Dynamics in the European Petroleum Markets

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Abstract

This paper analyses horizontal and vertical price dynamics in the EU petroleum markets. The results indicate that the cross-country price differentials have significant impact on the local price adjustments. The uncovered patterns can be seen as the first empirical support for the politically-charged concept of "fuel tourism", obtained using pan-European cross-product time-series database. Even more interestingly, when analysed in cross-country setting, the dreaded welfare transfer due to the asymmetric price transmission phenomenon is found to be less pronounced than claimed before.

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1 Introduction

1.1 Motivation

Modelling the impact of crude oil prices on retail petroleum product prices continues to receive significant attention in the applied literature, particularly with respect to asymmetries in price transmission. Understandably, the focus is on asymmetries that involve a slower adjustment of downstream (retail) prices to increases in upstream (crude oil) prices decreases, since they result in marketable idea of welfare transfer (from ordinary drivers to "Big Oil" companies upstream - see inset in Figure 1).

Up till now, the analysis has been restrained to one-country setting and has neglected the notion that the disequilibria in the neighbouring countries affect home prices. In other words it had neglected the horizontal (multinational) dimension of the transmission. This dimension is usually associated with the notion of the "fuel tourism" i.e. cross-country purchases of petroleum products (mainly motor spirits),

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which given the EU-wide differences in energy taxation (see European Parliament (2003)[1]), represent significant drain on budget revenues in high-petroleum-tax countries. The significance of energy taxes and danger related to their decreases cannot be understated, since:

> (...) fuel and vehicle taxes have usually been introduced for fiscal rather than environmental reasons. (they) represent a much higher share of GDP in EU countries than in most other OECD countries (...)

Joumard (2002, p. 112)

Given the above, it is hardly surprising that the issue of decreased energy taxation due to adverse pricing dynamics receives significant political attention - House of Commons (2001).

This paper analyses cross-country dynamics in the EU petroleum markets using the multi-product and multi-country framework. The purpose is to check for possible differences between EU countries and the impact they have on price transmission, particularly from the point of view of asymmetric price transmission. This is done in two stages, with the first involving analysis of cross-country linkages and focused on testing for the existence of the "fuel tourism" phenomena and the second focused on it impacts on asymmetries (rigidities) in price transmission.

By doing so this study links two strands of literature: the one on cross-national price dynamics (summarised in Section 1.2) and the one on asymmetric price transmission (briefly summarised in Section 1.3).

This is done in three stages using 25 country, 7 product dataset described in Section 2.1. Firstly, in Section 2.2 we analyse the price series and apply cointegration apparatus to check for the presence of long-run crude oil - end product relationship to which retail prices revert. In Section 2.3 we check for the presence of cross-country dynamics and link them with price differentials, and in Section 2.4 we check how the results of typical non-linear testing framework change once the cross-country effects are included in the modelling framework. Conclusions and suggestions for further research follow.

1.2 Literature on Cross-Country Dynamics

Journalists like to paint the romantic picture of drivers travelling to another neighbouring low-tax countries in order to tank-up and avoid high taxation levied at home. This picture tends to be accepted by the politicians and even environmentalists. For example, the European Parliament (2002) deemed it important enough to vote on local harmonisation of petroleum taxation,[2] while Expert Group on the UN Framework Convention on Climate Change (1997) claimed that such trade might be even responsible for increased pollution and CO_2 emission in the low-tax EU countries.

For North America, Slade (1992) reported a shift in demand from Canada to USA that followed a reverse in price differentials between those two countries. Slade

[1] Directive 2003/96/EC

[2] Updates to Directives 92/81/EEC and 92/82/EEC.

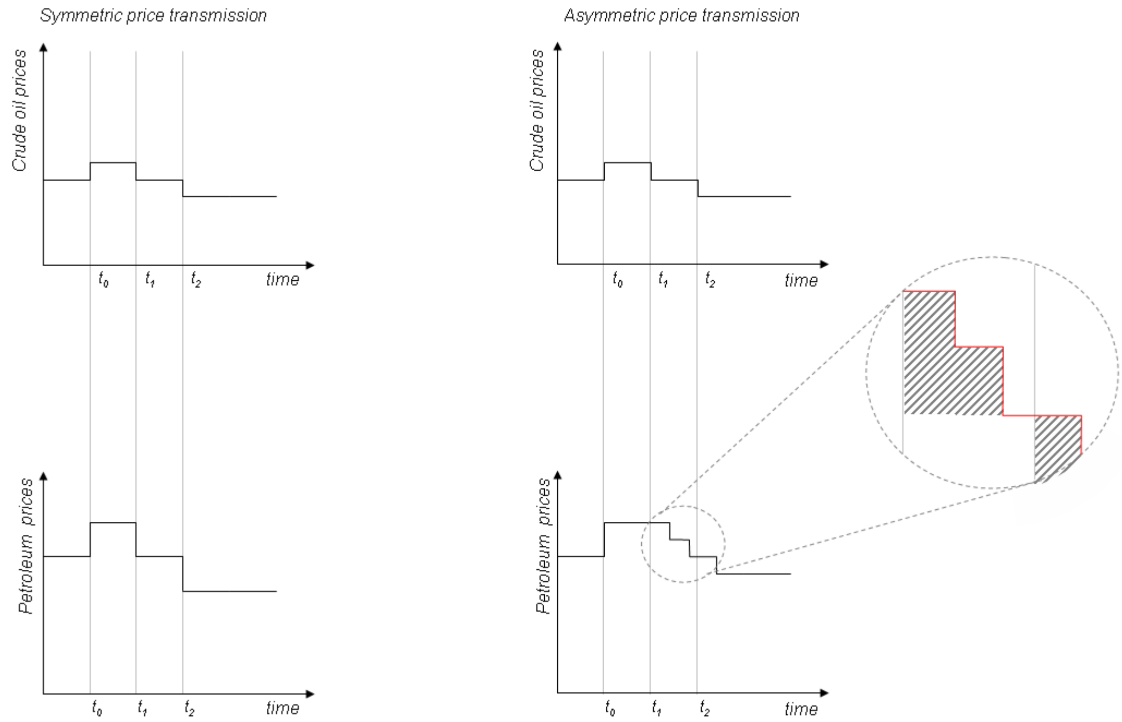

Figure 1: Example of asymmetries in price transmission. Shaded are represents per-unit welfare transfer from downstream to upstream agents.

(1992, p. 263) claimed that the resulting "fuel tourism" was so significant that it resulted in a price war and local market disruptions both in the USA and Canada.

Trips of this kind are only to be expected in the EU given the cross-national differences in taxation of petroleum products (see Newbery (2001) for details) and decreasing barriers to movements within EU, mainly due to removal of or reduction in passport and custom controls (see Williams (1996) for an overview of 1995 Schengen acquis and similar policies).

Given the tax and environmental implications of the "fuel tourism", the cross-country dynamics receive relatively little attention from applied energy economics. The notable exceptions are described below.

Rietveld, Bruinsma & van Vuuren (2001) analyse the consequences of spatial distribution of fuel taxes, and shifts between the Netherlands and Germany. The results of drivers' survey indicate that approximately 30% of the Dutch drivers fuel in Germany which confirms the view that the "fuel tourism" is indeed widespread.

Bentzen (2003) analyses retail petroleum price convergence in 20 OECD countries over the 1978-2002 period with the help of standard time-series techniques (existence of common trends using Dickey Fuller (DF) tests). The results indicate that there is very little or no support for the notion of price convergence either in nominal nor purchasing-power-parity-adjusted prices. No detailed analysis of cross-border purchases was performed.

Michaelis (2004) analyses the incentives for "fuel tourism" and shows that even comparably small price differences induce a strong incentive for cross-border purchases which could potentially be utility-decreasing. The author concludes that it is necessary for the drivers to learn the complete private costs of purchasing the fuel abroad. Unfortunately, the analysis is not backed-up by estimation and relies mainly on the simulations based on price differentials.

Dreher & Krieger (2005) analyse the prices of petroleum, diesel, gasoil and fuel oils in the old EU-15 countries over the period 1994-2005. Using univariate and panel techniques they show consumer price arbitrage (i.e. arbitrage for retail tax-inclusive prices) to be weaker than producer price arbitrage (i.e. arbitrage for retail prices net of taxes). This is hardly surprising as the latter requires both tax convergence and realisation of arbitrage opportunities by the drivers while latter does not depend on synchronisation of taxes. The results do not focus on the pattern of the adjustment nor on whether the adjustment differs between high and low-price countries.

Banfi, Filippini & Hunt (2005) analyse "fuel travels" to Switzerland from Germany, France and Italy. Based on the estimates of the panel demand model, they argue that as long as price differentials persist the foreign drivers cannot be easily convinced to stop fuelling in Switzerland. The simulations indicate that from 1985 to 1992 "fuel tourism" accounted for about 15% of overall petrol sales in the three neighbouring regions, falling to about 7% from 1992 to 1997.

1.3 Literature on Price Transmission

Starting from and Bacon (1991) and Kirchgassner & Kubler (1992), the vertical dynamics continues to receive a significant attention in the applied literature (see Meyer & Cramon-Taubadel (2004), Frey & Manera (2005) and Radchenko (2005)) for recent literature reviews), the focus stays on single-country, single-product framework. The notable exceptions are described below.

Indejehagopian, Lantz & Simon (2000) focus on German and French heating oil market and attempts to link them via cointegration techniques to the Brent prices and respective currency-USD exchange rates. The results obtained using January 1987-December 1997 data, confirmed the existence of a long-run relationship between the price series and the predominance of the Rotterdam spot market. The analysis of exogeneity revealed that German market directly affects the Rotterdam markets (feedback relationship), while the French market follows both German and Rotterdam markets. Interestingly, the results indicate that asymmetry is caused by the exchange rates but not by the upstream (Rotterdam) prices.

Bremmer & Christ (2002) analyse the effects of cross-section data aggregation on the transmission between weekly prices of:

- retail and spot unleaded petrol;
- WTI crude oil prices.

over the period January 1991 - May 2002. In order to analyse the effects of spatial aggregation, the authors analyse the prices aggregated across the following regions:

- the USA as a whole;
- five multi-state regions;[3]

[3] the East region, the Midwest region, the Gulf region, the Rockies region and the West region.

- 3 sub-regions;
- five states (California, Colorado, Minnesota, New York and Texas);
- six cities (Chicago, Denver, Houston, Los Angeles, New York City and San Francisco).

The testing strategy assumes that vertical dynamics follows Error Correction Process in which the downstream (retail) price adjusts to the long-run equilibrium given by the upstream (crude oil) prices via short-run changes (i.e. impact of lagged changes - Reilly & Witt (1998)) and long-run adjustment (i.e. lagged residuals from the level equation) of the disequilibrium. This could be summarised as:

$$\Delta y_t = \sum_{l=1}^{n} \alpha_l \Delta y_{t-l} + \sum_{j=0}^{m} \beta_j \Delta x_{t-j} + \gamma(y_{t-1} - \delta_0 - \delta_1 x_{t-1}) + \nu_t \tag{1}$$

where:

- y are the downstream prices which are linked to upstream prices x;
- Δ is the difference operator;
- $y_{t-1} - \delta_0 - \delta_1 x_{t-1}$ is the disequilibrium proxy, i.e. residuals ϵ_t from the level price equation $y_t = \hat{\delta}_0 + \hat{\delta}_1 x_t$, lagged one period.

The analysis of vertical dynamics involves splitting series in (1) in a way that allows different adjustment to positive and negative shocks in the system (following Wolfram (1971)). This results in:

$$\begin{aligned} \Delta y_t = & \textstyle\sum_{j=0}^{m^+} \beta_j^+ (\Delta x_{t-j})^+ + \sum_{i=0}^{m} \beta_i (\Delta x_{t-i}) \\ & + \gamma^+ (y_{t-1} - \delta_0 - \delta_1 x_{t-1})^+ + \gamma(y_{t-1} - \delta_0 - \delta_1 x_{t-1}) \\ & + \nu_t \end{aligned} \tag{2}$$

where $(\ldots)^+$ is the slope dummy (Heaviside indicator) set to unity when the argument is positive, zero otherwise.

In such a setting, the asymmetries or rigidities in price transmission persist when the coefficients on the slope dummies are significantly different from zero. If that's the case, the adjustment to increases and decreases is asymmetrical and prices respond (in absolute values) differently to upstream increases and decreases.

For example, in (2) the coefficients on the dummy variables are significantly different from zero, the difference between negative and positive adjustment is statistically significant and equal to β_j^+ for short-run adjustment and γ^+ for long-run adjustment. Since the positive disequilibria persist when the actual price is above its long-run equilibrium value, they coincide with time of high-margins. It follows that when the coefficient γ^+ is positive, the adjustment speed is *lower* at times of increased margins as compared to times of constant margins which implies welfare transfer described in Section 1 and depicted in Figure 1.

Unfortunately, the modelling techniques applied are partially incorrect (Wolfram split of first differences was proved invalid by Cramon-Taubadel & Meyer (2001)) and disregard the possible cross-regional effects (although authors admit these are likely to occur and affect transmission).

Galeotti, Lanza & Manera (2002) analyse the transmission between monthly prices of:

- international c.i.f. crude oil;
- Rotterdam LP (f.o.b. spot);
- the appropriate exchange rate (necessary as crude oil prices are expressed in USD);
- local retail leaded petrol prices;

in France, Italy, Spain, and the UK (for the period January 1985 - June 2000) and Germany (for the period January 1985 - February 1997). The study analyses the transmission between crude oil and wholesale tiers, wholesale and retail tiers, and indirect transmission from crude oil to retail tiers. Estimation of the equations begins with augmented DF (ADF) tests for the presence of the unit root in level variables and cointegration tests. The results indicated that the residuals were stationary, which was taken as a proof that all series in question do cointegrate.

Testing the null of no asymmetries in transmission is performed for all tiers described above using (2), but with $m^+ = m = 1$, i.e. assuming that the short run adjustment was completed after only one month. The results indicated widespread presence of non-linearities in price transmission. However, one has to notice that the lag structure imposed allows only for the one-month short-run adjustment, which might lead to over-estimation of other coefficients (e.g. long-run elasticities) and under-estimation of the short-run adjustment.[4]

The cointegration tests performed included only ADF tests on the residuals from the level equation. As indicated by Cook (1999), when testing for asymmetries using (2), traditional ADF tests should be accompanied by the tests for the join significance of the ECM terms, split in the Wolffram's manner. Since the coefficients on ECM terms are *not* statistically different from zero at 5% and 1% - Galeotti et al. (2002, p. 21), the cointegration between variables in question for some countries (e.g. Italy and the UK) is dubious. Given the above, the results are not necessarily credible. Again, despite using multinational data, the analysis is done in a piece-wise manner disregarding the cross-country dynamics.

Ye, Zyren, Shore & Burdette (2005) analyse regional dynamics in the USA over the period January 2000 - December 2003 for five Petroleum Administration for Defence Districts, the state of California and US. The analysis is focused on the asymmetries in price transmission and the only finding related to intra-regional dynamics was that individual trade between regions might be present as the speed of adjustment estimated for one region is higher than the weighted average of corresponding values for the sub-regions.

[4] This seems to be supported by the fact that the γ coefficients on error term are greater than the unity. In the traditional one-regime ECM, adjustment speed greater than unity indicates that the relationship between prices is not stable, but rather explosive. The introduction of the second regime might cure that.

2 Empirical Analysis

2.1 Data

Data used for our empirical analysis involves three sets of weekly series:

- USD prices of Brent crude oil (denoted x_t^{Brent}) which was found to be the price leading crude oil for European Union - Hagströmer & Wlazlowski (2007);
- k-th country's net-of-taxes retail prices for:
  - EURO-95 unleaded petrol ($y_t^{(EURO,k)}$);
  - Diesel fuel ($y_t^{(DIESEL,k)}$);
  - heating oil($y_t^{(HGASOIL,k)}$);
  - Lead replacement petrol ($y_t^{(SUPER,k)}$);
  - Liquified Petroleum Gas -LPG ($y_t^{(LPG,k)}$);
  - two kinds of heavy oils (low and high sulphur) ($y_t^{(RFO.1,k)}$ and $y_t^{(HRFO.2,k)}$)[5];
- exchange rates between k-th country's local currency and USD, necessary as crude oil prices are quoted in USD (ex_t^k).

Retail prices were obtained from the OilBulletin published by the European Commission. They cover 25 EU countries, i.e. Austria (AT), Belgium (BE), Cyprus (CY), Czech Republic (CZ), Germany (DE), Denmark (DK), Estonia (EE), Spain (ES), Finland (FI), France (FR), United Kingdom (UK), Greece (GR), Hungary (HU), Ireland (IE), Italy (IT), Lithuania (LT), Luxembourg (LU), Latvia (LV), Malta (MT), Netherlands (NL), Poland (PL), Portugal (PT), Sweden (SE), Slovenia (SI) and Slovakia (SK). In the last section, where we analyse the international setting (i.e. countries which border countries with appropriate sample), this results in the total of 71 cases, presented in Table 2.[6]

The length of period covered differs on the country and product basis. The longest sample for the EU-15 countries[7] stretches back to January 1994, while the data for the EU-10 countries[8] starts in mid-2004. All series end in December 2005.

Data on the exchange rates between local EU currencies and USD at relevant times were obtained from DataStream. The data follow the official exchange up till the introduction of Euro (January 2002), after which the exchange rate follows the EUR/USD exchange rate. The quotes were taken for the same (or the earliest available) day as the crude oil data. The prices expressed in Euro were converted

[5]Products analysed are summarised in Table 3.

[6]It was assumed that the UK borders another EU country - Ireland. While this is might be questioned, recent research into integration of UK energy market (gas) into continental network - Panagiotidis & Rutledge (2006) suggests that the economic integration had already taken place, even prior to the physical one.

[7]Austria, Belgium, Denmark, Germany, Finland, France, Great Britain, Greece, Ireland, Italy, Luxemburg, the Netherlands, Portugal, Spain, and Sweden.

[8]Cyprus, the Czech Republic, Estonia, Hungary, Lithuania, Latvia, Malta, Poland, Slovenia, Slovakia.

to the original currencies using fixed parities established by the European Central Bank.

Using the standard ADF tests, all series were found to be integrated of the order one.[9] It was assumed that the price discovery emanates from the larger, more liquid market where trading volume is concentrated - e.g. Adrangi, Chatrath, Raffiee & D Ripple (2001).

2.2 Cointegration

Since the series in question are integrated of order one, they have to be analysed in the cointegrating framework - Maddala & Kim (1999). Only when a common stochastic trend between the series in question exists, the possibility of spurious regression is rejected and an economically valid link between crude oil and energy product prices can be identified.

As specified by Engle & Granger (1987), cointegration implies an error correction model mechanism, which describes short and long run responses of prices to external shocks and allows for testing for endogeneity of the variables. Intuitively, variables that do react to shocks in other variables should be modelled on the left-hand side, while those which remain exogenous (determined outside the system), should be treated as explanatory and the model should be conditioned upon them.

As the first step in the analysis, the following cointegrating equation was estimated for every of crude oil-product pair.

$$ln(y_t^{(j,k)}) = \alpha_{(j,k)} + \beta_{(j,k)} ln(x) + \gamma_{(j,k)} ln(ex^k) + \epsilon_t \tag{3}$$

where:

- j stands for product;
- k stands for country.

For every equation, the Phillips-Perron Z_α test for cointegration was conducted, under the null hypothesis of no cointegration, the long truncation parameter $(n/30)$ and a constant.[10]. For product-crude pairs for which the null of no cointegration was rejected at 5%, the following VAR(p) model was estimated:

$$B(\mathcal{L})\mathbf{z_t} = \mathbf{z_t} - \Phi_1 \mathbf{z_{t-1}} - \ldots - \Phi_p \mathbf{z_{t-p}} = \epsilon_\mathbf{t} \tag{4}$$

where:

- $B(\mathcal{L})\mathbf{z_t}$ is the lag polynomial;
- $\mathbf{z_t} = (ln(y_t^{(Product,Country)}), ln(x), ln(ex^{Country}))'$ is the column vector of the variables (per country, per product for all analysed crudes);

[9] Detailed results for so many series would require a large amount of space, so the results of the tests are not reported here - they can be provided by the author on request.

[10] Z_α test is similar to typical ADF and Z_t tests, i.e. it is also based on residuals from level estimation. However it has slower rate of divergence and better small-sample properties, i.e. higher power - Phillips & Ouliaris (1990)

- $\epsilon_\mathbf{t}$ is the disturbance vector.

The VAR model was used to confirm the results of the test for cointegration with the help of eigenvalue and trace tests - i.e. rejection the null of $r = 0$ and failure to reject $r \leq 1$ and $r \leq 2$. Those results should be interpreted as a confirmation that the relationship between retail prices, crude oil prices and exchange rate is not spurious.

The only remaining part is to establish the direction of the transmission and its properties. As the next step, (4) was re-parameterised to the VECM model.

$$\Delta \mathbf{z_t} = \Pi \mathbf{z_{t-1}} - \sum_{i=1}^{p-1} \Gamma_i \Delta \mathbf{z_{t-i}} + \epsilon_\mathbf{t} \tag{5}$$

where:

- $\Pi = B(1)$;
- $\Gamma_i = -\sum_{i+i}^{p} \Phi_i$.

For the purposes of this study specified in the Section 1 it is necessary to examine the properties of the Π matrix, which contains the information about the dynamic stability of the system. After ascertaining the presence of one cointegrating vector in the system, the matrix in question can be normalised and re-written as $\Pi = \alpha\beta'$. In this setting, β contains the cointegrating vector and α represents the speed of adjustment from the errors ($\beta' \mathbf{z_{t-1}}$) towards the long-run equilibrium. If the coefficient is zero in the particular equation, that variable is considered to be weakly exogenous, i.e. determined outside the system and setting the retail prices.

2.3 Cross-country Links

A significant drawback of the testing framework provided by the VECM model (5) is that cross-country effects cannot be readily tested, unless some restrictions are placed on other parts of the model. As an example consider a situation when one is interested in analysing pricing system in the two-country framework, and test whether the retail prices in the respective countries affect each other. In such a setting, the standard solution for testing the null hypothesis of no effect of foreign retail prices on domestic retail prices involves estimation of:

$$B(\mathcal{L})\mathbf{z_t^*} = \mathbf{z_t^*} - \Phi_1 \mathbf{z_{t-1}^*} - \ldots - \Phi_p \mathbf{z_{t-p}^*} = \epsilon_\mathbf{t} \tag{6}$$

where:

- $country^*$ stands for countries bordering the country analysed;
- $\mathbf{z_t^*} = (ln(y_t^{(Product,Country)}), ln(y_t^{(Product,Country^*)}), ln(x), ln(ex^{Country}), ln(ex^{Country^*}))'$ is the column vector of the variables (by country, its neighbours, and by product for all analysed crudes);

and testing linear restrictions on (6) in the form of a vector with zero values for the foreign prices and ones otherwise - $(1, 0, 1, 1, 1)'$. Unfortunately, this specification restricts all other effects (such as marginal effects of crude oil and the exchange rate) to be of equal magnitude, which is often implausible.

In this section we deal with a situation similar to the example presented above, as we are interested in establishing whether disequilibria in prices abroad could affect prices at home. In particular, we want to verify the anecdotal evidence about the potential impact of high petrol prices on cross-border purchases.

The reasoning is that if a bordering country has constantly higher prices, a certain portion of users from that country regularly purchases petrol abroad and this is reflected via aggregated demand in the home country's prices. This portion of the demand is assumed to be constant and cannot be distinguished from domestic demand based on aggregated data. However, this demand is likely to increase when prices of products abroad increase and are close to their long-run equilibrium.

In order to test for the presence of such a pattern and overcome the restrictions of the VAR framework described above, we estimated the auxiliary ECM model of the following form:

$$\Delta ln(y_t^{(j,k)}) = \pi^{(j,k)} \hat{\epsilon}_{t-1}^{(j,k)} + \sum_{k^*=1}^{n^*} \pi^{(j,k^*)} \hat{\epsilon}_{t-1}^{(j,k^*)} + \sum_{i=0}^{p} \iota_i^{(j,k)} \Delta ln(ex_{t-i}^k) + \sum_{i=0}^{q} \kappa_i^{(j,k)} \Delta ln(x_{t-i}) + \nu_t \quad (7)$$

where:

- k^* describes the neighbourhood of the country k, i.e. other countries from the sample that border country k, n^* denotes the number of these countries;
- $\hat{\epsilon}_{t-1}^{(j,k)}$ are lagged residuals from the level equation $\hat{\epsilon}_t^{(j,k)} = ln(y_t^{(j,k)}) - \hat{\alpha}_{(j,k)} - \hat{\beta}_{(j,k)} ln(x) - \hat{\gamma}_{(j,k)} ln(ex^k)$ for the country k and product j;
- $\hat{\epsilon}_{t-1}^{(j,k^*)}$ are lagged residuals from the level equations $\hat{\epsilon^*}_t = ln(y_t^{(j,k^*)}) - \hat{\alpha}_{(k^*,j)} - \hat{\beta}_{(k^*,j)} ln(x) - \hat{\gamma}_{(k^*,j)} ln(ex^{k^*})$ for the all the countries that border country k, i.e. k^* and product j;

In the setting described above, the focus is on the π and π^* coefficients. In the traditional one-product setting, the $\pi^{(j,k)}$ coefficient represent the adjustment of the system towards the long-run equilibrium after a disequilibrium. In the setting given by (7), the $\pi^{(j,k^*)}$ coefficients show the response of the local prices to disequilibria in neighbouring countries. If the coefficients are positive it means that local prices increase when disequilibria in the neighbourhood are positive, i.e. when the actual prices are above their long-run equilibrium levels. Intuitively, this could lead to an increase in individual cross-border purchases, thus resulting in the "fuel tourism" and increase in demand in low-price/tax country.[11]

[11] Obviously, this can occur only when *after-tax* prices in a neighbouring country are higher than in the home country so that such trade is profitable for most users. The tax portion of the retail price is irrelevant for some users (via VAT reimbursement), but the majority of buyers consider only fully-loaded prices.

2.4 Asymmetries in Price Transmission

As the last step, the traditional tools used to test for asymmetries in price transmission (2) were augmented to account for cross-country effects captured by (7). In such setting the following model was estimated:

$$\begin{aligned}\Delta ln(y_t^{(j,k)}) = & \sum_{i=0}^{p} \iota_i^{(j,k)} \Delta ln(ex_{t-i}^k) + \sum_{i=0}^{q} \kappa_i^{(j,k)} \Delta ln(x_{t-i}) \\ & + \pi^{(j,k)} \hat{\epsilon}_{t-1}^{(j,k)} + \pi^{+(j,k)} \hat{\epsilon}_{t-1}^{+,(j,k)} + \nu_t\end{aligned} \tag{8}$$

In this setting the focus is on the parameter $\pi^{+(j,k)}$ which captures the asymmetries in price transmission. As described in 1.3, if the disequilibrium is positive, the coefficient on the dummy - $\hat{\epsilon}_{t-1}^{+,(j,k)}$ gives the measure of asymmetry in transmission with positive values values occurring when asymmetry involves a welfare transfer to companies upstream and negative values occurring when prices fall faster than they rise.

Then, the results are compared to those obtained when using the model that accounts for the cross-country effects (i.e. (7). This results in:

$$\begin{aligned}\Delta ln(y_t^{(j,k)}) = & \sum_{i=0}^{p} \iota_i^{(j,k)} \Delta ln(ex_{t-i}^k) + \sum_{i=0}^{q} \kappa_i^{(j,k)} \Delta ln(x_{t-i}) \\ & + \pi^{(j,k)} \hat{\epsilon}_{t-1}^{(j,k)} + \pi^{+(j,k)} \hat{\epsilon}_{t-1}^{+,(j,k)} \sum_{k^*=1}^{n^*} \pi^{(j,k^*)} \hat{\epsilon}_{t-1}^{(j,k^*)} + \nu_t\end{aligned} \tag{9}$$

In such model, the typical tools for testing for asymmetries (i.e. whether the coefficients $\pi^{+(j,k)}$ are significantly different from zero) are accompanies by tools that allow us for accounting for cross-country dynamics (illustrated by $\pi^{(j,k^*)}$ coefficients).

3 Discussion of Results

3.1 Cross-Country Links

In the majority of cases, crude oil was found to be in the long-run relationship with all the products. This supports the previous research (see Asche, Gjolberg & Volker (2003) and Gjolberg & Johnsen (1999) for sample analysis on different market levels and different countries).

The results of the estimation of (7) with the p and q parameters set equal to 4 (one month coverage) are presented in Table 4. To ease the comparisons the prices were ordered by their tax-inclusive, common-currency (USD) values, averaged over the available data. The resulting pattern indicates that the fully-loaded prices are highest in the Netherlands and lowest in the new-EU members from Eastern Europe.

The signs of $\pi^{(j,k^*)}$ coefficients and the comparison of average prices over the sample size reveal that in countries which have lower all-inclusive prices compared to their neighbours retail prices increase when the prices in the neighbouring countries are above their equilibrium level. This fits the stylised story of drivers travelling abroad to buy cheaper petrol.

As an example consider first model for EURO-95 petrol in Austria. The mean tax-inclusive prices in Austria over the sample period are amongst the lowest in the region (lower than in Italy and Germany). The results of estimation of 7 indicate that when prices of the product are 1% below their long-run values (1% disequilibrium), the adjustment equals .08%. Accordingly, when the similar disequilibrium exists in Germany, Austrian prices increase by .07%.

This pattern of $\pi^{(j,k^*)}$ values is such that:

- when neighbours' prices are higher than home prices the coefficients of interest are positive, i.e. home prices increase whenever neighbours' prices are above their equilibrium values (are even higher up than usual);
- when neighbours' prices are lower than home prices the coefficients of interest are zero, i.e. home prices are not affected.

While the former conclusion is self-explanatory via the supply-demand relationship, the latter one requires some interpretation. Basically, our results show that local buyers who could do it are already buying abroad and even the extra higher prices abroad do not change that pattern. This is in line with the results obtained by Rietveld et al. (2001) and Michaelis (2004).

The results also confirm the conclusions presented in the qualitative study by Rietveld et al. (2001) - in both countries bordering the Netherlands (Germany and Belgium) the results of estimation of (7) for both motor spirits (Diesel and petroleum) show that when Dutch prices increase (i.e. they are even more expensive, the disequilibrium is positive), the German and Belgian prices increase via supply and demand link.

3.2 Asymmetries in Price Transmission

The estimated coefficients on the asymmetry speed are presented in Table 1.[12]

We found asymmetries in 16 out of 71 cases analysed. The results of estimation of (8) and (9) indicate that the inclusion of cross-country effects significantly changes the results of tests for nonlinearity. In 13 out of 16 cases, we found the revision of the direction of asymmetry with the most prominent examples of motor spirits in Belgium, Finland, Luxembourg, Portugal and Spain.

This indicates that the traditional one-country approach adopted in most studies into price transmission might lead to over-rejection of symmetry hypothesis and incorrect inference on the direction of the welfare transfer.

4 Conclusions and Suggestions for Further Research

The pattern visible in the results offers strong and consistent support for the widespread presence of "fuel tourism" and its impact on asymmetries in price transmission. In particular it supports the view of Rietveld et al. (2001) and Michaelis (2004) - the drivers in high-tax countries tend to travel to neighbouring low-tax countries reaping the price differentials, thus contributing to the demand abroad. Furthermore, the

[12]The cases when the null of no asymmetries were *not* rejected were omitted from the table. For the comparison purposes, the difference between estimates was reported, even for cases when one of the estimates was statistically insignificant.

Table 1: Asymmetries in Price Transmission - One Country (A) and Cross Country (B) Setting

Country	Product	(A)	(B)	Asymmetry - (A)	Asymmetry - (B)	Difference
BE	EURO	$\surd$		0.239		-0.106
DE	EURO	$\surd$		0.186		-0.129
FI	EURO		$\surd$		-0.185	-0.046
GB	EURO		$\surd$		0.08	0.017
GB	DIESEL	$\surd$	$\surd$	0.077	0.083	0.006
PT	DIESEL		$\surd$		-0.068	-0.025
SE	DIESEL	$\surd$	$\surd$	-0.144	-0.168	-0.024
GB	HGASOIL		$\surd$		-0.088	-0.008
LU	HGASOIL	$\surd$	$\surd$	-0.152	-0.182	-0.03
AT	RFO.1		$\surd$		-0.104	-0.039
DE	RFO.1	$\surd$	$\surd$	0.14	0.154	0.014
IT	RFO.1	$\surd$	$\surd$	-0.096	-0.102	-0.006
LU	RFO.1		$\surd$		-0.163	-0.084
BE	SUPER		$\surd$		-0.225	-0.135
DE	SUPER	$\surd$		0.463		-0.176
ES	SUPER		$\surd$		-0.087	-0.031

intensity of those travels increases whenever prices in the drivers' own country are above their long-run equilibrium levels, thus resulting in extra incentives to fill up abroad. This needs to be verified with the use of volume of trade and commuting, but such data is unfortunately not available for all EU countries.

The results for other products which are not subject to "fuel tourism" are less obvious. In particular, the existence of the France-Germany relationship found by Indejehagopian et al. (2000) for the heating oil is not confirmed, which might be due to different sample coverage and inclusion of other bordering countries (such as Spain, Italy and Belgium), which were found to be linked to the German and French markets.

Perhaps even more interestingly, the inclusion of cross-country effects significantly affects the framework used for symmetry in the price transmission (horizontal dynamics). In particular, the nature of asymmetry and the direction of welfare transfer seems to be reverted once cross-country effects are taken into account.

The results of the analysis have wide-raging implications. In particular the empirically-confirmed presence of "fuel tourism" has to be taken into account when discussing benefits from fuel-tax harmonisation within the EU. If drivers are likely to travel abroad, the EU-wide harmonisation might be the only viable option to be employed for the sake of environment and prevention of tax-base erosion. Partial attempts that do not account for geographical features of the EU borders might not necessarily be successful.

From the point of view of asymmetric price transmission, the results suggest that at least some of the claims of the presence of nonlinearities in price transmission and associated welfare transfer should be re-visited in the multi-national framework.

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Table 2: Countries and Borders

	AT	BE	CY	CZ	DE	DK	EE	ES	FI	FR	GB	GR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	SE	SI	SK
AT				√	√								√		√									√	√
BE					√					√							√			√					
CY																									
CZ	√				√																√				√
DE	√	√		√		√				√							√			√	√				
DK					√																				
EE																		√							
ES										√												√			
FI																							√		
FR		√			√			√							√		√								
GB														√											
GR																									
HU	√																							√	√
IE											√														
IT	√									√														√	
LT																		√			√				
LU		√			√					√															
LV							√									√									
MT																									
NL		√			√																				
PL				√	√											√									√
PT								√																	
SE									√																
SI	√												√		√										
SK	√			√									√								√				

Table 3: Products Analysed

Product		Usage	Source
Unleaded petrol	EURO	Motor spirit	Crude Oil
Diesel Oil	DIESEL	Motor spirit	Crude Oil
Heating oil	HGASOIL	Heating	Crude Oil
Liquified Petroleum Gas	LPG	Motor spirit, cooking	Natural Gas / Crude Oil
Fuel oil - high sulphur	RFO.2	Heat / Electricity	Crude Oil
Fuel oil - low sulphur	RFO.1	Heat / Electricity	Crude Oil
Lead Replacement Petrol	SUPER	Motor Spirit	Crude Oil

Table 4: Results of the Cross-Country Analysis

Variable	**Coefficient**	**Standard Error**	**t-Value**	**Pr**($\geq \|\mathbf{t}\|$)
$\Delta y^{(AT;EURO)} = f(\Delta ex_t^{(AT)}; \Delta x_t^{Brent} \epsilon_{t-1}^{(AT;EURO)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(IT)}) \| AT < DE < IT$				
$\epsilon_{t-1}^{(AT)}$	−0.0883514	0.0179603	−4.919272	0.0000012
$\epsilon_{t-1}^{(DE)}$	0.0724997	0.0181104	4.003195	0.0000716
$\epsilon_{t-1}^{(IT)}$	−0.0444939	0.0242609	−1.833978	0.0672296
$\Delta y^{(BE;EURO)} = f(\Delta ex_t^{(BE)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(BE;EURO)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(FR)}; \epsilon_{t-1}^{(LU)}; \epsilon_{t-1}^{(NL)}) \| LU < BE < DE < FR < NL$				
$\epsilon_{t-1}^{(BE)}$	−0.4876667	0.0407949	−11.9541037	0.0000000
$\epsilon_{t-1}^{(DE)}$	−0.0235378	0.0346723	−0.6788637	0.4975022
$\epsilon_{t-1}^{(FR)}$	0.0770948	0.0497065	1.5509996	0.1214617
$\epsilon_{t-1}^{(LU)}$	−0.0223134	0.0613546	−0.3636792	0.7162336
$\epsilon_{t-1}^{(NL)}$	0.2978437	0.0580030	5.1349701	0.0000004
$\Delta y^{(DE;EURO)} = f(\Delta ex_t^{(DE)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(DE;EURO)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(DK)}; \epsilon_{t-1}^{(FR)}; \epsilon_{t-1}^{(LU)}; \epsilon_{t-1}^{(NL)}) \| LU < BE < DE < DK < FR < NL$				
$\epsilon_{t-1}^{(DE)}$	−0.3612283	0.0326797	−11.0536085	0.0000000
$\epsilon_{t-1}^{(BE)}$	0.0630105	0.0417724	1.5084265	0.1320054
$\epsilon_{t-1}^{(DK)}$	−0.0147888	0.0419622	−0.3524317	0.7246462
$\epsilon_{t-1}^{(FR)}$	−0.1191563	0.0483207	−2.4659484	0.0139615
$\epsilon_{t-1}^{(LU)}$	0.0760945	0.0594689	1.2795690	0.2012229
$\epsilon_{t-1}^{(NL)}$	0.3155382	0.0566034	5.5745498	0.0000000
$\Delta y^{(DK;EURO)} = f(\Delta ex_t^{(DK)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(DK;EURO)}; \epsilon_{t-1}^{(DE)}) \| DE < DK$				
$\epsilon_{t-1}^{(DK)}$	−0.2007338	0.028777	−6.975491	0.0000000
$\epsilon_{t-1}^{(DE)}$	0.0248203	0.023045	1.077036	0.2819215
$\Delta y^{(ES;EURO)} = f(\Delta ex_t^{(ES)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(ES;EURO)}; \epsilon_{t-1}^{(FR)}; \epsilon_{t-1}^{(PT)}) \| ES < PT < FR$				
$\epsilon_{t-1}^{(ES)}$	−0.0831133	0.0182684	−4.549563	0.0000066
$\epsilon_{t-1}^{(FR)}$	0.0450806	0.0167486	2.691613	0.0073207
$\epsilon_{t-1}^{(PT)}$	−0.0166639	0.0064853	−2.569485	0.0104394
$\Delta y^{(FI;EURO)} = f(\Delta ex_t^{(FI)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(FI;EURO)}; \epsilon_{t-1}^{(SE)}) \| SE < FI$				
$\epsilon_{t-1}^{(FI)}$	−0.2216587	0.0281454	−7.875493	0.0000000

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Variable	Coefficient	Standard Error	t-Value	Pr(≥ ‖t‖)
$\epsilon_{t-1}^{(SE)}$	0.1285039	0.0371693	3.457262	0.0005904
$\Delta y^{(FR;EURO)} = f(\Delta ex_t^{(FR)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(FR;EURO)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(ES)}; \epsilon_{t-1}^{(IT)}; \epsilon_{t-1}^{(LU)}) \| LU < ES < BE < DE < FR < IT$				
$\epsilon_{t-1}^{(FR)}$	−0.1172447	0.0261427	−4.4847989	0.0000088
$\epsilon_{t-1}^{(BE)}$	0.0264069	0.0208464	1.2667380	0.2057719
$\epsilon_{t-1}^{(DE)}$	0.0053211	0.0181375	0.2933751	0.7693434
$\epsilon_{t-1}^{(ES)}$	−0.0393395	0.0224516	−1.7521916	0.0802843
$\epsilon_{t-1}^{(IT)}$	−0.0926115	0.0292261	−3.1687898	0.0016137
$\epsilon_{t-1}^{(LU)}$	0.1238098	0.0294467	4.2045425	0.0000304
$\Delta y^{(GB;EURO)} = f(\Delta ex_t^{(GB)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(GB;EURO)}; \epsilon_{t-1}^{(IE)}) \| IE < GB$				
$\epsilon_{t-1}^{(GB)}$	−0.0332381	0.0112090	−2.965316	0.0031507
$\epsilon_{t-1}^{(IE)}$	−0.0561248	0.0139508	−4.023045	0.0000652
$\Delta y^{(IE;EURO)} = f(\Delta ex_t^{(IE)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(IE;EURO)}; \epsilon_{t-1}^{(GB)}) \| IE < GB$				
$\epsilon_{t-1}^{(IE)}$	−0.1271967	0.0164362	−7.738794	0.0000000
$\epsilon_{t-1}^{(GB)}$	0.0430882	0.0135999	3.168277	0.0016159
$\Delta y^{(IT;EURO)} = f(\Delta ex_t^{(IT)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(IT;EURO)}; \epsilon_{t-1}^{(FR)}) \| FR < IT$				
$\epsilon_{t-1}^{(IT)}$	−0.0787722	0.0163329	−4.822921	0.0000018
$\epsilon_{t-1}^{(FR)}$	0.0384346	0.0139699	2.751245	0.0061264
$\Delta y^{(LU;EURO)} = f(\Delta ex_t^{(LU)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(LU;EURO)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(FR)}) \| LU < BE < DE < FR$				
$\epsilon_{t-1}^{(LU)}$	−0.1266630	0.0323065	−3.9206661	0.0000991
$\epsilon_{t-1}^{(BE)}$	0.0250194	0.0287984	0.8687788	0.3853364
$\epsilon_{t-1}^{(DE)}$	0.0281591	0.0254797	1.1051604	0.2695597
$\epsilon_{t-1}^{(FR)}$	−0.0051751	0.0359340	−0.1440171	0.8855382
$\Delta y^{(NL;EURO)} = f(\Delta ex_t^{(NL)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(NL;EURO)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(DE)}) \| BE < DE < NL$				
$\epsilon_{t-1}^{(NL)}$	−0.0500495	0.0240385	−2.0820566	0.0377851
$\epsilon_{t-1}^{(BE)}$	−0.0375625	0.0224834	−1.6706777	0.0953372
$\epsilon_{t-1}^{(DE)}$	0.0003234	0.0214003	0.0151141	0.9879465
$\Delta y^{(PT;EURO)} = f(\Delta ex_t^{(PT)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(PT;EURO)}; \epsilon_{t-1}^{(ES)}) \| ES < PT$				
$\epsilon_{t-1}^{(PT)}$	−0.0611151	0.0115908	−5.272740	0.0000002
$\epsilon_{t-1}^{(ES)}$	0.0488238	0.0257072	1.899225	0.0580412
$\Delta y^{(SE;EURO)} = f(\Delta ex_t^{(SE)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(SE;EURO)}; \epsilon_{t-1}^{(FI)}) \| SE < FI$				
$\epsilon_{t-1}^{(SE)}$	−0.1260691	0.0245234	−5.1407623	0.0000004
$\epsilon_{t-1}^{(FI)}$	0.0016662	0.0193470	0.0861236	0.9314013
$\Delta y^{(AT;DIESEL)} = f(\Delta ex_t^{(AT)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(AT;DIESEL)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(IT)}) \| AT < DE < IT$				
$\epsilon_{t-1}^{(AT)}$	−0.0773975	0.0176846	−4.376557	0.0000146
$\epsilon_{t-1}^{(DE)}$	0.0407119	0.0173832	2.342019	0.0195569
$\epsilon_{t-1}^{(IT)}$	−0.0310684	0.0162419	−1.912858	0.0563163
$\Delta y^{(BE;DIESEL)} = f(\Delta ex_t^{(BE)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(BE;DIESEL)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(FR)}; \epsilon_{t-1}^{(LU)}; \epsilon_{t-1}^{(NL)}) \| LU < BE < FR < DE < NL$				
$\epsilon_{t-1}^{(BE)}$	−0.3978450	0.0361122	−11.016921	0.0000000
$\epsilon_{t-1}^{(DE)}$	−0.0406978	0.0298818	−1.361961	0.1737530
$\epsilon_{t-1}^{(FR)}$	0.1641871	0.0482048	3.406036	0.0007060

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Variable	Coefficient	Standard Error	t-Value	Pr(≥ ‖t‖)
$\epsilon_{t-1}^{(LU)}$	−0.1114700	0.0522368	−2.133937	0.0332779
$\epsilon_{t-1}^{(NL)}$	0.2991805	0.0448943	6.664108	0.0000000
$\Delta y^{(DE;DIESEL)} = f(\Delta ex_t^{(DE)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(DE;DIESEL)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(DK)}; \epsilon_{t-1}^{(FR)}; \epsilon_{t-1}^{(LU)}; \epsilon_{t-1}^{(NL)}) \| LU < BE < FR < DE < NL < DK$				
$\epsilon_{t-1}^{(DE)}$	−0.3041892	0.0321779	−9.4533689	0.0000000
$\epsilon_{t-1}^{(BE)}$	−0.0107680	0.0425752	−0.2529180	0.8004238
$\epsilon_{t-1}^{(DK)}$	−0.0066380	0.0349904	−0.1897095	0.8496050
$\epsilon_{t-1}^{(FR)}$	0.0366956	0.0535964	0.6846653	0.4938364
$\epsilon_{t-1}^{(LU)}$	−0.0167176	0.0567190	−0.2947445	0.7682975
$\epsilon_{t-1}^{(NL)}$	0.2306883	0.0483835	4.7679141	0.0000024
$\Delta y^{(DK;DIESEL)} = f(\Delta ex_t^{(DK)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(DK;DIESEL)}; \epsilon_{t-1}^{(DE)}) \| DE < DK$				
$\epsilon_{t-1}^{(DK)}$	−0.1303307	0.0224244	−5.81201	0.0000000
$\epsilon_{t-1}^{(DE)}$	−0.0242246	0.0221038	−1.09595	0.2735651
$\Delta y^{(ES;DIESEL)} = f(\Delta ex_t^{(ES)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(ES;DIESEL)}; \epsilon_{t-1}^{(FR)}; \epsilon_{t-1}^{(PT)}) \| ES < PT < FR$				
$\epsilon_{t-1}^{(ES)}$	−0.0593424	0.0185208	−3.2040918	0.0014310
$\epsilon_{t-1}^{(FR)}$	0.0430570	0.0173470	2.4820945	0.0133497
$\epsilon_{t-1}^{(PT)}$	−0.0079903	0.0109439	−0.7301174	0.4656200
$\Delta y^{(FI;DIESEL)} = f(\Delta ex_t^{(FI)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(FI;DIESEL)}; \epsilon_{t-1}^{(SE)}) \| FI < SE$				
$\epsilon_{t-1}^{(FI)}$	−0.1594603	0.0229713	−6.941704	0.0000000
$\epsilon_{t-1}^{(SE)}$	0.0264213	0.0150548	1.755013	0.0798459
$\Delta y^{(FR;DIESEL)} = f(\Delta ex_t^{(FR)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(FR;DIESEL)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(ES)}; \epsilon_{t-1}^{(IT)}; \epsilon_{t-1}^{(LU)}) \| LU < ES < BE < FR < DE < IT$				
$\epsilon_{t-1}^{(FR)}$	−0.1002292	0.0281566	−3.5597025	0.0004026
$\epsilon_{t-1}^{(BE)}$	0.0148880	0.0194526	0.7653512	0.4443826
$\epsilon_{t-1}^{(DE)}$	0.0053205	0.0168767	0.3152566	0.7526834
$\epsilon_{t-1}^{(ES)}$	0.0110975	0.0232112	0.4781080	0.6327586
$\epsilon_{t-1}^{(IT)}$	−0.0288300	0.0238131	−1.2106760	0.2265267
$\epsilon_{t-1}^{(LU)}$	0.0307820	0.0301555	1.0207765	0.3077980
$\Delta y^{(GB;DIESEL)} = f(\Delta ex_t^{(GB)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(GB;DIESEL)}; \epsilon_{t-1}^{(IE)}) \| IE < GB$				
$\epsilon_{t-1}^{(GB)}$	−0.0477747	0.0119109	−4.010991	0.0000685
$\epsilon_{t-1}^{(IE)}$	−0.0251139	0.0114339	−2.196441	0.0284637
$\Delta y^{(IE;DIESEL)} = f(\Delta ex_t^{(IE)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(IE;DIESEL)}; \epsilon_{t-1}^{(GB)}) \| IE < GB$				
$\epsilon_{t-1}^{(IE)}$	−0.0840505	0.0141935	−5.921772	0.0000000
$\epsilon_{t-1}^{(GB)}$	0.0259213	0.0150817	1.718720	0.0862103
$\Delta y^{(IT;DIESEL)} = f(\Delta ex_t^{(IT)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(IT;DIESEL)}; \epsilon_{t-1}^{(FR)}) \| FR < IT$				
$\epsilon_{t-1}^{(IT)}$	−0.0437989	0.0113935	−3.844217	0.0001346
$\epsilon_{t-1}^{(FR)}$	0.0176785	0.0128360	1.377264	0.1689732
$\Delta y^{(LU;DIESEL)} = f(\Delta ex_t^{(LU)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(LU;DIESEL)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(FR)}) \| LU < BE < FR < DE$				
$\epsilon_{t-1}^{(LU)}$	−0.1882031	0.0311941	−6.0332999	0.0000000
$\epsilon_{t-1}^{(BE)}$	0.0166185	0.0253738	0.6549498	0.5127662
$\epsilon_{t-1}^{(DE)}$	0.0338886	0.0226897	1.4935704	0.1358452

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Variable	Coefficient	Standard Error	t-Value	Pr(≥ ‖t‖)
$\epsilon_{t-1}^{(FR)}$	0.0515341	0.0362928	1.4199510	0.1561725
$\Delta y^{(NL;DIESEL)} = f(\Delta ex_t^{(NL)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(NL;DIESEL)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(DE)}) \| BE < DE < NL$				
$\epsilon_{t-1}^{(NL)}$	−0.1157797	0.0258439	−4.4799604	0.0000090
$\epsilon_{t-1}^{(BE)}$	0.0246405	0.0237621	1.0369663	0.3001936
$\epsilon_{t-1}^{(DE)}$	−0.0059894	0.0215480	−0.2779573	0.7811465
$\Delta y^{(PT;DIESEL)} = f(\Delta ex_t^{(PT)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(PT;DIESEL)}; \epsilon_{t-1}^{(ES)}) \| ES < PT$				
$\epsilon_{t-1}^{(PT)}$	−0.1028810	0.0121166	−8.49093	0
$\epsilon_{t-1}^{(ES)}$	0.1118816	0.0173499	6.44855	0
$\Delta y^{(SE;DIESEL)} = f(\Delta ex_t^{(SE)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(SE;DIESEL)}; \epsilon_{t-1}^{(FI)}) \| FI < SE$				
$\epsilon_{t-1}^{(SE)}$	−0.0675879	0.0152022	−4.445917	0.0000107
$\epsilon_{t-1}^{(FI)}$	0.0255080	0.0251034	1.016120	0.3100446
$\Delta y^{(AT;HGASOIL)} = f(\Delta ex_t^{(AT)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(AT;HGASOIL)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(IT)}) \| DE < AT < IT$				
$\epsilon_{t-1}^{(AT)}$	−0.1069538	0.0199238	−5.368145	0.0000001
$\epsilon_{t-1}^{(DE)}$	0.1297385	0.0363733	3.566859	0.0003947
$\epsilon_{t-1}^{(IT)}$	−0.0807418	0.0249420	−3.237188	0.0012843
$\Delta y^{(BE;HGASOIL)} = f(\Delta ex_t^{(BE)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(BE;HGASOIL)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(FR)}; \epsilon_{t-1}^{(LU)}; \epsilon_{t-1}^{(NL)}) \| BE < LU < DE < FR < NL$				
$\epsilon_{t-1}^{(BE)}$	−0.3739601	0.0408035	−9.1649012	0.0000000
$\epsilon_{t-1}^{(DE)}$	0.1657267	0.0523478	3.1658760	0.0016295
$\epsilon_{t-1}^{(FR)}$	0.0324913	0.0468327	0.6937737	0.4881092
$\epsilon_{t-1}^{(LU)}$	0.0481703	0.0588265	0.8188533	0.4132154
$\epsilon_{t-1}^{(NL)}$	0.0833816	0.0358898	2.3232663	0.0205189
$\Delta y^{(CZ;HGASOIL)} = f(\Delta ex_t^{(CZ)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(CZ;HGASOIL)}; \epsilon_{t-1}^{(AT)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(PL)}; \epsilon_{t-1}^{(SK)}) \| DE < AT < SK < PL < CZ$				
$\epsilon_{t-1}^{(CZ)}$	−0.4972093	0.1666943	−2.9827608	0.0059935
$\epsilon_{t-1}^{(AT)}$	−0.1224775	0.2579458	−0.4748187	0.6387345
$\epsilon_{t-1}^{(DE)}$	0.0377018	0.2149717	0.1753804	0.8620894
$\epsilon_{t-1}^{(PL)}$	0.4192936	0.1773726	2.3639137	0.0255344
$\epsilon_{t-1}^{(SK)}$	−0.1661558	0.0723066	−2.2979340	0.0295416
$\Delta y^{(DE;HGASOIL)} = f(\Delta ex_t^{(DE)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(DE;HGASOIL)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(DK)}; \epsilon_{t-1}^{(FR)}; \epsilon_{t-1}^{(LU)}; \epsilon_{t-1}^{(NL)}) \| BE < LU < DE < FR < NL < DK$				
$\epsilon_{t-1}^{(DE)}$	−0.1666137	0.0404854	−4.1154052	0.0000444
$\epsilon_{t-1}^{(BE)}$	0.0632389	0.0324092	1.9512630	0.0515205
$\epsilon_{t-1}^{(DK)}$	0.0281878	0.0251482	1.1208692	0.2628206
$\epsilon_{t-1}^{(FR)}$	0.0063748	0.0356302	0.1789161	0.8580678
$\epsilon_{t-1}^{(LU)}$	−0.0902324	0.0466705	−1.9333927	0.0536880
$\epsilon_{t-1}^{(NL)}$	0.0387194	0.0284299	1.3619254	0.1737651
$\Delta y^{(DK;HGASOIL)} = f(\Delta ex_t^{(DK)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(DK;HGASOIL)}; \epsilon_{t-1}^{(DE)}) \| DE < DK$				
$\epsilon_{t-1}^{(DK)}$	−0.1103796	0.0243126	−4.5400168	0.0000069
$\epsilon_{t-1}^{(DE)}$	0.0178731	0.0292809	0.6103996	0.5418413
$\Delta y^{(ES;HGASOIL)} = f(\Delta ex_t^{(ES)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(ES;HGASOIL)}; \epsilon_{t-1}^{(FR)}) \| ES < FR$				
$\epsilon_{t-1}^{(ES)}$	−0.1280000	0.0199370	−6.420208	0.0000000

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Variable	Coefficient	Standard Error	t-Value	Pr(≥ ‖t‖)
$\epsilon_{t-1}^{(FR)}$	0.0842945	0.0224842	3.749052	0.0001957
$\Delta y^{(FI;HGASOIL)} = f(\Delta ex_t^{(FI)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(FI;HGASOIL)}; \epsilon_{t-1}^{(SE)}) \Vert FI < SE$				
$\epsilon_{t-1}^{(FI)}$	−0.2168308	0.0276787	−7.833848	0.0000000
$\epsilon_{t-1}^{(SE)}$	0.0555560	0.0275556	2.016138	0.0442992
$\Delta y^{(FR;HGASOIL)} = f(\Delta ex_t^{(FR)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(FR;HGASOIL)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(ES)}; \epsilon_{t-1}^{(IT)}; \epsilon_{t-1}^{(LU)}) \Vert BE < LU < DE < ES < FR < IT$				
$\epsilon_{t-1}^{(FR)}$	−0.0717172	0.0256563	−2.7953061	0.0053616
$\epsilon_{t-1}^{(BE)}$	0.0465517	0.0216441	2.1507779	0.0319179
$\epsilon_{t-1}^{(DE)}$	0.0088988	0.0267972	0.3320791	0.7399529
$\epsilon_{t-1}^{(ES)}$	−0.0401478	0.0207530	−1.9345484	0.0535455
$\epsilon_{t-1}^{(IT)}$	0.0380357	0.0193015	1.9706114	0.0492570
$\epsilon_{t-1}^{(LU)}$	−0.0572673	0.0310618	−1.8436534	0.0657581
$\Delta y^{(GB;HGASOIL)} = f(\Delta ex_t^{(GB)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(GB;HGASOIL)}; \epsilon_{t-1}^{(IE)}) \Vert GB < IE$				
$\epsilon_{t-1}^{(GB)}$	−0.0782890	0.0153170	−5.111248	0.0000004
$\epsilon_{t-1}^{(IE)}$	−0.0183697	0.0103835	−1.769120	0.0774105
$\Delta y^{(IE;HGASOIL)} = f(\Delta ex_t^{(IE)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(IE;HGASOIL)}; \epsilon_{t-1}^{(GB)}) \Vert GB < IE$				
$\epsilon_{t-1}^{(IE)}$	−0.0453878	0.0104165	−4.357288	0.0000156
$\epsilon_{t-1}^{(GB)}$	−0.0210719	0.0174870	−1.205002	0.2287045
$\Delta y^{(IT;HGASOIL)} = f(\Delta ex_t^{(IT)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(IT;HGASOIL)}; \epsilon_{t-1}^{(FR)}) \Vert FR < IT$				
$\epsilon_{t-1}^{(IT)}$	−0.0219396	0.0134267	−1.634025	0.1028077
$\epsilon_{t-1}^{(FR)}$	−0.0306348	0.0151142	−2.026886	0.0431406
$\Delta y^{(LT;HGASOIL)} = f(\Delta ex_t^{(LT)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(LT;HGASOIL)}; \epsilon_{t-1}^{(PL)}) \Vert LT < PL$				
$\epsilon_{t-1}^{(LT)}$	−0.458974	0.097789	−4.69351	0.000014
$\epsilon_{t-1}^{(PL)}$	0.264644	0.108833	2.43165	0.017839
$\Delta y^{(LU;HGASOIL)} = f(\Delta ex_t^{(LU)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(LU;HGASOIL)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(FR)}) \Vert BE < LU < DE < FR$				
$\epsilon_{t-1}^{(LU)}$	−0.3529515	0.0379447	−9.3017446	0.0000000
$\epsilon_{t-1}^{(BE)}$	0.0637327	0.0295040	2.1601391	0.0311810
$\epsilon_{t-1}^{(DE)}$	0.1209793	0.0363030	3.3324889	0.0009169
$\epsilon_{t-1}^{(FR)}$	0.0302517	0.0326215	0.9273534	0.3541384
$\Delta y^{(NL;HGASOIL)} = f(\Delta ex_t^{(NL)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(NL;HGASOIL)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(DE)}) \Vert BE < DE < NL$				
$\epsilon_{t-1}^{(NL)}$	−0.1173039	0.0257383	−4.5575573	0.0000063
$\epsilon_{t-1}^{(BE)}$	0.0326736	0.0313499	1.0422210	0.2977534
$\epsilon_{t-1}^{(DE)}$	−0.0142810	0.0365683	−0.3905294	0.6962918
$\Delta y^{(SE;HGASOIL)} = f(\Delta ex_t^{(SE)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(SE;HGASOIL)}; \epsilon_{t-1}^{(FI)}) \Vert FI < SE$				
$\epsilon_{t-1}^{(SE)}$	−0.1081218	0.0181967	−5.941825	0.0000000
$\epsilon_{t-1}^{(FI)}$	0.0562983	0.0193911	2.903302	0.0038494
$\Delta y^{(AT;RFO.1)} = f(\Delta ex_t^{(AT)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(AT;RFO.1)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(IT)}) \Vert DE < IT < AT$				
$\epsilon_{t-1}^{(AT)}$	−0.1398289	0.0203361	−6.875892	0.0000000
$\epsilon_{t-1}^{(DE)}$	0.0553030	0.0247491	2.234542	0.0258724
$\epsilon_{t-1}^{(IT)}$	0.0824266	0.0312217	2.640046	0.0085390
$\Delta y^{(BE;RFO.1)} = f(\Delta ex_t^{(BE)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(BE;RFO.1)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(FR)}; \epsilon_{t-1}^{(NL)}) \Vert BE < DE < FR < NL$				

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Variable	Coefficient	Standard Error	t-Value	Pr(≥ ‖t‖)
$\epsilon_{t-1}^{(BE)}$	−0.3077584	0.0360061	−8.5474019	0.0000000
$\epsilon_{t-1}^{(DE)}$	0.0449245	0.0314859	1.4268149	0.1541866
$\epsilon_{t-1}^{(FR)}$	0.1917338	0.0350970	5.4629661	0.0000001
$\epsilon_{t-1}^{(NL)}$	0.0217432	0.0286762	0.7582286	0.4486309
$\Delta y^{(DE;RFO.1)} = f(\Delta ex_t^{(DE)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(DE;RFO.1)}; \epsilon_{t-1}^{(DK)}; \epsilon_{t-1}^{(NL)}) \| DE < NL < DK$				
$\epsilon_{t-1}^{(DE)}$	−0.1897712	0.0261388	−7.260122	0.0000000
$\epsilon_{t-1}^{(DK)}$	0.1142081	0.0254147	4.493785	0.0000085
$\epsilon_{t-1}^{(NL)}$	0.0601781	0.0257169	2.340022	0.0196286
$\Delta y^{(DK;RFO.1)} = f(\Delta ex_t^{(DK)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(DK;RFO.1)}; \epsilon_{t-1}^{(DE)}) \| DE < DK$				
$\epsilon_{t-1}^{(DK)}$	−0.2103937	0.0292535	−7.192078	0.0000000
$\epsilon_{t-1}^{(DE)}$	0.1005487	0.0263529	3.815473	0.0001508
$\Delta y^{(ES;RFO.1)} = f(\Delta ex_t^{(ES)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(ES;RFO.1)}; \epsilon_{t-1}^{(FR)}) \| FR < ES$				
$\epsilon_{t-1}^{(ES)}$	−0.1814258	0.0201886	−8.986536	0
$\epsilon_{t-1}^{(FR)}$	0.1522335	0.0190744	7.981025	0
$\Delta y^{(FI;RFO.1)} = f(\Delta ex_t^{(FI)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(FI;RFO.1)}; \epsilon_{t-1}^{(SE)}) \| FI < SE$				
$\epsilon_{t-1}^{(FI)}$	−0.1322795	0.0212929	−6.212365	0.0000000
$\epsilon_{t-1}^{(SE)}$	0.0471045	0.0261817	1.799139	0.0725764
$\Delta y^{(FR;RFO.1)} = f(\Delta ex_t^{(FR)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(FR;RFO.1)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(IT)}) \| BE < DE < FR < IT$				
$\epsilon_{t-1}^{(FR)}$	−0.0880974	0.0390398	−2.2566057	0.0244147
$\epsilon_{t-1}^{(BE)}$	0.0030152	0.0316466	0.0952765	0.9241291
$\epsilon_{t-1}^{(DE)}$	0.0746419	0.0284088	2.6274216	0.0088376
$\epsilon_{t-1}^{(IT)}$	−0.0744320	0.0352554	−2.1112232	0.0351925
$\Delta y^{(HU;RFO.1)} = f(\Delta ex_t^{(HU)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(HU;RFO.1)}; \epsilon_{t-1}^{(AT)}; \epsilon_{t-1}^{(SI)}) \| AT < HU < SI$				
$\epsilon_{t-1}^{(HU)}$	−0.7758816	0.1243616	−6.2389158	0.0000000
$\epsilon_{t-1}^{(AT)}$	0.5051398	0.1705206	2.9623387	0.0043027
$\epsilon_{t-1}^{(SI)}$	0.0826857	0.1949604	0.4241153	0.6729264
$\Delta y^{(IT;RFO.1)} = f(\Delta ex_t^{(IT)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(IT;RFO.1)}; \epsilon_{t-1}^{(FR)}) \| FR < IT$				
$\epsilon_{t-1}^{(IT)}$	−0.1682125	0.0283416	−5.935172	$0e+00$
$\epsilon_{t-1}^{(FR)}$	0.1127398	0.0262122	4.301043	$2e-05$
$\Delta y^{(LT;RFO.1)} = f(\Delta ex_t^{(LT)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(LT;RFO.1)}; \epsilon_{t-1}^{(PL)}) \| PL < LT$				
$\epsilon_{t-1}^{(LT)}$	−0.7514264	0.1248389	−6.0191700	0.0000001
$\epsilon_{t-1}^{(PL)}$	0.1256175	0.2142336	0.5863576	0.5596977
$\Delta y^{(LU;RFO.1)} = f(\Delta ex_t^{(LU)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(LU;RFO.1)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(DE)}; \epsilon_{t-1}^{(FR)}) \| LU < BE < DE < FR$				
$\epsilon_{t-1}^{(LU)}$	−0.1365908	0.0203700	−6.7054991	0.0000000
$\epsilon_{t-1}^{(BE)}$	0.0177277	0.0348092	0.5092836	0.6107777
$\epsilon_{t-1}^{(DE)}$	0.0236157	0.0318659	0.7410966	0.4589821
$\epsilon_{t-1}^{(FR)}$	0.0875093	0.0360371	2.4283138	0.0155202
$\Delta y^{(NL;RFO.1)} = f(\Delta ex_t^{(NL)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(NL;RFO.1)}; \epsilon_{t-1}^{(DE)}) \| DE < NL$				
$\epsilon_{t-1}^{(NL)}$	−0.1340743	0.0207472	−6.462284	$0.00e+00$

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Variable	Coefficient	Standard Error	t-Value	Pr(≥ ‖t‖)
$\epsilon_{t-1}^{(DE)}$	0.0731819	0.0182709	4.005376	$7.02e-05$
$\Delta y^{(PT;RFO.1)} = f(\Delta ex_t^{(PT)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(PT;RFO.1)}; \epsilon_{t-1}^{(ES)}) \| ES < PT$				
$\epsilon_{t-1}^{(PT)}$	−0.1047439	0.0138945	−7.538524	$0e+00$
$\epsilon_{t-1}^{(ES)}$	0.0949510	0.0187930	5.052482	$6e-07$
$\Delta y^{(SE;RFO.1)} = f(\Delta ex_t^{(SE)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(SE;RFO.1)}; \epsilon_{t-1}^{(FI)}) \| FI < SE$				
$\epsilon_{t-1}^{(SE)}$	−0.1442663	0.0217140	−6.643918	0.0000000
$\epsilon_{t-1}^{(FI)}$	0.0382646	0.0212165	1.803530	0.0718837
$\Delta y^{(ES;RFO.2)} = f(\Delta ex_t^{(ES)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(ES;RFO.2)}; \epsilon_{t-1}^{(PT)}) \| ES < PT$				
$\epsilon_{t-1}^{(ES)}$	−0.0870859	0.0219904	−3.9601799	0.0000879
$\epsilon_{t-1}^{(PT)}$	−0.0042934	0.0128356	−0.3344892	0.7381762
$\Delta y^{(GB;RFO.2)} = f(\Delta ex_t^{(GB)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(GB;RFO.2)}; \epsilon_{t-1}^{(IE)}) \| GB < IE$				
$\epsilon_{t-1}^{(GB)}$	−0.0694459	0.0205218	−3.384003	0.0007830
$\epsilon_{t-1}^{(IE)}$	0.0276852	0.0162774	1.700839	0.0897297
$\Delta y^{(IT;RFO.2)} = f(\Delta ex_t^{(IT)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(IT;RFO.2)}; \epsilon_{t-1}^{(FR)}) \| IT < FR$				
$\epsilon_{t-1}^{(IT)}$	−0.1239722	0.0323795	−3.82873	0.0001511
$\epsilon_{t-1}^{(FR)}$	0.0712360	0.0343944	2.07115	0.0390338
$\Delta y^{(BE;LPG.1)} = f(\Delta ex_t^{(BE)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(BE;LPG.1)}; \epsilon_{t-1}^{(FR)}; \epsilon_{t-1}^{(LU)}; \epsilon_{t-1}^{(NL)}) \| BE < LU < NL < FR$				
$\epsilon_{t-1}^{(BE)}$	−0.2340598	0.0615125	−3.805080	0.0001750
$\epsilon_{t-1}^{(FR)}$	−0.0584495	0.0471549	−1.239521	0.2162173
$\epsilon_{t-1}^{(LU)}$	0.1321537	0.0636098	2.077569	0.0386838
$\epsilon_{t-1}^{(NL)}$	0.0720271	0.0606651	1.187291	0.2361449
$\Delta y^{(FR;LPG.1)} = f(\Delta ex_t^{(FR)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(FR;LPG.1)}; \epsilon_{t-1}^{(IT)}; \epsilon_{t-1}^{(LU)}) \| LU < IT < FR$				
$\epsilon_{t-1}^{(FR)}$	−0.1148483	0.0233272	−4.923368	0.0000015
$\epsilon_{t-1}^{(IT)}$	−0.0004955	0.0187034	−0.026492	0.9788841
$\epsilon_{t-1}^{(LU)}$	0.0404685	0.0116733	3.466744	0.0006111
$\Delta y^{(LU;LPG.1)} = f(\Delta ex_t^{(LU)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(LU;LPG.1)}; \epsilon_{t-1}^{(FR)}) \| LU < FR$				
$\epsilon_{t-1}^{(LU)}$	−0.0519789	0.0239190	−2.1731186	0.0306219
$\epsilon_{t-1}^{(FR)}$	−0.0178439	0.0468554	−0.3808304	0.7036220
$\Delta y^{(BE;SUPER)} = f(\Delta ex_t^{(BE)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(BE;SUPER)}; \epsilon_{t-1}^{(FR)}) \| BE < FR$				
$\epsilon_{t-1}^{(BE)}$	−0.2068836	0.0337541	−6.129136	0.0000000
$\epsilon_{t-1}^{(FR)}$	0.1094646	0.0431697	2.535684	0.0115835
$\Delta y^{(DE;SUPER)} = f(\Delta ex_t^{(DE)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(DE;SUPER)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(FR)}; \epsilon_{t-1}^{(LU)}) \| LU < BE < DE < FR$				
$\epsilon_{t-1}^{(DE)}$	−0.6052851	0.0924715	−6.5456378	0.0000000
$\epsilon_{t-1}^{(BE)}$	0.1272663	0.1488533	0.8549781	0.3943409
$\epsilon_{t-1}^{(FR)}$	0.2159725	0.1840773	1.1732707	0.2431116
$\epsilon_{t-1}^{(LU)}$	0.1704941	0.1173562	1.4527917	0.1490048
$\Delta y^{(DK;SUPER)} = f(\Delta ex_t^{(DK)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(DK;SUPER)}; \epsilon_{t-1}^{(DE)}) \| DK < DE$				
$\epsilon_{t-1}^{(DK)}$	−0.3240257	0.0872704	−3.712893	0.0003801
$\epsilon_{t-1}^{(DE)}$	0.1509328	0.0981357	1.538001	0.1280444
$\Delta y^{(ES;SUPER)} = f(\Delta ex_t^{(ES)}; \Delta x_t^{Brent};\ \epsilon_{t-1}^{(ES;SUPER)}; \epsilon_{t-1}^{(FR)}) \| ES < FR$				

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Variable	**Coefficient**	**Standard Error**	**t-Value**	$\mathbf{Pr}(\geq \|\mathbf{t}\|)$
$\epsilon_{t-1}^{(ES)}$	-0.0698624	0.0162524	-4.298601	0.0000202
$\epsilon_{t-1}^{(FR)}$	0.0482748	0.0173138	2.788226	0.0054773
$\Delta y^{(FR;SUPER)} = f(\Delta ex_t^{(FR)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(FR;SUPER)}; \epsilon_{t-1}^{(ES)}) \| ES < FR$				
$\epsilon_{t-1}^{(FR)}$	-0.0550445	0.0201506	-2.7316568	0.0064976
$\epsilon_{t-1}^{(ES)}$	-0.0020058	0.0196745	-0.1019491	0.9188331
$\Delta y^{(IT;SUPER)} = f(\Delta ex_t^{(IT)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(IT;SUPER)}; \epsilon_{t-1}^{(FR)}) \| IT < FR$				
$\epsilon_{t-1}^{(IT)}$	-0.0294114	0.0140944	-2.0867477	0.0376121
$\epsilon_{t-1}^{(FR)}$	0.0074871	0.0147369	0.5080475	0.6117303
$\Delta y^{(LU;SUPER)} = f(\Delta ex_t^{(LU)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(LU;SUPER)}; \epsilon_{t-1}^{(BE)}; \epsilon_{t-1}^{(FR)}) \| LU < BE < FR$				
$\epsilon_{t-1}^{(LU)}$	-0.1101396	0.0319086	-3.4517212	0.0006581
$\epsilon_{t-1}^{(BE)}$	0.0886359	0.0433486	2.0447248	0.0419731
$\epsilon_{t-1}^{(FR)}$	0.0035652	0.0543816	0.0655594	0.9477832
$\Delta y^{(PT;SUPER)} = f(\Delta ex_t^{(PT)}; \Delta x_t^{Brent}; \epsilon_{t-1}^{(PT;SUPER)}; \epsilon_{t-1}^{(ES)}) \| ES < PT$				
$\epsilon_{t-1}^{(PT)}$	-0.0692773	0.0198546	-3.489231	0.0005633
$\epsilon_{t-1}^{(ES)}$	0.0832082	0.0605677	1.373804	0.1706133