Endogenous Price asymmetries in the Fuel Market: an application to the Spanish case

Baltasar Manzano   José María Martín-Moreno

(Universidad de Vigo and Rede)

Rafaela Pérez   Jesús Ruiz

(Universidad Complutense de Madrid and ICAE)

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Outline

1. Introduction
2. Data and econometric methods
3. Estimation results
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1. Introduction

- In this paper we analyze the potential asymmetric response in the Spanish Market of retail prices for gasoline and gasoil to changes in crude oil prices, the so-called ‘rockets and feathers’ behavior.

- The standard hypothesis is that
  - an increase in oil price will translate quickly into an increase in the retail prices, whilst
  - a decrease in oil price will pass slowly and with a lower magnitude to the retail prices.

1. Introduction

- Most of previous works have analyzed the different causality channel depending on the negative or positive sign for the variation rate of the oil price:

  That is, they put apart those periods corresponding to increases in the price of oil from those with decreases in such a price.

- Previous results for Spain are inconclusive:

  - Evidence of Price asymmetry: Galeotti et al. (2003), Grasso and Manera (2007)

  - No evidence of asymmetry: Contín-Pilart et al (2009)

1. Introduction

- With a different approach

First we follow Bermingham and O'Brien (2011) by estimating a model that allows for the possibility of responses rates changing when passing a non-zero threshold rather than the typical zero threshold (Threshold Auto-regressive Error Correction Model)

Second, we test the robustness of these results by developing a two-regime Markov-switching model to characterize the dynamic relationship between the crude oil price and the retail price for gasoline and diesel

1. Introduction

- We find evidence of an asymmetric response of the gasoline and gasoil prices to changes in the price of crude oil,

  both in the short-run and

  with respect to the adjustment speed towards the long-run equilibrium

2. Data and econometric methods

- We use weekly data for:

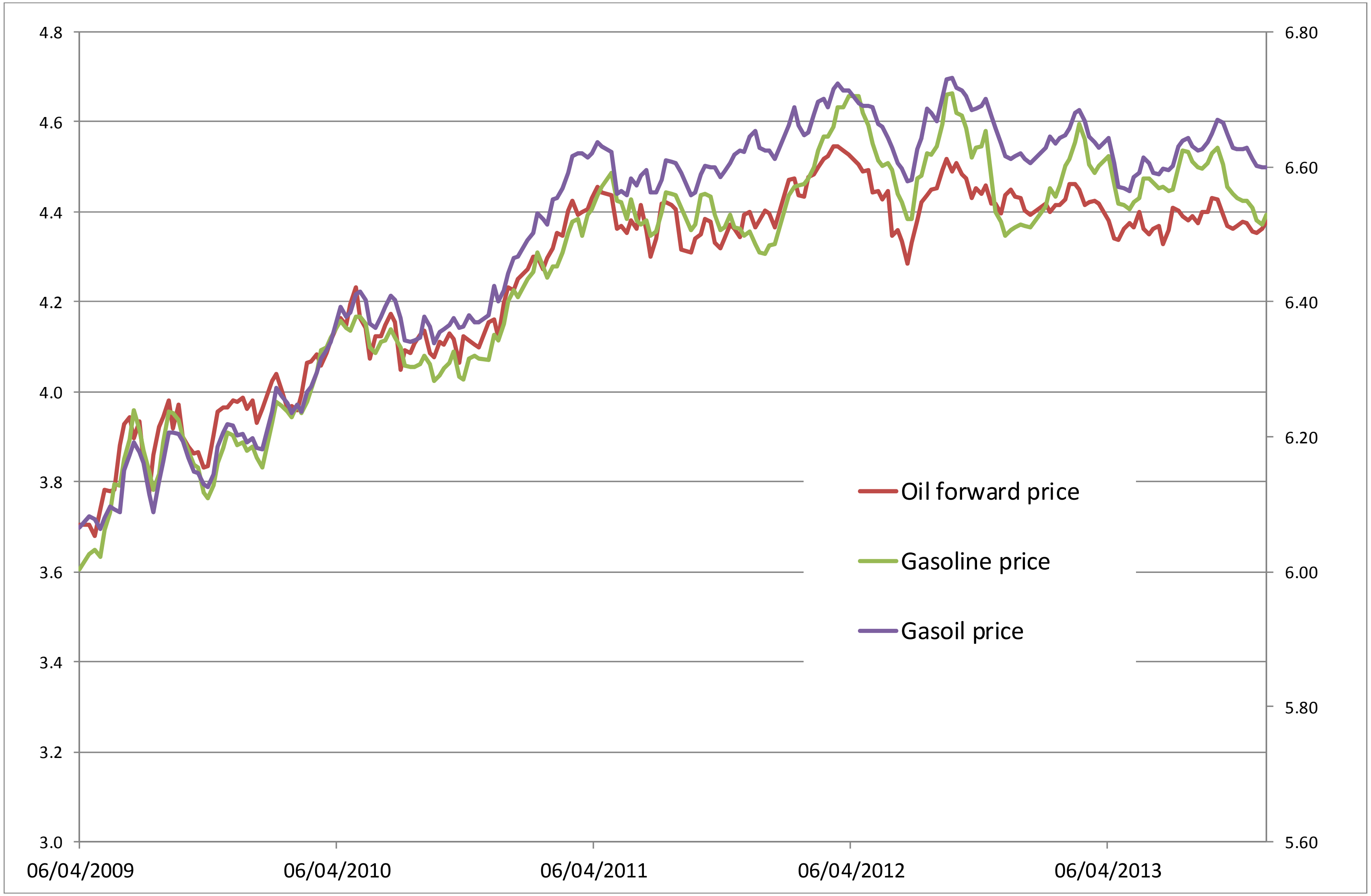
 i) Crude Oil-Brent price, 3 Months Forward (free on board) US Dollar per barrel, which is conveniently transformed into euros by using the dollar to euro 3 month forward exchange rate,

 ii) price before taxes, in euros, of gasoline per 1000 liters (Spain),

 iii) price before taxes, in euros, of gas-oil per 1000 liters (Spain)

- Sample: April 2009 to November 2013
- Data sources: Datastream for Oil price and the exchange rate and European Commission Weekly Oil Bulletin for gasoline and gasoil prices

2. Data and econometric methods



2. Data and econometric methods

First econometric model:

Threshold Auto-regressive Error Correction Model (TAR-ECM)

- We formulate two causality regimes and endogenously estimate the threshold value for the variation rate of crude oil price that determines the jump from the first to the second regime.

- As a previous step we have checked the cointegration relationship between the retail price of petrol or diesel and the price of crude oil (Engle-Granger two-step procedure):

$$x_{jt} = \alpha_0 + \alpha_1 p_t + \varepsilon_t \quad \text{, for } j\text{=gasoline, gasoil} \qquad (1)$$

x_{jt} = retail price of gasoline or gasoil (in logs), and
p_t = Crude Oil-Brent forward price (in logs).

2. Data and econometric methods

First econometric model: TAR-ECM

- Then we estimate the TAR-ECM model:

$$\nabla x_{jt} = \left[\delta^{(1)} \hat{\varepsilon}_{t-1} + \beta^{(1)} + \sum_{i=1}^{p} \rho_i^{(1)} \nabla x_{jt-i} + \sum_{l=0}^{q} \gamma_l^{(1)} \nabla p_{t-l} \right] \cdot Ind\left(\nabla p_t > \overline{c}\right) + \left[\delta^{(2)} \hat{\varepsilon}_{t-1} + \beta^{(2)} + \sum_{i=1}^{p} \rho_i^{(2)} \nabla x_{jt-i} + \sum_{l=0}^{q} \gamma_l^{(2)} \nabla p_{t-l} \right] \cdot \left(1 - Ind\left(\nabla p_t > \overline{c}\right)\right) + \zeta_t \quad , \tag{2}$$

x_{jt} = retail price of gasoline or gasoil; p_t = Crude Oil forward price

$\left\{\delta^{(1)}, \beta^{(1)}, \rho_1^{(1)}, \ldots, \rho_p^{(1)}, \gamma_1^{(1)}, \ldots, \gamma_q^{(1)}\right\}$: parameters of the first regime

$\left\{\delta^{(2)}, \beta^{(2)}, \rho_1^{(2)}, \ldots, \rho_p^{(2)}, \gamma_1^{(2)}, \ldots, \gamma_q^{(2)}\right\}$: parameters of the second regime

$\hat{\varepsilon}_t$: residuals of the cointegration equation (1)

$\overline{c}$: threshold parameter, estimated jointly with the remaining parameters

If $\nabla p_t < \overline{c}$, fuel dealers prefer to “wait and see” before translating variations in costs to the consumers’ price

2. Data and econometric methods

Second econometric model: two regimes Markov-switching

Difference with respect to the TAR-ECM: under the Markov-switching methodology, we assume that the regime that occurs at time *t* cannot be observed, as it is determined by an unobservable process, denoted as S_t

$$\nabla x_{jt} = \beta + \sum_{i=1}^{p} \rho_i \nabla x_{jt-i} + \sum_{l=0}^{q} \gamma_l^{(S_t)} \nabla p_{t-l} + \delta^{(S_t)} \hat{\varepsilon}_{t-1} + \zeta_t \qquad (3)$$

x_{jt} = retail price of gasoline or gasoil; p_t = Crude Oil forward price

where $S_t = 1, 2$ are the two possible states of nature or regimes

$\{\delta^{(1)}, \gamma_1^{(1)}, \ldots, \gamma_q^{(1)}\}$: parameters of the first regime

$\{\delta^{(2)}, \gamma_1^{(2)}, \ldots, \gamma_q^{(2)}\}$: parameters of the second regime

$\{\beta, \rho_1, \ldots, \rho_p\}$: assumed to be invariant with regime switching

$\hat{\varepsilon}_t$: residuals of the cointegration equation (1)

2. Data and econometric methods

Second econometric model: two regimes Markov-switching

- S_t is assumed to be a first-order Markov process
- This implies that the current regime S_t only depends on the regime one period ago, S_{t-1} .
- So the model is completed by defining the **transition probabilities** of switching from one state to the other:

$$P(S_t = i \mid S_{t-1} = j) = p_{ji}, \text{ for } i, j=1,2$$

3. Estimation results

I. TAR-ECM

- Seven different models have been estimated depending on the lags for the endogenous and exogenous variables (1 to 4 lags)

- AIC and BIC tests suggest that the most desirable models are the simplest ones: with 1 lag for the endogenous variable (gasoline/gasoil) and 2 terms for the exogenous variable, crude oil (contemporaneous effect and 1 week after the shock in the oil price)

- In terms of the model described in equation (2), the chosen models correspond to the cases $p=q=1$

- Adding additional lags do not provide more information: they are not significant in statistic terms

3. Estimation results

Table 1. Gasoline-crude Oil TAR-ECM Models: M.1 (p=1,q=1)

Regime 1	
β (constant)	**.0031 (.0016)**
ρ_1 (auto-reg)	-.0316 (.0673)
γ_0 (t_0 oil shock)	**.2426 (.0359)**
γ_1 (t_1 oil shock)	**.3651 (.0374)**
δ (EC term)	**-.2355 (.0526)**

Regime 2	
β (constant)	-.0000 (.0053)
ρ_1 (auto-reg)	.0213 (.1266)
γ_0 (t_0 oil shock)	**.3182 (.0543)**
γ_1 (t_1 oil shock)	**.2496 (.0795)**
δ (EC term)	-.1099 (.1088)

$\overline{c}$	**- .0189**

3. Estimation results

Conclusions gasoline TAR-ECM model:

• Robustness of the estimations, whatever the number of lags considered

• The threshold value for the variation of the crude oil price that determines the shift from one regime to the other is very robust : around -1.8%

✓ This result suggests that the standard zero threshold is not suitable for the case of the Spanish economy

• Evidence of asymmetry in the short-run behavior of prices: similar contemporaneous effect but stronger delayed effect for regime 1

•In all the models the coefficient for the error correction term is negative, meaning that it is working to bring the system back to equilibrium

✓ Evidence of asymmetry in long-run adjustment: faster adjustment in regime 1 (mild adjustment in regime 2)

✓ Both short and long-run asymmetries in line with rockets-feathers hypothesis

3. Estimation results

Table 2. Gasoil-crude Oil TAR-ECM Models: M.1 (p=1,q=1)

Regime 1	
β (constant)	**.0018 (.0011)**
ρ_1 (auto-reg)	-.0839 (.0695)
γ_0 (t_0 oil shock)	**.2715 (.0254)**
γ_1 (t_1 oil shock)	**.4170 (.0321)**
δ (EC term)	**-.2102 (.0500)**

Regime 2	
β (constant)	**-.0066 (.0037)**
ρ_1 (auto-reg)	**-.1855 (.0898)**
γ_0 (t_0 oil shock)	**.3522 (.0408)**
γ_1 (t_1 oil shock)	**.3320 (.0500)**
δ (EC term)	**-.3749 (.1104)**

$\overline{c}$	**- .0166**

Standard deviations in brackets; bold-typo for significative parameters

3. Estimation results

Conclusions gasoil TAR-ECM model:

• Robustness of the estimations, whatever the number of lags considered

• The threshold value for the variation of the crude oil price that determines the shift from one regime to the other is also very robust : around -1.7%

• Evidence of asymmetry in the short-run behavior of prices:
Regime 1: stronger delayed effect of crude oil shocks on retail prices;
Regime 2: slightly stronger contemporaneous effect of crude oil on retail prices

•The coefficients for the error correction term are also negative and different between regimes: evidence of asymmetry in the speed of adjustment towards long-run equilbrium, but opposite to rockets-feathers hypothesis (also found for UK gasoil market)

✓ Non-conclusive results in terms of rockets-feathers (further research: impulse response functions to shocks in oil prices)

3. Estimation results

II. Two regimes Markov-switching model:

In this case we use a gradual generalization of the model:

1) Only the effect of oil prices on retail prices is allowed to differ between regimes, the remaining parameters are invariant with the regimes.
2) Similar to 1), but we also allow that the variance of the innovation term to be regime-switching.
3) The coefficient of the error correction term is allowed to change with the regime, and the remaining parameters are invariant.
4) Similar to 3) and includes the regime-switching nature of the variance for the innovation of the equation.
5) The parameters capturing the effect of crude oil on retail prices as well as the coefficient for the error correction term are allowed to be regime-switching, and finally
6) The same model in 5) including also the regime-switching characterization for the variance of innovations.

3. Estimation results

Table 3. Gasoline-crude Oil Markov-switching Model 6 (p=q=1)

Short and long-run asymmetries

Regime 1	
γ_0 (t_0 oil shock)	**.2791 (.0334)**
γ_1 (t_1 oil shock)	**.3327 (.0337)**
δ (EC term)	**-.1486 (.0309)**
σ^2 (variance)	**.0163 (.0009)**
p_{11} (probability)	**.9364 (.0464)**

Regime 2	
γ_0 (t_0 oil shock)	**.2102 (.0190)**
γ_1 (t_1 oil shock)	**.3354 (.0194)**
δ (EC term)	**-.0657 (.0318)**
σ^2 (variance)	**.0024 (.0007)**
p_{22} (probability)	**.4580 (.1965)**

Regime invariant	
β (constant)	.0008 (.0007)

3. Estimation results

Conclusions Markov-switching model for Gasoline Market:

- Evidence of asymmetries in the behavior of prices in the short-run: stronger contemporaneous effect of crude-oil price shocks on retail prices in regime 1 (similar delayed effects in both regimes)

- Evidence of asymmetries in the speed of adjustment towards the long-run equilibrium: stronger in regime 1

✓ Both short and long-run asymmetries in line with the rockets-feathers hypothesis

- Furthermore:

i) the volatility of the noise term is also statistically different between regimes: larger in regime 1

ii) The probability of staying in one given regime for two consecutive periods is also different: larger for regime 1 (corresponds to upward trends in oil prices, more frequent and persistent within the sample)

3. Estimation results

Table 4. Gasoil-crude Oil Markov-switching Model 6 (p=q=1)

Short and long-run asymmetries

Regime 1	
γ_0 (t_0 oil shock)	**.2303 (.0272)**
γ_1 (t_1 oil shock)	**.4143 (.0275)**
δ (EC term)	**-.1972 (.0366)**
σ^2 (variance)	**.0098 (.0007)**
p_{11} (probability)	**.9262 (.0517)**

Regime 2	
γ_0 (t_0 oil shock)	**.5238 (.0807)**
γ_1 (t_1 oil shock)	**.2750 (.0764)**
δ (EC term)	-.0239 (.0860)
σ^2 (variance)	**.0108 (.0017)**
p_{22} (probability)	**.7284 (.1382)**

Regime invariant	
β (constant)	-.0002 (.0007)
ρ_1 (auto-reg)	**-.1194 (.0589)**

3. Estimation results

Conclusions Markov-switching model for the Gasoil Market:

- Evidence of asymmetries in the behavior of prices in the short-run: Stronger contemporaneous effect of crude-oil price shocks on retail prices in regime 2, but stronger delayed effect in regime 1

✓ Inconclusive results in terms of the rockets-feathers hypothesis in the short-run (need further research)

- Evidence of asymmetries in the long-run: faster adjustment in regime 1, in line with the rockets-feathers hypothesis

- Similar volatilities of the noise term
- Larger probability of staying in regime 1 for two consecutive periods

4. Conclusions

- In this paper we analyze, for the Spanish market, the potential asymmetric response of retail prices for gasoline and gasoil to changes in oil prices, the so-called ‘rockets and feathers’ behavior

- Using a Threshold Auto-regressive Error Correction Model we estimate endogenously the threshold in the variation rate of the price of oil that leads to a jump from the first regime to the second

- We test the robustness of the results by using a Markov-switching estimation

- We find evidence of an asymmetric response of the gasoline and gasoil prices to changes in the price of crude oil, both in the short-run and with respect to the adjustment speed towards the long-run equilibrium