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# On the relationship between forward prices of crude oil and domestic fuel: A panel data cointegration approach[1]

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**Abstract.** The aim of this paper is to investigate the existence of a long-term relationship between the forward prices of crude oil and domestic fuel (FOD) on the period from August 2003 to April 2010. To this end, we rely on a panel data setting by considering a sample of 36 maturities for the forward prices. Using panel cointegration tests, our results show that oil and fuel prices are characterized by a strong homogeneous long-term equilibrium relationship for several maturities. Estimating a panel error correction model, we find that FOD prices are influenced by oil prices variations on both the short and the long run. The existence of a unique equilibrium model for all maturities may have important implications for financial arbitrage strategies based on energy prices relationships, industrial product plan and calculating consumer prices.

*JEL* Classification: C23; Q40.
Keywords: Forward Energy Prices; Oil; Domestic Fuel; Panel Cointegration.

**Résumé.** L'objectif de ce papier est d'étudier l'existence d'une relation de long terme entre les prix à terme du pétrole et du fioul domestique (FOD) sur la période allant d'Août 2003 à Avril 2010. Pour cela, nous adoptons une approche en panel en considérant les prix à terme de 36 maturités différentes. Les résultats provenant des tests de cointégration en panel montrent l'existence d'une relation d'équilibre de long terme homogène selon les maturités entre les prix du pétrole et du FOD. L'estimation d'un modèle à correction d'erreur en panel a par ailleurs mis en évidence que les prix du FOD étaient influencés par ceux du pétrole à court comme à long terme. L'existence d'un modèle d'équilibre homogène selon les maturités peut avoir des implications fortes dans les stratégies d'arbitrage financier, les plans de production industrielle et le calcul de prix à la consommation pour les entreprises du secteur énergétique.

Classification *JEL* : C23 ; Q40.
Mots-clefs : Prix à terme des énergies ; pétrole ; fioul domestique ; cointégration en panel.

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## 1. Introduction

The aim of this paper is to study the long-term relationship between forward prices of crude oil and domestic fuel (FOD). The empirical literature devoted to this relationship - and more generally to the relationship between oil and refined product prices – relies mainly on a cointegration analysis in a time series framework (see, Serletis (1994), Gjølberg and Johnsen (1999), Asche, Gjølberg and Völker (2003), Lanza *et al.* (2005), Mjelde and Bessler (2009), among others). Serletis (1994) investigates the number of common stochastic trends in a system containing three petroleum daily prices: crude oil, unleaded gasoline and heating oil. The data covers the period between December 3rd, 1984 and April, 30th 1993. Applying Johansen's maximum likelihood approach, Serletis concludes to the existence of a cointegrated system with only one common trend. Gjølberg and Johnsen (1999) analyze co-movements between the prices of crude oil and major refined products during the 1992-1998 period, and examine also whether the deviations from a potential long-term equilibrium relationship can be used for short-term predictions and risk management. The authors find that crude and other products spot prices are cointegrated, and rely on a vector error correction modeling. Asche *et al.* (2003) focus on the Northwest European petroleum market by considering a multivariate framework on the period from January 1992 to November 2000. They conclude in favor of a long-term relationship and show that the crude oil is weakly exogenous. Lanza *et al.* (2005) analyze the price dynamic between heavy crude oil and product prices by considering fourteen prices series of petroleum product and ten prices series of crude in Europe and America during the 1994-2002 period. Using a cointegration and error correction model (ECM) approach the authors conclude that the significance of the long-run relationship of product prices depends on the market area (weaker in America and stronger in Europe) and on the gravity of crude. Subsequently, they run predictions for crude oil prices and compare the respective performance of ECM and other naïve (first difference) specifications and find that cointegration marginally improves static forecasts in Europe. More recently, Mjelde and Bessler (2009) investigate prices dynamic of US electricity weekly wholesale spot prices and the major electricity generation fuel sources prices (like, crude oil, natural gas, uranium and coal), over the period June 6, 2001-April 23, 2003. Using multivariate time series methods the authors show that the degree of integration between the different markets varies and that peak electricity prices move natural gas prices, which, in turn, influence oil prices.

In this paper, we improve on previous analyses based on spot/future prices series by investigating the long-term link between forward prices of crude oil and domestic fuel across several maturities. To this end, we rely on a panel data framework including both cross-sectional and time dimensions. From a methodological viewpoint, it is well known that in small samples, traditional unit root and cointegration tests have low power against near stationary alternatives. By adding the individual dimension to the analysis, the use of panel data increases the power of the tests by raising the number of observations (see, Hsiao (2003), Hurlin and Mignon (2005) and Baltagi (2008), among others).