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Orlen or Lotos? Which is Setting Prices at the Wholesale Market for Unleaded Petrol in Poland?*

1. Introduction

The wholesale market for unleaded petrol in Poland is dominated by its two producers, PKN Orlen S.A. and Lotos S.A. Their share in the overall supply amounts to 84 per cent. The remaining 16 per cent is split among many importers, none of which has a significant market power[1]. Since the barriers of entry into domestic market are relatively weak, it seems to have been duopolistic with the prevailing price-type competition. Each duopolist while setting its price, apart from its vis-à-vis competitor's behaviour, has to account for the world price of unleaded petrol and the exchange rate of U.S. dollar to Polish zloty in which the import contracts are settled.

The aim of the paper is to reveal the price-setting mechanism in this market. In particular the problem of price leadership is addressed. In doing so it is demonstrated that the prices of both Polish producers, the world price, and the exchange rate are all integrated of order one variables. Assuming that there are no arbitrage opportunities in the integrated European market (the law of one price

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[1] See *Polski*… (2007), Tab. 8 (Sales of petrol in the domestic market and imports of petrol in 2005 with the exclusion of oil refineries) and Charts 37, 37a (Sales of petrol by independent operators in 2005).

(LOP) applies to petroleum products), and the import costs are stationary[2], the analysis is nested within a trivariate vector error correction model (VECM) (Brenner, Kroner, 1995). The prices of unleaded petrol in this model are endogenous and the exchange rate is exogenous. The model is build with the use of Johansen's procedure (Johansen, 1988, 199). Its estimation and the inference are performed on the sample of daily wholesale prices of the 95-octane unleaded petrol produced by Orlen and Lotos, its spot price quoted in Rotterdam (ARA), and the National Bank of Poland U.S dollar selling rate from the period January 5, 2004-January 26, 2007[3]. The computations are executed within Microfit 4.0.

The analysis reveals the co-integration of unleaded petrol prices with two co-integrating vectors, which prove their common stochastic movement and the existence of two long run equilibrium relations: the first between the domestic producers' prices, and the second between whichever the domestic price and the world price. Departures from the first long run equilibrium relation cause a moderate feedback only into Orlen price; departures from the second interfere with both Orlen and Lotos prices. The world price in these circumstances remains unchanged. The price impulses run from the world price to the domestic prices, and from the exchange rate to the domestic prices. When setting their current prices each producer takes into account neither its own past prices nor its competitor's past prices. These lead to the conclusion that it is only Orlen which actively sets its price and can be pronounced the price leader in the wholesale unleaded petrol market in Poland. Lotos adjusts its price only then, when either the world price or the exchange rate changes.

The rest of the paper is organized as follows. Section 2 summarizes the results of investigation for the price setting mechanism in the wholesale unleaded petrol market in Poland. Firstly, the co-integrating properties of the variables in question are reported. Then the estimation and inference results including Granger causality testing based on the appropriate VECM are discussed. The last section briefly concludes.

2. Identification of the Price-setting Mechanism

The co-integration analysis of the variables in question sets off with testing for their (non)stationarity. In doing so the Leybourne ADF_{max} and the KPSS test statistics have been used (Leybourne, 1995; Kwiatkowski, Phillips, Schmidt,

[2] The import costs comprise the world price, transport costs, the exchange commission, the excise, and the fuel rate.

[3] The wholesale producers' prices were taken from their web pages; the Rotterdam ARA spot price was taken from the web page of the U.S. Department of Energy, Energy Information Administration; the National Bank of Poland U.S dollar selling rate was taken from the bank web page.

Shin, 1992). The tests results gathered in Table 1 prove that all unleaded petrol prices and the exchange rate are $I(1)$ variables.

Table 1. Testing for the unit roots and stationarity results for the unleaded petrol prices produced by Orlen (Orl) and Lotos (Lot), the world price (Rot), and the exchange rate (Ex), daily observations from the period Jan. 4, 2005-Jan. 26, 2007

Variable	No. obs.	Test					
		Leybourne				KPSS	
		ADF_f	AIC(j)	ADF_r	AIC(j)	$KPSS_A$	$KPSS_B$
Orl	789	-2.4628 A	-3798.3 (2)	-1.9146 A	-3801.0 (2)	0.8896	0.1963
Lot	789	-2.4031 A	-3813.5 (2)	-2.3973 A	-3814.7 (2)	0.9070	0.1980
Rot	789	-2.0768 A	-2199.4 (1)	-1.2336 A	-2199.8 (1)	2.3214	0.2614
Ex	789	-1.2069	1793.6 (1)	0.9294	1789.1 (1)	2.5807	0.4435

ADF_f, ADF_r – estimates of the ADF test statistics on the sample in the chronological (f) and the reverse (r) order, with an intercept (A), and with an intercept and trend (B); AIC(j) – estimates of the Akaike information criterion for an auxiliary ADF regression with the augmentation of order j removing autocorrelation; l=20 – truncation lag parameter; asymptotical critical values for the ADFmax test statistics: -3.41 (B); -2.86 (A); -1.95 (ADF regression without an intercept and trend); $KPSS_A$, $KPSS_B$ – estimates of the KPSS test statistics (constant and trend stationarity), critical values 0.463 and 0.1416, respectively; all critical values at 5 per cent significance level.

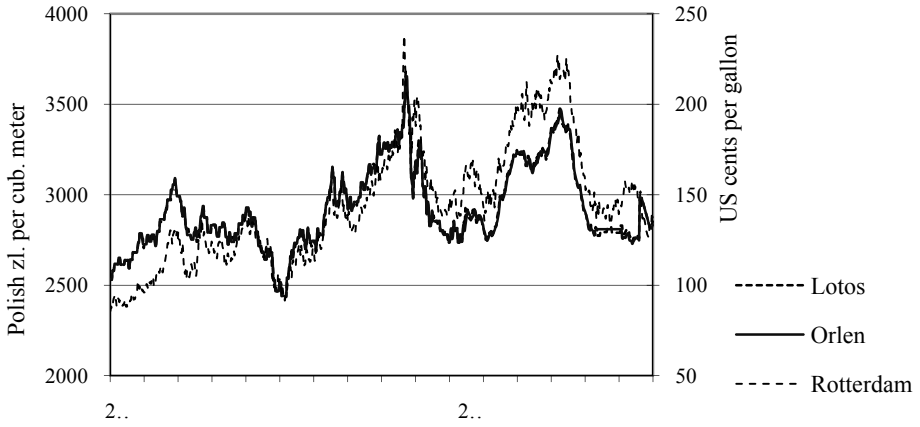

Figure 1. Daily 95-octane unleaded petrol prices, Jan. 4, 2005-Jan. 26, 2007

Inspection of Figure 1, on which the prices of both domestic producers and the world spot price of unleaded petrol are depicted suggests that they may exhibit common stochastic trends[4]. The above presumption is theoretically supported by no arbitrage opportunities existence in the integrated market. If this is the case, both domestic prices are in the long run equilibrium relation, $p_{1t} = p_{2t}$

[4] The left vertical axis applies to the producers' prices; the right vertical axis applies to the world spot price. Both domestic prices are measured in Polish zlotys per cubic meter, and the world price is measured in US cents per gallon.

($i = 1$ for Orlen and $i = 2$ for Lotos), and whichever of them is in the long run equilibrium relation with the Rotterdam spot price, $p_{it} = p_{3t} + x_t$, where p_{3t} – the foreign price of unleaded petrol, x_t – the U.S. dollar to Polish zloty exchange rate (all variables in natural logarithms). Then, under the Granger representation theorem, the unleaded petrol prices are to be modelled using the trivariate VECM

$$\Delta p_{it} = \sum_{j=1}^{3}\sum_{k=1}^{s-1}\delta_{i,jk}\Delta p_{jt-k} + \gamma_{ik}\sum_{k=1}^{s-1}\Delta x_{t-k} + \sum_{l=1}^{2}\varphi_{il}e_{lt-1} + \xi_{it} \qquad (1)$$

where $e_{it} = \beta_{i0} + \beta_{i1}p_{1t} + \beta_{i2}p_{2t} + \beta_{i3}p_{3t} + \beta_{i4}x_t$ ($i = 1,2,3$), in which: $\beta_{10} = 0$, $\beta_{11} = 1$, $\beta_{12} = -1$, $\beta_{13} = \beta_{14} = 0$ and $\beta_{21} = 0$, $\beta_{22} = 1$, $\beta_{23} = -1$, $\beta_{24} = -1$.

Coefficients φ_{il} in model (1) exhibit the pace of short run adjustment of the unleaded petrol prices towards their long run equilibrium relations, and the $\delta_{i,jk}$'s describe their causality structure (in a Granger sense). In the case in which $\beta_{10} < 0$ (> 0) and $\beta_{11} = 1$, $\beta_{12} = -1$, $\beta_{13} = \beta_{14} = 0$, in the long run Orlen price is higher (lower) than Lotos price. Parameters $\beta_{23} = \beta_{24} \in (-1,0)$ indicate that only a part of the world price change is incorporated into the domestic prices.

Table 2. Testing for the number of co-integrating vectors *r*

Test statistics									
Max. eigenvalue					Trace				
Null	Alt.	Statistic	Critical value		Null	Alt.	Statistic	Critical value	
			5%	10%				5%	10%
r=0	*r*=1	5.5771	25.5400	22.9800	*r*=0	*r*≥1	90.2204	42.4000	39.1200
r ≤1	*r*=2	18.6342	18.8800	16.7400	*r*≤1	*r*≥2	24.6432	25.2300	22.7600
r ≤2	*r*=3	6.0090	12.4500	10.5000	*r*≤2	*r*≥3	25.2300	12.4500	10.5000

Restricted intercepts and no trends in the co-integrating VAR; the lag length in the VAR *s*=7 is et using the Akaike information criterion (Lütkepohl, 2005, chap. 4); exogenous I(1) variable included in the model: Ex (exchange rate).

The number of co-integrating vectors $r = 2$ is validated on the ground of the maximum eigenvalue and the trace tests (Johansen (1988), (1991)). Their results are summarized in Table 2[5].

In order to normalize both long run equilibrium relations on Orlen and Lotos prices and to test for co-integrating properties of the price spreads the long run structural modelling has started with the $\beta_{11} = 1$, $\beta_{13} = 0$, $\beta_{21} = 0$, $\beta_{22} = 1$ restrictions set on co-integrating vectors $\beta_i^T = [\beta_{i0}, \beta_{i1}, \ldots, \beta_{i4}]$ ($i = 1,2$) containing coefficients pertaining the natural logs of the unleaded petrol prices

[5] The original time series of the Rotterdam spot price has been multiplied by 2.641721 in order the price is not expressed in the U.S. cents per barrel but in the U.S. dollars per cubic meter.

and the U.S. dollar to Polish zloty exchange rate. The estimates of the long run equilibrium relations are gathered in Table 3.

Table 3. Maximum likelihood estimates subject to exactly identifying restrictions

Variable	β_1	β_2
const	-0.0595	-6.0953
	(0.0734)	(0.4136)
p_1	1	0.0
	(-)	(-)
p_2	-0.9924	1
	(0.0087)	(-)
p_3	0.0	-0.2895
	(-)	(0.0514)
x	0.0008	-0.1370
	(0.0060)	(0.1244)

Asymptotic standard errors in brackets.

Next, on the ground of no arbitrage assumption (validity of LOP) three hypotheses concerning co-integrating properties of the price spreads have been tested for using the likelihood ratio test. The first (H_1) links Orlen and Lotos prices; the second (H_2) links Lotos (Orlen) and Rotterdam prices; and the last (H_3) links Orlen, Lotos and Rotterdam prices. To do so the following restrictions have been imposed onto the coefficients of the co-integrating vectors: (H_1) $\beta_{10}=0$, $\beta_{12}=-1$, $\beta_{14}=0$; (H_2) $\beta_{20}=0$, $\beta_{23}=-1$, $\beta_{24}=0$; (H_3) $\beta_{10}=0$, $\beta_{12}=-1$, $\beta_{14}=0$, $\beta_{20}=0$, $\beta_{23}=-1$, $\beta_{24}=0$. Since the estimates of the relevant test statistics distributed as χ^2 variables with 3, 3, and 6 degrees of freedom have equalled to 1.3279, 17.6384 and 20.9979 respectively, at the conventional 5 per cent significant level there has been no reason to reject the null only for H_1. In the consequence a less restrictive version of H_3 has been tested for linking domestic prices with the real world price. The additional restrictions in this case include: $\beta_{10}=0$, $\beta_{12}=-1$, $\beta_{14}=0$, $\beta_{23}=\beta_{24}$. The estimate of the relevant test statistics distributed as χ^2 variable with 4 degrees of freedom has amounted 5.1905 leading to a non rejection of the null. Additionally, $\hat{\beta}_{23}=\hat{\beta}_{24}=$ $=-0.3174\in(-1,0)$, and $\hat{S}\left(\hat{\beta}_{23}\right)=\hat{S}\left(\hat{\beta}_{24}\right)=0.0495$ indicate that in the long run only a slight part of the word price change is transmitted into the domestic prices of unleaded petrol.

Table 4. Results of model (1) estimation

Variable (statistics)	Equation		
	Δp_{1t}	Δp_{2t}	Δp_{3t}
e_{1t-1}	-0.3201	0.0952	0.3816
	(0.0881)	(0.0821)	(0.2912)
e_{2t-1}	-0.0246	-0.0329	0.0299
	(0.0092)	(0.0086)	(0.0304)
R^2	0.4466	0.5295	0.0363
LM(1)	0.9713	1.0433	0.1775
LM(5)	7.0051	6.4052	9.0660
ARCH(1)	0.1272	0.5475	**10.1264**
ARCH(5)	0.5184	1.2922	**17.5958**
W1	8.5691	5.9289	-
W2	9.6580	10.7133	-
W3	**447.1759**	**682.3345**	-
W4	**47.2602**	**60.8051**	-
W5	**10.8710**	2.3526	-
W6	-	-	29.1625

$e_{1t-1}=p_{1t}-p_{2t}$, $e_{2t}=p_{2t}-5.7123-0.3174(p_{3t}-x_t)$; asymptotic standard errors in brackets; test statistics: LM(k) – LM Godfrey's for autocorrelation of order k, ARCH(s) – LM Engle-Bollerslev's for ARCH effects of order s; Wald's for constraints: Wj: $\delta_{i,j1}=\delta_{i,j2}=\ldots=\delta_{i,js-1}=0$; W4: $\gamma_{i1}=\gamma_{i2}=\ldots=\gamma_{is-1}=0$; W5: $\varphi_{i1}=\varphi_{i2}$; W6: $\delta_{6,jk}=\gamma_{6k}=\varphi_{6l}=0$ (i, j=1, 2, 3; k=1,…,s-1; l=1,2); estimates of W1-W6 test statistics in bold – significance at 5 per cent significance level.

To end up the results of model (1) estimation with the co-integrating vectors obtained for the least restrictive form of the LOP are reproduced in Table 4. They lead to the following conclusions concerning the price-setting mechanism in the short run.

Firstly, there is no Granger causality in whichever direction in the full set of the 95-octane unleaded petrol prices. The current rates of growth of Orlen and Lotos prices do not react to changes in their past rates (see estimates of the W1-W2 test statistics, entries in the 5th and 6th lower rows).

Secondly, the price impulses run from the Rotterdam price to the domestic prices and from the exchange rate to the domestic prices (see estimates of the W3-W4 test statistics, entries in the 3rd and 4th lower rows).

Thirdly, the Rotterdam spot price is a martingale (see estimate of the W6 test statistics, entry in the 1st lower row).

Fourthly, the price spread in the domestic market relatively strongly affects Orlen price. One per cent increase (decrease) of the spread in period t results in 0.32 per cent decrease (increase) of Orlen price in the next period. Lotos price does not change, however (see coefficient φ_{11} estimates, entries in the 1st and the 2nd upper rows).

Fifthly, Lotos price is stronger affected than Orlen price by its departure from the real world price. One per cent increase (decrease) in such a spread results in 0.033 per cent decrease (increase) of Lotos price; a decrease (increase)

of Orlen price is lower by 25 per cent (see coefficient φ_{21} estimates, entries in the 3rd and the 4th upper rows).

3. Conclusion

The empirical analysis of the price-setting mechanism in the wholesale market for unleaded petrol in Poland has revealed that the price impulses run from its world price and the exchange rate of U.S. dollar to Polish zloty to the domestic prices. There is no causality (in a Granger sense) running from the domestic prices to the world price and causality running in whichever direction in domestic market. Since it is only Orlen which reacts in response to changes in the price spread in the domestic market, it can be pronounced the price leader in the wholesale unleaded petrol market in Poland.

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