Economic Modelling 42 (2014) 243–249

Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

The relative effects of crude oil price and exchange rate on petroleum product prices: Evidence from a set of Northern Mediterranean countries ☆

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A R T I C L E I N F O

Article history:
Accepted 3 July 2014
Available online xxxx

Keywords:
Oil prices
Exchange rates
Asymmetry

A B S T R A C T

This paper provides a set of empirical evidence from five Northern Mediterranean countries that are subject to similar refinery reference prices regarding the relative sensitivity of crude oil prices and exchange rate on (pre-tax) petroleum product prices. The empirical evidence reveals that a one percent increase in exchange rate (depreciation) increases petroleum product prices less than a one percent increase in crude oil prices does in the long run. In the short run, however, a one percent increase in exchange rate increases petroleum product prices more than a one percent increase in crude oil prices does.

1. Introduction

The two most important determinants of petroleum product prices in local markets are crude oil prices (denominated in US dollars (USD)) and local currency-USD exchange rate.[3] The purpose of this article is to study the relative pass-through effects of these two costs on petroleum product prices. To be particular, we will assess which of these two input' price changes affect petroleum product prices more. We will focus on how these two costs affect petroleum product prices in the long run as well as in the short run.

Retail petroleum product prices are subject to changes in cost stemming mainly from crude oil prices, exchange rate besides taxes, transportation, and labor. Norman and Shin (1991) and Bachmeier and Griffin (2003) for the US, Kirchgassner and Kubler (1992) for Germany, and Godby et al. (2000) for Canada report the positive effect of (crude) oil prices on gasoline prices. There are a number of studies that report the positive effect of exchange rate on petroleum product prices. Chou (2012), Bacon (1991), Balke et al. (1998), Reilly and Witt (1998), Asplund et al. (2000), and Galeotti et al. (2003) model the role of exchange rate and crude prices for a set of non-US countries. Different types of shocks affect product prices differently. For example, Pindyck (2001) distinguishes between permanent and temporary shocks and Radchenko (2005) decomposes shocks into long term versus short term. Since changing prices is costly, firms are less likely to change product prices if there is more chance that they will have to change their product prices again in the near future, such as if input price increases will correct themselves shortly. Firms tend to increase their product prices more if the shock is permanent (rather than transitory) and long term (rather than short term). These studies suggest that agents will move to adjust to changes differently depending on the type of shocks.

To assess the role of exchange rate on petroleum product prices, we gathered data from a set of countries whose currencies are neither the USD nor fixed to it. We chose a set of Northern Mediterranean (or Southern European) countries that share the same or similar crude oil reference prices and where exchange rate is determined by the markets. Thus, we collected data from France, Greece, Italy, Spain, and Turkey. Section 2 presents the data and Section 3 describes the methodology we employed and discusses the results obtained by the econometric specifications, and Section 4 concludes.

2. Data

We employed weekly data from January 03, 2005 to October 22, 2012 for France, Greece, Italy and Spain, and from January 01, 2005 to December 25, 2011 for Turkey. For France, Greece, Italy, and Spain we

☆ We would like to thank Bülent Hayaloğlu, Rana Nelson, Çağla Ökten and the anonymous referee for their helpful comments.

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3 There are other determinants of petroleum product prices, such as labor cost, transportation cost, and gas station rent. To enable cross-country comparisons, we assume that the contributions of these items to the cost of petroleum product prices are either stable or move with these determinants. Thus, we implictly assume that these determinants move with exchange rates or crude prices.

http://dx.doi.org/10.1016/j.econmod.2014.07.019
0264-9993/

gathered consumer prices of petroleum products, with duties and taxes deducted, for Euro-super 95, fuel oil, gas oil for automobiles, and heating gas oil from the Oil Bulletins of the European Commission. For Turkey, we collected the selling prices (vendor) without taxes for diesel, 95 octane unleaded gasoline, and fuel oil from the annual official reports of the Turkish Energy Market Authority. We obtained Brent oil data for world oil prices from Data Stream and gathered the USD-Euro exchange rate from the Federal Reserve Bank of St. Louis and the Turkish Lira-USD exchange rate from the data delivery system of the Central Bank of the Republic of Turkey. All the data employed in this study were used in their logarithmic forms.

3. Methodology

To model petroleum product pricing, we follow Campa and Goldberg's (2005) micro foundations of exporters' pricing behavior of import prices. The import price of oil (P_t^m) is the product of exchange rate (E_t) and the export price of a product (of an oil export price, OIL_t) P_t^x. The export price (in USD) can be equal to the marginal cost (MC_t^x) in USD that captures crude oil prices, exchange rate, and mark-up ($MARKUP_t^x$). If the lower case letters represent the logarithm of the variables, then we can write the import price of oil in Eq. (1) as follows:

$$p_t^m = e_t + mc_t^x + markup_t^x. \quad (1)$$

We further assume that marginal cost is affected by benchmark crude oil prices and that mark-up is affected by exchange rate:

$$mc_t^x = \psi_0 + \psi_1 oil_t \quad (2)$$

$$markup_t^x = \varphi_0 + \varphi_1 e_t. \quad (3)$$

Thus, we may write Eq. (1):

$$p_t^m = \psi_0 + \varphi_0 + \psi_1 oil_t + (1 + \varphi_1)e_t. \quad (4)$$

In this paper, we are interested in the effect of relative change of exchange rate to crude oil prices on petroleum product prices. Thus, we could write:

$$p_t^m = \psi_0 + \varphi_0 + \psi_1(oil_t + e_t) + (1 + \varphi_1 - \psi_1)e_t \quad (5)$$

where $(1 + \varphi_1 - \psi_1)$ can be positive or negative, but regardless, it captures the relative effect of change of exchange rate to crude oil prices on petroleum product prices. Thus, one may write:

$$petrol_t^{DC} = \beta_0 + \beta_1 trend + \beta_2 crude_t^{DC} + \beta_3 e_t + u_t. \quad (6)$$

Here, the domestic currency value of domestic petroleum product prices ($petrol^{DC}$) is determined by the domestic currency value of crude oil prices as well as exchange rate. The domestic currency value of crude oil prices ($crude^{DC}$) is found by adding the logarithms of USD-denominated crude oil prices and exchange rate. Here, we also include the time trend to account for lower transportation costs due to higher efficiency of transportation vehicles and higher efficiency of distribution channels over time. β_3 captures the relative effect of exchange rate changes to crude oil price changes on petroleum product prices.[4] A positive β_3 suggests that an increase in exchange rate increases petroleum products' pump prices more than the cost of crude oil prices in local currency does; a negative β_3 suggests that an increase in exchange rate increases petroleum products' pump prices less than the cost of crude oil prices in local currency does.[5]

If all the series have unit roots, these series should be cointegrated for a long-run relationship. Overall, unit root tests fail to reject the null of a unit root for world crude oil prices, exchange rates, and gasoline prices for each country.[6] These statistics are not provided here to save space, but are available from the authors upon request.

Table 1 reports the Dickey–Fuller test statistics that correspond to the Engle–Granger cointegration tests. We consider various three-variable systems. We include various petroleum product prices, crude oil prices in local currency, and exchange rate, along with the constant term and time trend in each system. The test statistics suggest that the series are cointegrated at least at the 10% level of significance. Thus, we estimate Eq. (6), and Table 2 reports these estimated coefficients for this equation. The estimated coefficients of crude oil prices in local currency ($crude^{DC}$) are always positive and statistically significant. These estimated coefficients are less than one and between 0.32 and 0.61. Campa and Goldberg (2005) report that even if there is a one percent increase in imported product prices in domestic currency, it almost always increases prices of products at the dock one percent (full pass-through of exchange rate to prices). This effect is smaller in consumer prices (incomplete pass-through) at the later stages of distribution channels. Thus, our results support their proposition.

On the estimated coefficient of the exchange rate, the estimated coefficients for all countries and products we consider are negative and statistically significant, except for unleaded (95 octane) for Turkey: it is positive, yet not statistically significant. This suggests that a one percent increase in crude oil prices increases petroleum product prices more than a one percent increase in exchange rate does. Even if crude oil is the most important input to the petroleum product production process, there are various other inputs, such as other types of chemicals, labor, and electricity. As the technology improves in the usage of these inputs, the output prices will be less affected (see Morrison, 1997). Since technological improvement on crude usage is limited compared to the non-crude inputs, crude prices will affect petroleum product prices more (see Concawe, 2007). Moreover, Burstein et al. (2003); Burstein et al. (2005); and Campa and Goldberg (2005) argue that the

Table 1
The Engle–Granger cointegration test for pre-tax distribution prices.

Countries	Euro-super 95	Fuel oil	Gas oil automobile	Heating gas oil
France	−5.0959***	−4.4557***	−3.8575**	−3.7166*
Greece	−6.1451***	−5.8599***	−3.124*	−4.4679***
Italy	−4.9949***	−4.4164***	−4.0059**	−3.8694*
Spain	−4.5001***	−4.6404***	−3.5635*	−3.5123*
	Unleaded (95 oct.)	Fuel Oil	Diesel	
Turkey	−5.5532***	−8.3611***	−3.5939*	

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

[4] Alternatively, we could include USD-denominated crude prices and exchange rates in the regression analysis. However, we would need to test whether the estimated parameters of these two variables are equal to each other. This test statistic is not readily available because it is also a function of the covariances of these two parameters (see Greene, 2008, ss. 53–56).

[5] Except for France, it is quite likely that crude oil prices and exchange rates are both exogenous to the system. Moreover, it is quite unlikely that pre-tax petroleum product prices affect world crude oil prices and exchange rate. Thus, we employ univariate but not multivariate analyses. We did estimate a VAR model but the confidence bands for the impulse responses had too wide a margin to make inferences. Crude oil prices and exchange rates were both exogenous to the system, thus estimating the model within a VAR framework might lead to overparamatization.

[6] We employed three unit root tests: ADF; Phillips and Perron (PP); and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS). For the first two tests, the null hypothesis is the unit root, but for the last test the alternative is the unit root. We performed the test for the log levels and log first differences. Overall, we concluded that all series are integrated in order one, I(1).