research has shown that parametric estimations of price transmission are sensitive to asymmetries in the error correction process (Meyer and von Cramon-Taubadel, 2004). So in order to specify the error correction model correctly without having to rely on a priori assumptions, we employ the non-parametric technique of penalized splines before estimating a set of candidate parametric models to test which one represents the data best, as suggested by Serra et al. (2006). In addition to demonstrating the existence and extent of market power, we also quantify a part of the resulting redistribution of welfare from the suppliers to the factories. These welfare implications are shown to be substantial. Subsequently we calculate the potential for redistributing forgone profits from factories to farmers under different scenarios of altered error correction processes.

To the best of our knowledge, this is the first paper combining the approaches of non-parametric and parametric estimation techniques of estimating asymmetric price transmission processes with a welfare perspective to quantify the distributional consequences of this intertemporal marketing margin manipulation. The calculation of different scenarios of alternative price transmissions and dataset of daily prices on such a disaggregated and local level required by this approach are also unique.

The paper is organized as follows: section two provides background on the rubber market

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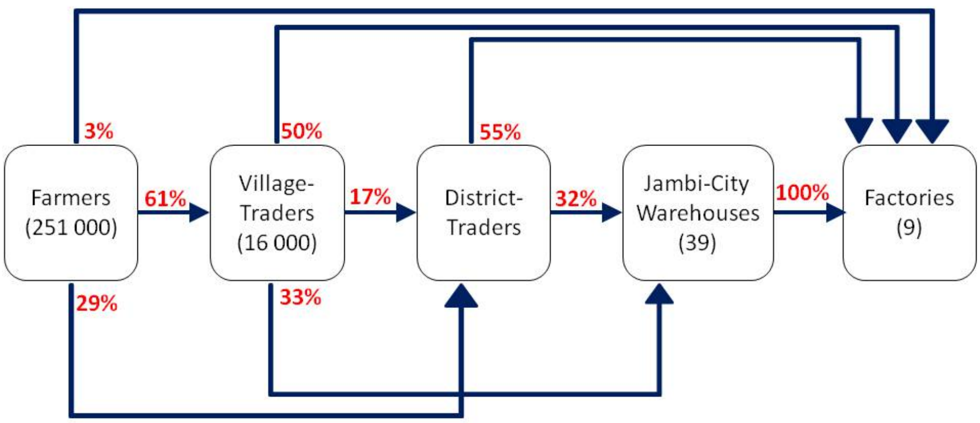
in the Jambi province and introduces the typical marketing chain for natural rubber originating from smallholder production in this area. In section three the rationale behind asymmetric price transmission is discussed. Section four is dedicated to model development, and section five presents the statistical results. Section six derives the resulting welfare implications before the concluding section seven.

2. Background

2.1 Rubber marketing in the Jambi Province

The structure of the Jambinese rubber sector is displayed in Figure 1.[5] Most farmers sell to a village trader who then has the choice between three different kinds of stakeholders: a factory, a warehouse or another trader, for example at the district level. This choice is influenced by various factors, including the remoteness of the trader, his or her capital, access to credit and information, etc. (Sujarwo et al., 2014).

Figure 1: Marketing channels for rubber.



Source: author's calculations, based on own survey data (2012) and Euler et al. (2012). The percentages indicate which marketing channel is employed and for how often.

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There are approximately 16 000 traders in the Jambi province and nine factories, five of which are located in Jambi City (Regional Account and Statistical Analysis Division, 2012 and own survey data, 2012).

2.2 Market concentration at the processing stage

It appears that oligopsonistic market power occurs at several stages in this value chain. On the village-level the traders' market power seems to be based on the farmers' credit constraints as well as asymmetric information between traders and farmers (Kopp and Brümmer, 2015).

In this paper, however, we are focusing on the market power at the next stage: the factory gates. The incriminating indicators are strong. During our traders survey in 2012 some respondents claimed that they were victims to the market power of downstream stakeholders (other traders, warehouses, and factories). It seems possible that the critique they express is justified to some extent. Each of the five factories located in Jambi City report the price that they are paying each day for their main input - slabs of raw rubber - to one central agent (their association). They also have the option to attain information on their competitors' prices from this agent. This enables each factory to control its competitors' pricing.

Another piece of evidence for the power of the factories is the standard procedure that follows when an external investor wants to construct a new crumb rubber factory. Before getting the required permission by the government, officials will first consult with the rubber processors' association on whether to give the permission or not (Jambi Provincial Government Office for Trade and Industry, personal communication, 2012).

Anwar (2004, cited in Arifin, 2005) argues that the margin of Jambinese rubber factories is much higher than those in other provinces. While Anwar argues this to be the result of close geographic proximity to one of the most important export market ports (Singapore), it is much more likely that this observed increased margin stems from the oligopsony power of the rubber factories (Arifin, 2005).

This market power has a tremendous effect on the distribution of welfare, both for the rubber farmers and Jambinese society in general. Welfare loss experienced by the farmers to the factories is due to lower pricing: the factories cause a transfer of income from the farmers to themselves by paying prices below the competitive level. The welfare loss to society in general stems from the farmers' total production below the competitive level

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because of the reduced raw rubber prices. In the long run it is reasonable to argue that the farmers could increase their rubber output, for example by shifting their production from palm oil to rubber. After 20-25 years an oilpalm plantation has to be replanted and the investments required for replanting oilpalm or rubber are similar.

However, as the supply function of rubber farmers is unknown, it is not possible to derive how much the supplied quantity, and thus total welfare loss, would be in the case of a general improvement of the price level. Therefore, we will concentrate on the farmers' welfare loss based on a below competitive market price in times of price hikes. We show *that* this oligopsonistic market power is exercised and *how large* the welfare loss to the farmers is, which results from intertemporal marketing margin manipulation.

3. Methodology

While the literature of the New Empirical Industrial Organization provides a direct approach to finding indications of market power (Bresnahan, 1982), these approaches require detailed information on the firms' demand and supply structures, data we do not have access to. One alternative way of finding empirical evidence for the existence of market power is by testing for a non-constant transmission of price changes (Kinnucan and Forker, 1987; McCorriston et al., 2001; Meyer and von Cramon-Taubadel, 2004). Weldegebriel (2004) derive from a theoretical model that the adjustment coefficient alone cannot be used as an indicator for market power. However, their argumentation refers to the absolute level of the adjustment coefficient while our study focuses on differences between adjustments to positive and negative changes of the leading price. The asymmetry that we are discussing here implies that positive changes of an agent's selling price are passed on to the provider at a lower speed than negative price changes. This means that when the agent's margin increases – that is in times of international price hikes – the buying price is corrected slower than when the margin decreases, enabling the processors to enjoy excess profits.

If asymmetries in the short-term dynamics occur (not only in the adjustment parameter) it would also be interesting to analyse these dynamics via impulse response functions. As we will see however, there are no asymmetries in the short-run dynamics, so the generation of impulse response functions would not increase the quality of information.

The assumption behind the asymmetric price transmission between the international rubber price and the Jambinese price for raw rubber is that the factories are price

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takers at the international market. While Indonesia as a whole can be assumed to have an influence on international rubber prices, this is unlikely to be true for the five Jambinese factories under consideration. Mundlak and Larson (1992) finds that world market prices are the main reason for variations in domestic prices, also in the presence of policy intervention. In the domestic market, however, it can be assumed that they are price setters. (Both these assumptions are tested below). One can therefore understand the shocks that arise in the first one as exogenous and the ones arising in the latter as reactions to that shock.

3.1 Non-stationarity and co-integration

Given that we are working with prices, a non-stationarity nature of the data is expected which is tested via the Augmented Dickey-Fuller (ADF) test with both variables of interest (ln_p^{Sell} and ln_p^{Buy}). As will be shown, they are indeed non-stationary, which we address by taking the first differences. We will then test whether the two series are co-integrated which is done by employing both the Johansen test (Johansen, 1998) and the Engle-Granger Two-Step method (Engle and Granger, 1987). For both tests we need to find the optimal lag-length. As we are using daily data, it is likely that the price of one day depends also on past shocks. To select the optimal number of lags we consider the Akaike's Information Criterion (AIC), Schwarz's Bayesian information criterion (SBIC), and the Hannan and Quinn information criterion (HQIC).

3.2 Error correction model

We assume a multiplicative mark-up model. The rationale for using a multiplicative instead of additive model is that the margin is assumed to be a percentage markup. This has been concluded from qualitative interviews with representatives at the rubber factories. We tested both approaches, and the results confirmed that taking the logarithm represents the data better. p_t^{Buy} refers to the buying price at time t and p_t^{Sell} to the selling price. The long-run ('co-integrating') relationship in its logarithmic form is given by

$$\ln p_t^{Buy} = \beta_0 + \beta_1 \ln p_t^{Sell} + \varepsilon \tag{1}$$

which we estimate with the Johansen method. The reason for doing so (despite our general approach of the Engle-Granger two-step method) is that the Johansen approach delivers better results when estimating the co-integrating relationship (Gonzalo, 1994).

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From the residuals of this relation we can generate the error correction term (ect) which is defined as follows:

$$ect_t = \ln p_t^{Buy} - \hat{\beta}_0 - \hat{\beta}_1 \ln p_t^{Sell} \tag{2}$$

In the case of a positive price shock on the international level (i. e. a positive deviation from the long-run equilibrium in which the factories' margin increases) the ect will be < 0 and if the price is shocked negatively, the ect is > 0. The error correcting process (symmetric case) is expressed as

$$\Delta \ln p_t^{Buy} = \xi_0 + \alpha\, ect_{t-1} + \sum_{\omega=1}^{M} \left(\gamma_\omega \Delta \ln p_{t-\omega}^{Buy} + \lambda_\omega \Delta \ln p_{t-\omega}^{Sell} \right) + \varepsilon \tag{3}$$

M is the number of lags, ξ_0 a constant, and γ_ω and λ_ω the coefficients of short-run dynamics. ε represents an error term.

For the thoughts laid out in the theoretical section above, the model is extended to a threshold error correction process, which is the generalization of a simple asymmetric adjustment. The existence of any threshold is tested for with a SupLM test as suggested by Hansen and Seo (2002). Based on model (3) the ect is split up into N regimes by $N-1$ thresholds, which are located at Ψ_λ for $\lambda \in [1, \ldots, N-1]$ and $ect_t^\varsigma := ect_t$ if $\Psi_{\varsigma-1} < ect_t \leq \Psi_\varsigma$ for $\varsigma \in [1, \ldots, N]$:

$$\Delta \ln p_t^{Buy} = \xi_0 + \sum_{\varsigma=1}^{N} \alpha_\varsigma ect_{t-1}^\varsigma + \sum_{\omega=1}^{M} \left(\gamma_\omega \Delta \ln p_{t-\omega}^{Buy} + \lambda_\omega \Delta \ln p_{t-\omega}^{Sell} \right) + \varepsilon \tag{4}$$

An 'asymmetric' process, which is the simplest form of a threshold error correction, is characterized by the parameters $N = 2$ and $\Psi_1 = 0$, i.e. the error correction term is split into two varibles, one for negative and one for positive price changes.[6]

3.3 Non-parametric estimation

Most authors in the literature on threshold error correction models use a parametric estimation technique (Hansen and Seo, 2002, Lloyd et al., 2006, and Ihle et al., 2012). The drawback of this procedure is that one has to make certain a priori assumptions for specifying the model, such as the number of thresholds. In order to overcome this

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limitation, we employ a non-parametric approximation. While using non-parametric estimation techniques to detect unknown relationships is a widely used technique in the statistical and financial literature (Krivobokova et al., 2010; Escribano, 2004), in the agricultural economics literature this has not been often employed. One exception is the work by Serra et al. (2006) who use a local polynomial fitting approach in order to understand the error correction process without the need for restrictive a priori assumptions. Contrary to that, we work with penalized splines (Eilers and Marx, 1996). Regression splines consist of the sum of a number of polynomial functions. The spline is fitted to match the data by giving each of these functions an individual shape. Penalizing the splines refers to the method of including a penalty-term, which smoothes the spline by penalizing excessive zigzagging (i. e. big differences between neighboring values) of the spline (Wood, 2003).

3.4 Candidate models for parametric estimation

In order to get to know the exact slope-coefficients necessary for calculating the distributional effects, we continue with a parametric regression approach. Several approaches are employed to model the error correction process before the model that represents the data best is chosen via a testing procedure described below.

To start with, we estimate a simple linear error correction model (M1) which corresponds to the model described in equation 3. The second model (M2) is an asymmetric error correction model which corresponds to equation 4 with the specifications N=2 and Ψ_1=0. For the third model (M3) we assume a one-threshold model with no restriction on the location of the threshold. The rationale behind model three (M3) is that the price gets corrected quickly during price drops (regime 3) and moderate hikes (regime 2) when the factories generate a normal margin. In times of large price increases (regime 1) however, the prices get corrected at a much slower rate; the factories generate a greater margin. M3 corresponds to equation 4 with N=2 and an unknown value of Ψ_1.[7].

The exact location of this threshold can be found via a grid search approach. We test each possible value of the *ect* as the threshold value Ψ_1, estimate the model and save the log-likelihood value. We then select the model with the highest log-likelihood.

3.5 Threshold determination and model choice

We find the threshold of model M3 via the grid-search following the method laid out above. No assumptions are made about the location of the threshold until then.

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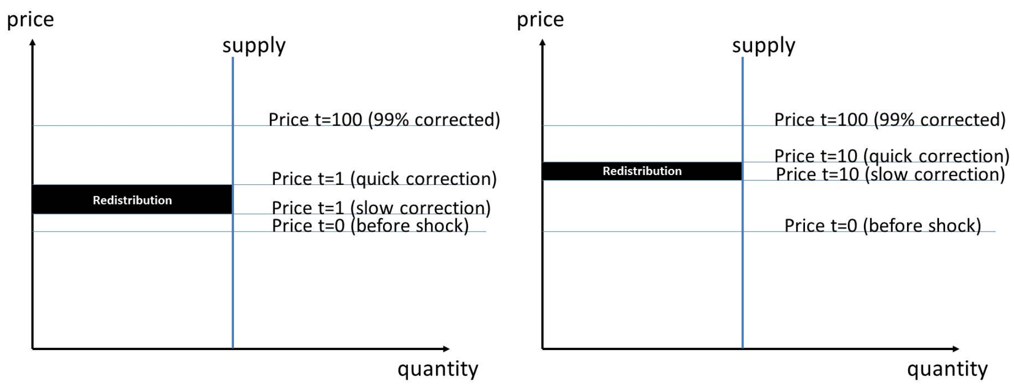
After estimating the different models described (M1-M3), we test which of them represents the data best. As we compare models with different specifications concerning the number of regimes (one and two), we rely on information criterion again. We employ the AIC which is in this case superior to other information criteria as laid out by Burnham and Anderson (2002).

3.6 Distributional effects

The quantification of the distributional effects stemming from asymmetric price transmission is based on the forgone income of smallholders due to slower price transmission in times of tremendous price hikes, compared to a baseline scenario of the fastest adjustment possible which is assumed to be the adjustment that occurs in times of price decreases (see Figure 2). As discussed above, we do not focus on the total welfare effect because the price elasticities of the supply and demand are unknown. The part of the welfare effect which stems from the intertemporal marketing margin manipulation is calculated as the difference between the price that is theoretically possible in times of price hikes and the price that is actually paid, multiplied by the quantity.

Figure 2: Welfare effect during adjustment process after shock at t=0



(a) time = t+1 (b) time= t+10

Source: author's draft.

In order to quantify the effect that the intertemporal marketing margin manipulation had on all Jambinese farmers, we calculate the differences between two hypothetical scenarios of local price development after 14 periods (the time after which a farmer sells his/her produce is around two weeks) following each shock to the global price during

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2009-2012. The two scenarios differ in the assumed adjustment parameter, following the results from the asymmetric error correction model.

We start with the following equation

$$\ln p_t^{Buy} = \ln p_{t-1}^{Buy} + \Delta \ln p_t^{Buy} + \varepsilon \tag{5}$$

in which we substitute $\Delta \ln p_t^{Buy}$ from a simplified version (without lagged prices)[8] of equation 3 and then ect_t from equation 2 in order to calculate the adjusted price after one period:[9]

$$\ln p_t^{Buy} = \ln p_{t-1}^{Buy} + \hat{\alpha} \left(\ln p_{t-1}^{Buy} - \hat{\beta}_0 - \hat{\beta}_1 \ln p_{t-1}^{Sell} \right) + \varepsilon \tag{6}$$

Iterating this procedure 14 times generates the price after 14 periods after the shock in period 1. In the computation the error term is set to zero. The difference p^{diff} between the two scenarios is given as

$$p^{diff} = exp\left(\ln p_{t+14}^{Buy(\alpha^+)} \right) - exp\left(\ln p_{t+14}^{Buy(\alpha^-)} \right) \tag{7}$$

The total redistribution (RED) based on intertemporal marketing margin manipulation is then the sum of all price differences, multiplied by the quantity sold at time $t + 14$:

$$RED = \sum_{t=1}^{T} \left(p_t^{diff} q_{t+14} \right) \tag{8}$$

4. Data

The daily buying prices of the five factories in Jambi City were provided by Gapkindo. There is one price for each factory available for each day between 1 January 2009 and 31 December 2012, except for Thursdays, public holidays and one holiday week in August or September. Out of these five series, an unweighted average for the Jambi-buying price was generated. The selling prices were drawn from PT. Kharisma (2013), a marketing company located in Jakarta. These prices represent the average results of the auctioning of Standard Indonesian Rubber (SIR20) on each day rubber was sold (maximum four days per week, except for two weeks of holidays in December). In combination, this

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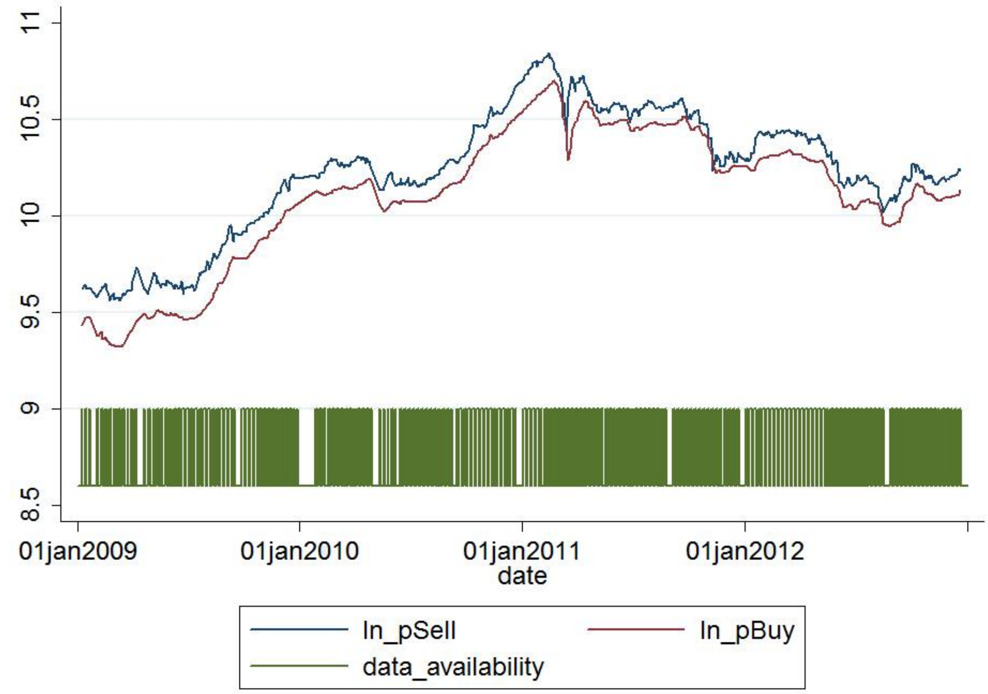
gives us 701 days for which we have both selling and buying prices. The price series are graphed in Figure 3.

Figure 3: Time series of buying and selling prices.



Source: author's production. Values are the logarithm of the prices in Indonesian Rupiah. 1.00 USD = 10.93 Indonesian Rupiah (December, 2013). The green bar indicates the existence of data, so the holes in the green bar represent days without data. In the graph, the last point before a gap was connected with the first one after it.

5. Results

5.1 Non-stationarity and co-integrating relationship

The initial suspicion is confirmed. The series are indeed both non-stationary (the H0 of non-stationarity cannot be rejected at a confidence level of 10%). To avoid the problem of spurious regressions, we take the first differences. As the results of the ADF test show (H0 can be rejected at a 1% confidence level), this solves the problem. The SBIC suggests a lag-length of the order two, the HQIC three lags, and the AIC opts for four lags. Following Ivanov and Kilian (2005), who suggests we trust the AIC in situations of

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large sample sizes (>250) and data of relatively high frequency (>weekly), we use four lags. The second reason for choosing the lag order suggested by the AIC is the danger of biasing the results by under-parametrizing the model; over-parametrizing does not cause too much damage (Gonzalo, 1994). So the lag length was specified as four periods in each case, including a constant and without trend. Test results are available on request.

From the test for a simple (i. e. non-threshold) ARVECM with the Johansen method we can confirm our assumption that the factories are clearly price-takers on the international market and price setters on the domestic market. The selling price does not react significantly to the buying price ($\alpha = -.0152704$, p-value= 0.511), while the reaction of the buying price is strong and highly significant ($\alpha = -.0593225, p - value = 0.001$)[10]. Using the Engle-Granger two-step approach results in a very similar adjustment parameter of -.0582281 for the buying price and is also highly significant (p-value=0.001). Hence, the use of the Engle-Granger two-step approach seems appropriate. The co-integrating relationship is presented in Table 1. We continue the analysis using the residuals of the co-integrating relationship generated with the Johansen method ($p^{Buy} = 0.45(p^{Sell})^{1.07}$), following the results of Gonzalo (1994) who finds that the Johansen method delivers the best results when estimating long-run relationships. An F-Test confirms that the constant is significantly (1% level) different from the value one. Testing the residuals with the ADF test yields a test statistic of -6.980, with which we can reject the H0 of non-stationarity at the 1% level. The results of Hansen and Seo's (2002) SupLM test indicate the presence of a threshold, as the H0 of an error correction process without a threshold can be rejected at a 10% level (robust SupLM), and respectively a 1% level (standard SupLM) of significance.

Table 1: Estimates of long-run relation.

5.2 Penalized splines

Figure 4 shows the penalized spline (blue line). The dotted lines represent the 5% confidence intervals.[11] In order to deal with the small numbers of observations at both ends of the population, we add a thin plate penalized spline for comparison (bronze line) (Wood, 2003). The thin plate regression splines penalize by compiling the spline of the group of functions which are the most relevant. These are chosen via an Eigenvalue decomposition.

The splines exhibit narrow confidence intervals in the area of many observations and

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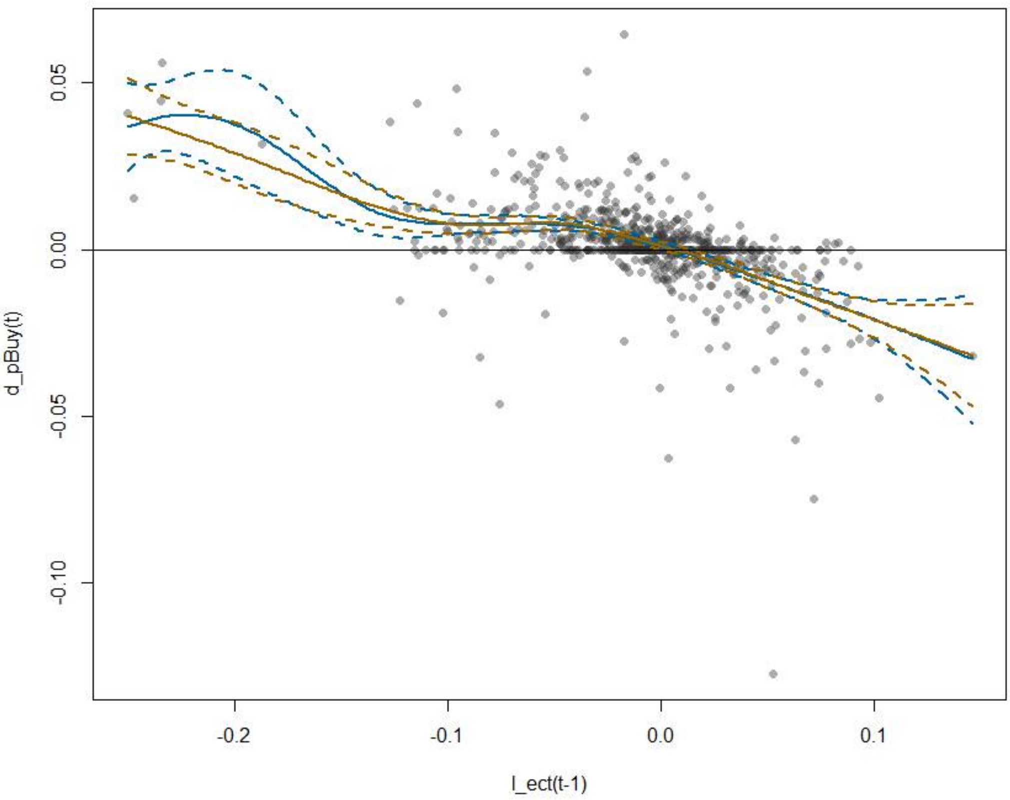
Figure 4: Penalized splines.



Source: author's production.

show one threshold in the region [-0.05; 0], thus indicating at least two regimes. The two regimes can be characterized as follows: the slope is steeper for positive values of ect_{t-1}, which means that the shock gets corrected more rapidly in cases of negative price-shocks than in the case of positive price-shocks. While in the area [-0.1; 0.1] the splines are robust to changes in their specification,[12] the confidence intervals widen substantially at the rather extreme values in $]-\infty; -0.1[\cup]0.1; \infty[$, which is caused by the small number of observations in those areas.

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5.3 Model choice

Table 2 presents the AIC values of the models M1-M3. Following this criterion, M3 represents the data best. Executing an F-Test indicates that the two slope-coefficients of Model 3 are different from each other with a significance of 6.58%. The following discussion is therefore based on the two-regime model with one threshold at -0.038 (M3).

Table 2: Results of Akaike Information Critereon.

5.4 Parametric regressions

The estimation results are presented in Table 3. The specification of M3 stems from a one-dimensional Gridsearch. Its results are shown in Figure 5. The display of the likelihood values shows two peaks which indicate possible locations for the threshold, one at the *ect* value of -0.038 (splitting up the *ect* into one regime of 135 observations and one of 571 observations) and one at the value of 0.052 (662 and 44 observations per regime). Considering that the likelihood values are nearly identical (2226.714 with the threshold at the 135th observation vs. 2226.863 at the 662nd observation) but the latter value produces one regime of only 44 observations, we chose the first possibility.[13]

Table 3: Results of all models discussed.

6. Discussion

6.1 Interpretation of coefficients

Table 3 displays the results of the three models of the parametric estimation. On average (column M1), 5.83% of a price shock is corrected per day. If the buying price deviates from the long-run equilibrium price by 100% for example (i. e. it is half of what it should actually be in the long-run), 5.83% of that shock is, on average, corrected the following day. This is equivalent to an average half-life of a price shock of 11.4 days. Reasons for these deviations include a shock to the international price, or past shocks which have not been fully corrected.

When accounting for the asymmetric price adjustment, the picture looks different. During the last four years, after 135 out of 390 price hikes (positive shocks to the price, i. e. $ect < 0$), which is roughly 1/3 of these cases, the price was corrected significantly slower than during price declines. More specifically, these 135 cases occurred at times

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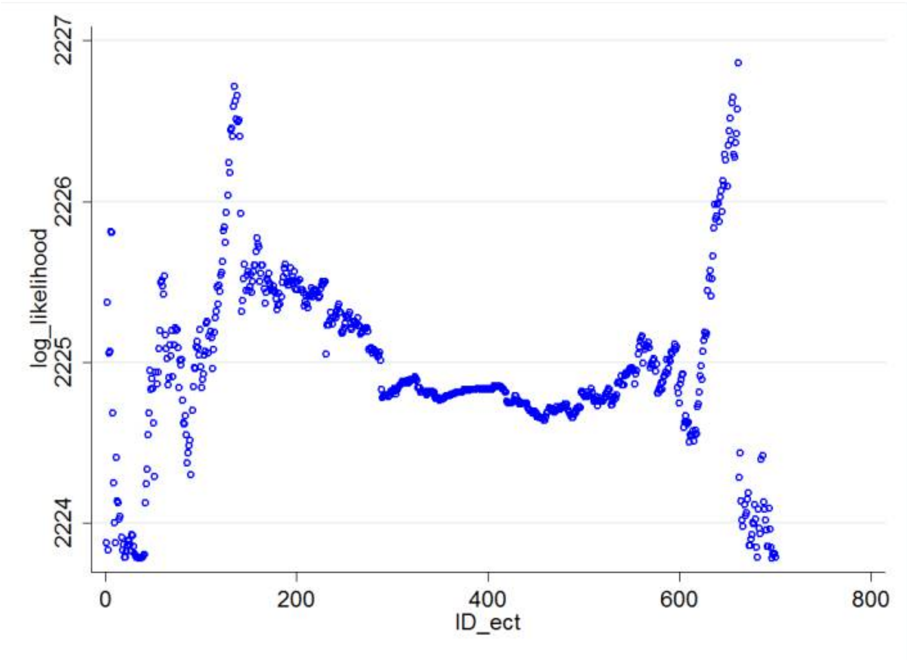
Figure 5: Results of one-dimensional grid search.



Source: author's production.

of extreme price hikes, i. e. $ect < -0.038$. It takes 16.5 days to correct half of a strong positive price change and only 7.5 days in the case of a negative or small positive shock (see Figure 6. The simulations are based on equations 6 and 7, see below). The sign of the threshold value is counterintuitive (negative *ects* refer to positive price changes) because the *ect* is defined as the long-run equilibrium price minus the actual price in that period. This means that when the international price sinks, the factories' buying prices decrease twice as fast as when the international price rises strongly. The time needed to correct 99% of a shock is 49 days in the case of a negative shock and 107 days in the case of a strong positive shock. The lagged values of p_t^{Sell} are positive and significant while the lags of p_t^{Buy} are insignificant which supports the results from the Johansen test above that p_t^{Sell} is the leading price.

There are two explanations as to why the price shocks are not transmitted in an instant (9.4% per period is a very quick error correction, considering that we are working with daily data). Firstly, technical reasons in the factories, such as communication between the selling and buying departments. The second reason is more of a methodological issue.

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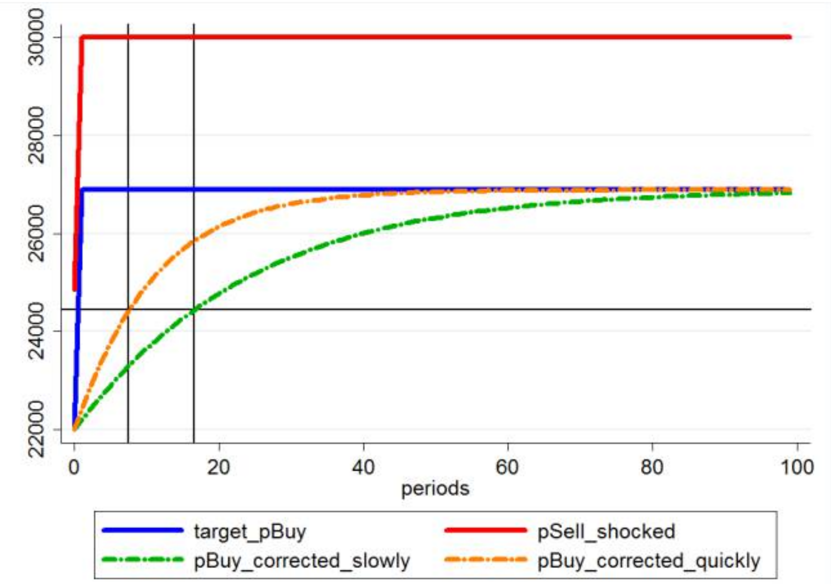
Figure 6: Correction of shocks over time.



Source: author's calculations. In Indonesian Rupiah; 1.00 USD = 10.93 Indonesian Rupiah.

For the analysis, the average prices of five crumb rubber factories was generated. There are always small differences between the five prices. These small differences impact the average in a way that leads to an apparent short delay in the transmission time that is the average between the firms.

6.2 Market power or not?

As asymmetries in price adjustments can result from different kinds of processes other than market power (von Cramon-Taubadel, 1998), this kind of analysis cannot provide a definite 'proof' of market power. Meyer and von Cramon-Taubadel (2004) show that asymmetric price transmission (APT) is not necessarily caused by market power. In their literature review, they present an overview of reasons for asymmetric price transmission other than market power, arguing that evidence for asymmetric price transmission is not equivalent to a proof of market power. For the case of our study however, the alternative explanations that can lead to APT discussed in the literature can be ruled out. This leads us to the conclusion that the APT observed in the rubber processing sector in Jambi is indeed most likely caused by market power, based on cartel-like behaviour or

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an oligopsonistic market structure.

a) '*Menu costs*' or the costs associated with changing the price: the prices the factories pay to their suppliers change every day. There is no reason to believe that the costs of changing the price depend on the direction of the price change.

b) Fixed costs forcing a firm to operate close to its production capacity: as the agricultural input (the slabs of coagulated rubber) is extremely durable; the factories always have a stock available big enough to keep the factory running for more than a week.

c) Perishability generates an incentive to sell the product quickly: processed crumb rubber is not perishable.

d) A strong inflation in times of rising prices leads to data that exhibit asymmetry: while the inflation of the Indonesian Rupiah is greater than that of the U.S. Dollar, for example, it is not great enough to have any impact on a daily basis which is the horizon of our data.

e) Policy interventions, price support, etc. can also lead to asymmetric price transmission, but this has not occurred in Jambi (or on a national level in Indonesia) during the timeframe under consideration. Neither were new factories built or a new national/provincial government elected. Other input prices have also stayed constant (energy has been subsidized at a constant level, and the minimum wage did not change during the time of analysis). Hassouneh et al. (2010) suggest searching for a regime-switch which was not found in the data.

f) Processing time: though a delayed reaction (caused by processing time) in combination with high inflation can show misleading signs of APT, this does not apply here for two reasons: 1.) While it is true that inflation is high in Indonesia (4.3% in 2012),[14] we work with daily data. During the typical reaction times price hikes due to inflation are close to zero. 2.) Besides that, we are observing a potentially mono- or oligopsonistic setting, implying that the shock that hits the leading (selling) price occurs after the processing. If factories who set their buying price (and take their selling price) would want to set the buying price according to what they receive for that specific load of rubber after processing, they would have to anticipate the price after the processing already at the time of purchasing. This is impossible.

g) Non-cooperative game: there are cases where it looks like price-fixing has happened, while in fact there was no outspoken agreement. It occurred in situations in which

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firms could threaten to punish another firm which deviated from the cartel-solution (Perloff et al., 2007). However, only rarely could it be argued that these companies would have had an agreement that was not the subject of debate, especially given the fact that in all other respects they are such close companions. Besides, even if there were indeed no explicit agreement on pricing, the oligopsony-hypothesis would still hold.

An explanation as to why cartels adjust (increase) their buying prices at all – i. e. why they do not always pay a low price to the farmers – is that even cartels face restrictions concerning their price setting. There is always one margin that cannot be exceeded without risking government interference. This is the margin that is realized in times of constant or falling prices but temporarily increased when prices rise.

6.3 Distributional consequences

In order to account for the distributional consequences of the intertemporal marketing margin manipulation we calculate the difference between the observed distribution of rents to hypothetical distributions in two alternative scenarios (equations 6 to 8).

The first scenario assumes perfect symmetry by setting α^- equal to α^+. This means that the asymmetry is fully eradicated. In the second scenario half of the asymmetry remains. This is operationalised by setting α^- to the arithmetic mean between the two estimated coefficients (6.9%).

The 252 000 Jambinese rubber producing smallholders produce 281 000 tons of rubber per year on average (Regional Account and Statistical Analysis Division, 2012) and we assume them to sell, on average, the same amount every day at which they sell.

The results for scenario 1 yield an estimated forgone revenue of 32.4 billion IDR (3.0 million USD) for the Jambinese rubber farmers in times of rising prices in every year. This is only the amount that was redistributed from farmers in Jambi to the factories, due to the asymmetric price transmission of the factories. The total welfare loss due to the below free-market prices can be assumed to be substantial, too. For a single farmer, this amount represents 2.25% of his or her annual revenue. Considering that around 32% of the revenue turns into income (calculation based on Euler et al., 2012), the calculation of the forgone income is based on the following: profit π is equal to rs with r being the revenue, and s the profit share of the revenue (32%). $\pi = r - c$ with c representing the costs. The possible increased revenue (if the price transmission was

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symmetrical) r' is equal to $r(1+x)$ with x being the percentage share of the possible increase of the revenue (2.25%). Then $\pi' = r' - c$. The potential increase of income can be calculated as

$$\left(\pi' - \pi\right)/\pi = \left(r\left(1+x\right) - c - \left(r+c\right)\right)/\left(rs\right) \tag{9}$$

According to this analysis, increasing the revenue by 2.25% would have led to an increased income of 7.03%. So effectively each farmer could have generated 6.97% more income when the prices were increasing by more than the threshold value.

In the second scenario we find an estimated forgone income of only 13.5 billion IDR (1.2 million USD) for the farmers due to the factories' price rigging. Due to the logarithmic nature of the price transmission effect, this is significantly less than half of the amount calculated in scenario 1, although only half of the asymmetry is balanced out.

7. Conclusions

Indications that the five rubber processing businesses in Jambi City, Sumatra, possess market power and use it to rig the prices they pay to their suppliers are strong. In this paper we found evidence for an asymmetric transmission of prices, which has led to a great redistribution of revenue from the farmers to the processors during the four years of observation. Compared to a non-monopsonistic market situation, the rubber farmers have missed out on an income of 7%. The net welfare loss generated in the process could not be quantified in this analysis but can be assumed to be substantial. It is likely that these kinds of processes occur all over Indonesia.

The group has achieved its advantage by correcting price changes on the international market (where its members act as price takers) asymmetrically. If the international price drops, the buying price decreases much quicker than in times of great price hikes. All alternative explanations for asymmetric price transmission - other than market power - could be ruled out for the rubber processing sector in Jambi. Risk managing strategies would lead to a generally lower price level but not to a different reaction, depending on the direction of price changes.

One policy recommendation that could be drawn from our results is to involve all stakeholders (including farmer representatives) in consultations before deciding to grant permits for the construction of new crumb rubber factories. If more factories were competing

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for the input of raw rubber, the general price level would be expected to increase. The calculation of an alternative scenario shows that if the asymmetric price transmission was halved, the farmers' loss of income would be reduced significantly.

Another issue that has been touched upon only briefly is the behaviour *between* Jambinese rubber processors. It would be interesting to know if there is a rather random section of stakeholders who apply price changes first, or one clear Stackelberg leader determining the price. With this sort of game-theoretical approach one would be able to get a clearer picture of the roles of different stakeholders within the group, and the functioning of it as a whole. This calls for research at a more disaggregated level.

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References

Ahmadi-Esfahani, F. (2009). Estimation of trade elasticities in the presence of trade barriers, multinationals and imperfect competition. *Australian Journal of Agricultural and Resource Economics*, 53:385–392.

Arifin, B. (2005). Supply-Chain of Natural Rubber in Indonesia. *Jurnal Manajemen Agribisnis*, 2(1):1–16.

Bresnahan, T. F. (1982). The oligopoly solution concept is identified. *Economics Letters*, 10(1):87–92.

Burnham, K. and Anderson, D. (2002). *Model selection and multimodel inference: a practical information-theoretic approach.* Springer, Heidelberg, Germany.

Eilers, P. H. C. and Marx, B. D. (1996). Flexible smoothing with B-splines and penalties. *Statistical Science*, 11(2):89–102.

Engle, R. F. and Granger, C. W. J. (1987). Co-integration and Error Correction: Representation, Estimation, and Testing. *Econometrica*, 55(2):251–276.

Escribano, A. (2004). Nonlinear Error Correction: the Case of Money Demand in the United Kingdom (1878–2000). *Macroeconomic Dynamics*, 8:76–116.

Euler, M., Krishna, V., Fathoni, Z., Hermanto, S., Schwarze, S., and Qaim, M. (2012). Ecological and Socioeconomic Functions of Tropical Lowland Rainforest Transformation Systems (Sumatra, Indonesia), Household Survey 2012. Göttingen, Germany; Jambi, Indonesia; Bogor, Indonesia; Georg-August University of Goettingen, Bogor Agricultural Uni.

Fathoni, Z. (2009). Evaluation of Market System and Market Integration for Rubber Cultivation in Jambi Province - Indonesia. *Masters Thesis, Bogor Agricultural Institute, Bogor, Indonesia.*

Gonzalo, J. (1994). Five alternative methods of estimating long-run equilibrium relationships. *Journal of Econometrics*, 60(1):203–233.

Hansen, B. E. and Seo, B. (2002). Testing for two-regime threshold cointegration in vector error-correction models. *Journal of Econometrics, Long Memory and Nonlinear Time Series*, 110(2):293–318.

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Hassouneh, I., Radwan, A., Serra, T., and Gil, J. M. (2012). Food scare crises and developing countries: The impact of avian influenza on vertical price transmission in the Egyptian poultry sector. *Food Policy*, 37:264–274.

Hassouneh, I., Serra, T., and Gil, J. M. (2010). Price Transmission in the Spanish Bovine Sector: The BSE Effect. *Agricultural Economics*, 41(1):33–42.

Ihle, R., Brümmer, B., and Thompson, S. R. (2012). Structural change in European calf markets: Decoupling and the blue tongue disease. *European Review of Agricultural Economics*, 39:157–179.

Ivanov, V. and Kilian, L. (2005). A Practitioner's Guide to Lag Order Selection For VAR Impulse Response Analysis. *Studies in Nonlinear Dynamics & Econometrics*, 9(1):1–36.

Johansen, S. (1998). *Likelihood-based inference in cointegrated vector autoregressive models*. Oxford University Press, Oxford.

Kinnucan, H. W. and Forker, O. D. (1987). Asymmetry in Farm-Retail Price Transmission for Major Dairy Products. *American Journal of Agricultural Economics*, 69(2):285–292.

Kopp, T. and Brümmer, B. (2015). Moving Rubber to a Better Place – and Extracting Rents from Credit Constrained Farmers along the Way. *CRC990 Discussion Paper Series: Efforts Discussion Paper 9*.

Krivobokova, T., Kneib, T., and Claeskens, G. (2010). Simultaneous Confidence Bands for Penalized Spline Estimators. *Journal of the American Statistical Association*, 105(490):852–863.

Lloyd, T. A., McCorriston, S., Morgan, C. W., and Rayner, A. J. (2006). Food Scares, Market Power and Price Transmission: The UK BSE Crisis. *European Review of Agricultural Economics*, 33(2):119–147.

McCorriston, S., Morgan, C. W., and Rayner, A. J. (2001). Price transmission: the interaction between market power and returns to scale. *European Review of Agricultural Economics*, 28(2):143–159.

Meyer, J. and von Cramon-Taubadel, S. (2004). Asymmetric Price Transmission: A Survey. *Journal of Agricultural Economics*, 55(3):581–611.

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Mundlak, Y. and Larson, D. F. (1992). On the transmission of world agricultural prices. *World Bank Economic Review*, 6(3):399–422.

Peramune, M. R. and Budiman, A. (2007). A Value Chain Assessment of the Rubber Industry in Indonesia. U.S. Agency for International Development. *Project Report, USAid.*

Perloff, J. M., Karp, L. S., and Golan, A. (2007). *Estimating Market Power and Strategies.* Cambridge University Press, New York, USA.

Rajcaniova, M. and Pokrivcak, J. (2013). Asymmetry in price transmission mechanism: the case of Slovak potato market. *Review of Agricultural and Applied Economics*, 16(2):16–23.

Regional Account and Statistical Analysis Division (2012). *Jambi in Figures 2011.* BPS Statistics of Jambi Province, Jambi, Indonesia.

Serra, T., Gil, J. M., and Goodwin, B. K. (2006). Local Polynomial Fitting and Spatial Price Relationships: Price Transmission in EU Pork Markets. *European Review of Agricultural Economics*, 33(3):415–436.

Sujarwo, R. M., Kopp, T., Nurmalina, R., Asmarantak, R. W., and Brümmer, B. (2014). Choice of Marketing Channels by Rubber Small Traders in the Jambi Province, Indonesia. *Tropentag 2014: Conference Proceedings.*

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

Weldegebriel, H. T. (2004). Imperfect Price Transmission: Is Market Power Really to Blame ? *Journal of Agricultural Economics*, 55(1):101–114.

Wood, S. N. (2003). Thin plate regression splines. *Journal of the Royal Statistical Society. Series B (Statistical Methodology)*, 65(1):95–114.

Notes

[1]WorldBank World Development Indicators. Accessed March 2015, available at `http://databank.worldbank.org`.

[2]FAO FAOSTAT. Accessed March 2015, available at `http://faostat3.fao.org/home/E`.

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[3]Exchange rate (December 2013) from Oanda Corporation.

[4]WorldBank: WorldBank World Development Indicators. Accessed March 2015, available at `http://databank.worldbank.org`.

[5]Farmers' marketing channels do not add up to 100, because they sell a minor share on auction markets (6%) where the buyer is unknown, as well as to farmers' associations (1%). The missing 13% of the district traders stem from the fact that they can also sell to another trader, which was omitted from this graph.

[6]I was checked whether the non-linearities in the error correction do not only occur in dependence of the direction of the price change, but also in the form of structural breaks between regimes such as high- or low- price phases as done so by Rajcaniova and Pokrivcak (2013). It was also checked for asymmetries in the short term adjustments. Since none of these have altered the results they were omitted from the tables to save space. They are available upon request.

[7]It was also experimented with a smooth-transition type of model as employed by Hassouneh et al. (2012). The results did not show statistical significance, but can be made available on demand.

[8]We can make this simplification of equation 3 since the short-run dynamics are not asymmetric.

[9]The adjustment of p^{Sell} to p^{Buy} is close to zero, since p^{Sell} was shown above to be clearly the leading price, and not reacting to p^{Buy})

[10]The full results of the ARVECM can be made available upon request.

[11]These calculations were carried out with the software R 3.0.1 and version 1.7-22 of R package MGCV.

[12]Available on request.

[13]For model tests see below. The results of the estimation that assumes the other threshold can be made available on demand. We also executed a two-dimensional grid-search and estimated a three-threshold model, whose results can also be made available on demand.

[14]Inflation in 2009: 4.8%, 2010: 5.1%, 2011: 5.4%. All from World Bank Database, 2015, dataset 'Inflation, consumer prices (annual %).

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Table 1: Estimates of long-run relation.

ln_pBuy	OLS	Johansen
ln_pSell	1.067***	1.067***
	(0.0071)	(0.0186)
Constant	-0.811***	-0.800
	(0.0723)	
Observations	701	701
R-squared	0.982	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Since the VEC is not linear, it does not report t-statistics. The Johansen results have four observations less, because they include lags, while the first step of the Engle-Granger method does not require the inclusion of lags.

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Table 2: Results of Akaike Information Critereon.

Model	ln(L)	k	AIC	Rank
M1	2223.7814	10	-4427.5628	3
M2	2224.8331	11	-4427.6662	2
M3	2226.7141	11	-4431.4282	1

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Table 3: Results of all models discussed.

d_ln_pBuy	(M1) Regular OLS	(M2) One Threshold (at zero)	(M3) One Threshold (at -0.0383844)
L.ect	-0.0583***		
	(-4.234)		
L.ect_pos		-0.0875***	-0.0935***
		(-2.954)	(-4.284)
L.ect_neg		-0.0473***	-0.0438**
		(-2.601)	(-2.561)
LD.ln_pSell	0.156***	0.149***	0.145***
	(5.676)	(5.055)	(4.882)
L2D.ln_pSell	0.139***	0.136***	0.134***
	(4.535)	(4.385)	(4.289)
L3D.ln_pSell	0.109***	0.110***	0.110***
	(4.078)	(4.115)	(4.124)
L4D.ln_pSell	0.0364	0.0360	0.0357
	(1.136)	(1.121)	(1.113)
LD.ln_pBuy	0.0544	0.0541	0.0543
	(1.081)	(1.070)	(1.069)
L2D.ln_pBuy	-0.0192	-0.0211	-0.0222
	(-0.371)	(-0.411)	(-0.433)
L3D.ln_pBuy	0.0365	0.0330	0.0308
	(0.893)	(0.817)	(0.772)
L4D.ln_pBuy	0.130**	0.125**	0.124**
	(2.057)	(1.971)	(1.969)
Constant	4.98e-05	0.000646	0.000529
	(0.125)	(1.112)	(1.260)
Observations	701	701	701
R-squared	0.387	0.389	0.392

Robust t-statistics in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

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