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Dynamic effects of rising oil prices on consumer energy prices in Canada and the United States: Evidence from the last half a century ☆

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ABSTRACT

This paper examines the dynamic relationship between the price of crude oil and the CPI energy price sub-index in Canada and the U.S. using a Markov-regime switching model and the Bai–Perron sequential method. Since these two series are cointegrated during the sample period (January 1961–June 2013), a short-run dynamic model is thus estimated for each country in which all coefficients and the error-variance terms can freely switch over time between two values prevailing in Regimes 0 and 1. Previous studies indicate that the price of crude oil does not currently affect the aggregate CPI as much as it did in the 1970s. This finding is not disputed in this paper. However, the sequentially-determined break date as well as the time-varying regime-switching probabilities point to two new findings. First, the marginal effects of changes in oil price on consumer energy prices (not the aggregate CPI) have consistently increased and become more instantaneous for both countries after the Western U.S. Energy Crisis of 2000. Second, the speed of adjustment (proxied by different error-correction coefficients) has also risen, particularly for the U.S. Therefore, oil prices exert far more positive and immediate impacts on energy costs in the post- rather than pre-1999 periods.

1. Introduction

Oil prices can influence many vital economic indicators in an economy such as inflation, industrial production and stock market returns and volatility (Ali Ahmed and Wadud, 2011; Burbridge and Harrison, 1984; Filis, 2010; Hamilton, 1983; Kilian, 2008a, 2008b; Miller and Ratti, 2009; Ratti and Hasan, 2013; Ratti and Vespignani, 2013). There is a consensus among economists that changes in oil prices (particularly large variations) can exert significant influences on inflation (see inter alia Ajmera et al., 2012; Bachmeier and Cha, 2011; Goldberg, 1998; Nixon and Smith, 2012). For example, Nixon and Smith (2012) argue that producing an accurate inflation forecast without knowing the future path of oil and other commodity prices can be futile. They believe that when forecasting CPI inflation and GDP growth, the UK Monetary Policy Committee rigorously examines the slope of the oil future curve as it contains predictive information for explaining the expected path of spot prices.

Ratti and Vespignani (2013) attribute significant increases in real oil prices, global oil production, and global real aggregate demand to unanticipated rises in global real M2 particularly in the post- rather than pre-2005 period. In this comprehensive study they find that Brazil, China, India and Russia reinforce one another in terms of their liquidity effects on global real aggregate demand. On the other hand, Kilian (2008a) compares the impacts of exogenous shocks to oil supply on G7 economies in terms of their responses to output growth and inflation. Although such transitory disruptions do not exert sustained inflationary or deflationary pressure on any of these economies, inflation responses are mainly country-specific and typically peak after three to four quarters (Kilian, 2008a). He also asserts that exogenous shocks to oil supply can result in a fall in the real wage, higher short-term interest rates, and a depreciation of the local currency. Using monthly data (1986–2009), Ali Ahmed and Wadud (2011) examine the impact of oil price uncertainty on Malaysian macroeconomic activities and monetary responses by estimating a SVAR. They argue that the Malaysian central bank pursues an expansionary monetary policy in response to oil price uncertainty due to prolonged and dampening effects of oil price volatility shock on industrial production.

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Ajmera et al. (2012) analyse price movements of four commodities in the U.S. (namely crops, animal slaughter and processing, dairy, and oil and gas) and estimate price transmission from commodity prices to various sub-components of the consumer price indices. Out of these four commodities, they argue that only oil and gas prices have a significant impact on inflation both in the longer term as well as in specific years through influencing the three CPI sub-indices: transportation; motor fuel; and fuels and utilities (including electricity and natural gas). According to Ajmera et al. (2012, p.39) between 2003 and 2008 higher oil and gas prices were responsible for "approximately two-thirds of the increase in transportation prices, about one-half of the increase in motor fuel prices, and roughly two-thirds of the increase in fuels and utilities prices." Using the monthly Greek data during the period 1996 m1–2008 m6, Filis (2010) also studied the interplay among the cyclical components of the CPI, industrial production, stock market and oil prices within a multivariate VAR framework. His results also indicate that oil prices exert a positive effect on the CPI in the long run.

A number of studies in the literature support this view that the recent effects of oil shocks on core aggregate inflation (not energy prices) are no longer as large and significant as they were back in the 1970s because producers have substituted away from oil (see inter alia Bachmeier and Cha, 2011; De Gregorio et al., 2007; Hooker, 2002; Katayama, 2013). For example, Bachmeier and Cha (2011) used a disaggregate monthly database (97 sectors) to examine the relationship between oil price shocks and U.S. CPI inflation. Their comprehensive database contains sectoral inflation data, energy intensity, labour intensity, and sensitivity to monetary policy. Comparing the 1973–1985 and 1986–2006 time periods, inter alia they posit "that about two-thirds of the reduced response of core inflation to oil shocks can be attributed to changes in energy intensity and one-third to monetary policy" (Bachmeier and Cha, 2011, p.1167).

Oil and energy prices are typically more volatile than the prices of 95% of products sold by domestic U.S. producers (Regnier, 2007). Cologni and Manera (2008) examined the direct impacts of oil price shocks on output, prices and monetary variables within a structural VAR model for the G-7 countries. They found, inter alia, that for Canada and the U.S. the null hypothesis of an influence of oil prices on the inflation rate could not be rejected. Wang (2013) in his study of the G-7 countries used a logistic smooth transition model and argued that the threshold effects of rising oil prices on household consumption expenditures are larger than those of falling oil prices. He found that such influences arise from two channels: real balance effects and wealth transfer effects. On the same topic Venditti (2013) examined the effects of oil prices on weekly energy prices (gasoline and gasoil) in the U.S. and the four euro area countries (Germany, France, Italy and Spain) using nonlinear impulse response functions and forecast accuracy tests. According to Venditti (2013), there is some compelling evidence of asymmetries in the adjustment of retail prices for the U.S. but such evidence appears to be quite mixed for the euro area.

There has been little research in measuring the direct influence of the price of crude oil on the energy price sub-index within the CPI basket. Canada and the U.S. are chosen in the present study because these two countries possess the highest per capita consumption of petroleum-based liquid fuel among all OECD countries (Knittel, 2012). While concurring with previous studies in that the positive effect of rising crude oil prices on the overall CPI has diminished over time, the same cannot be said in relation to the dynamic impacts of oil prices on the CPI energy sub-index. The empirical results of this study provide convincing evidence that oil prices can influence consumer energy prices both faster and on a larger scale in the post-1999 period than they did in the pre-1999 period. If producers had not efficiently substituted away from oil due to technological advancements, rising oil prices would have increased consumer energy bills (i.e. fuel, transport as well as utilities including electricity and natural gas) far more than what is currently observed.

The remainder of this paper is organised as follows: Section 2 discusses two modelling approaches (i.e. Markov-regime switching model and the Bai–Perron sequential approach) in capturing any break or switching effects of rising crude oil prices on the consumer energy price sub-index. Section 3 briefly outlines the sources and summary statistics of the data employed. Section 4 presents empirical results and the major findings of the study followed by some concluding remarks in Section 5.

2. Econometric methodology

As an important production input crude oil can be refined into various types of fuels (including kerosene, gasoline and diesel) and other petroleum products. It is reasonable thus to assume that changes in the price of crude oil can have an appreciable effect on household energy bills. The production and consumption of other sources of energy such as natural gas and coal can also be indirectly influenced by the price of crude oil. One expects that the marginal effects of changes in the price of crude oil on the consumer price index vary due to (a) technological advancements in the use of this important production input; (b) environmental considerations and the use of other sources of energy. Given that oil prices can be influenced by a wide range of socio-economic and political factors as well as natural catastrophes in an unpredictable manner, this paper assumes that the marginal effects are random, variable and "memoryless". In other words, the marginal effects of changes in oil prices on consumer energy prices can vary from one state to another on a state space whereby the next state is dependent upon only the current state and not on the sequence of events that preceded it. A Markov chain process can capture these three attributes: randomness, time-variant and "memorylessness." (Valadkhani, 2014).

In addition, previous studies found that the effect of crude oil prices on the overall CPI has undergone significant changes since the 1970s. In order to capture any possible dynamic changes in the marginal effect of oil prices on the CPI energy price index, a hybrid Markov-switching model is adopted below in which both the marginal effects and the variance of error term are allowed to be regime variant.

Let us assume that the energy price index (E_t) within the CPI basket and the price of crude oil (PO_t) are both I(1) and they are also cointegrated in the long run. Due to possible endogeneity between these two variables, the Dynamic Least Square (DLS) method (Stock and Watson, 1993) can then be used to estimate the long-run coefficients (η_s) as follows:

$$Ln(E_t) = \eta_0 + \eta_1 T_t + \eta_2 Ln(PO_t) + \sum_{j=-k}^{+k} \varphi_j \Delta Ln\left(PO_{t-j}\right) + v_t \tag{1}$$

where T_t = the time trend variable; Ln = natural logarithm; and v_t = the residual term. Based on the Schwarz criterion, the optimal k lags and leads of $\Delta Ln(PO_{t\text{-}j})$ are included in Eq. (1) to address the possibility of endogeneity problem raised by Kilian (2008b). The long-run elasticity of oil price (η_2) is expected to be positive as higher crude oil prices lead to higher energy prices for consumers. According to the Engle–Granger theorem, the lagged residual term obtained from the long-run cointegrating vector can form an error correction ($EC_{t\text{-}1}$) term in a short-run dynamic model. For simplicity let us first define:

$$\begin{cases} Y_t = \Delta Ln(E_t) \\ X_t = \Delta Ln(PO_t) \end{cases} \tag{2}$$

One can then write the following conventional (non-switching) short-run dynamic model for the growth rate of the energy price index:

$$Y_t = \alpha + \sum_{i=0}^{q} \beta_i X_{t-i} + \sum_{i=1}^{q} \gamma_i Y_{t-i} + \lambda EC_{t-1} + u_t \tag{3}$$

where β_i is the short-run effect of a logarithmic change in the price of crude oil on the growth rate of the energy price index at time t-i; γ_i