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Energy Economics

Crude oil prices and exchange rates: Causality, variance decomposition and impulse response

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ABSTRACT

This paper examines the short-run and long-run dynamic relationship between the U.S. imported crude oil prices and exchange rates. The monthly data of the U.S. crude oil imports from five source countries during January 1996 and December 2009 are examined. Empirical results indicate that the exchange rates Granger-caused crude oil prices in the short run while the crude oil prices Granger-caused the exchange rates in the long run. Furthermore, oil prices were affected by the exchange rate changes at a minimal level. However, in the medium run and the long run, oil price shocks had a significant impact on exchange rate changes. Exchange rate shock has a significant negative impact on crude oil prices while the impulse response of the exchange rate variable to a crude oil price shock was statistically insignificant. Finally, the impact of extreme price volatility in June 2008 on exchange rates was significant. When world oil prices are stabilized, currency fluctuations and uncertainty can be minimized.

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1. Introduction

What makes oil price study interesting is not only the direct impact on economic performance, but also how the fluctuations in oil prices might reflect changes in international financial variables, such as exchange rates. Oil is one of the most important factors in the macro-economy because oil shock affects prices at all levels. According to the Energy Information Administration (EIA, http://www.eia.doe.gov/), in February 2009, the top ten sources of the U.S. crude oil imports (in million barrels per day) were Canada (1.913), Mexico (1.219), Saudi Arabia (1.099), Venezuela (0.960), Angola (0.671), Iraq (0.554), Nigeria (0.457), Brazil (0.365), Kuwait (0.251) and Ecuador (0.243). These top ten sources accounted for approximately 84% of all the U.S. crude oil imports, while the top five exporting countries accounted for 64% of the U.S. crude oil imports. The U.S. crude oil market has a property of the monopolistically competitive market structure — the domestic and foreign individual producers have their own monopolistic power,

but are competing rigorously in the market. Market power, pricing rivalry, or even collusive pricing can be observed. Existing literature provides a general connection between exchange rates and imported crude oil prices. This paper analyzes the short-run and long-run dynamic relationship between the U.S. imported crude oil prices and exchange rates using five source countries of the U.S. crude oil imports. Why is it important to know the short-run and long-run relationships between exchange rates and oil price movements? This is a vital issue because changes in currency value may have some effect on crude oil prices in the short run. On the other hand, the short-run crude oil price shocks may have the long-run effect on the exchange rates. Furthermore, as volatility and degree of co-movements between the U.S. imported crude oil prices and exchange rates are identified, it seems important to obtain the information regarding the relationship among them through generalized impulse response functions.

2. Literature review and hypotheses

This section summarizes and pulls together the relevant literature in relation to the objectives stated above. The general literature on these issues is presented in four main areas of study: connection between

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exchange rates and imported crude oil prices, oil prices and the exchange rate causality, variance decomposition and impulse response and the impact of crisis.

2.1. Connection between exchange rates and imported crude oil prices

According to Yousefi and Wirjanto (2003), most OPEC countries will adjust their prices on the value of the dollar to maintain market share and secure the purchasing power of oil revenue. A 10% depreciation in the dollar will result in a price increase (in dollars) between 1.9% and 8.5%. In addition, Yousefi and Wirjanto (2005) also suggest that the reasons that incomplete exchange rate pass-through occurs in OPEC nations are because of the collusive nature of OPEC and the fact that oil revenues are priced in U.S. dollars. Feinberg (1989) and others conclude that market power plays an important role in local price destabilization. This is due in part to the market power of the foreign producers who can easily pass the exchange rate shock to consumers by adjusting prices as frequently as they wish. Goldberg and Knetter (1997) confirm that incomplete or zero exchange rate pass-through is possible because the exporters have to absorb some or all the exchange rate cost shocks. Furthermore, Gross and Schmitt (1996, 2000) find in a related industry that pricing rivalry among foreign automobile producers in the Swiss market exists. One of their findings is that the low degree of pass-through may be attributed to a low degree of competition among foreign sellers. Much of the existing research including Aloui et al. (2013) find that there is a significant and symmetric dependence between exchange rates and oil price. Reboredo (2012) analyzes oil price and exchange rate co-movements for different currencies and finds that an increase in oil prices and depreciation against the U.S. dollar are weakly associated with two ways of causalities for different currencies. The relationship seems to be stronger for oil-exporting countries compared to oil-importing countries. Thus, the first hypothesis is presented below:

Hypothesis 1. There is a cointegrating relationship among variables.

2.2. Oil prices and the exchange rate causality

Causality between real oil prices and real dollar exchange rates has been analyzed but a clear distinction between oil prices and exchange rate dynamics has historically been inconclusive. The inclusiveness of the causation between exchange rates and oil price may depend on the choice of the exchange rate measure, the time-varying causality patterns or others. Huang and Tseng (2010) detect a significant two-way causal relationship between the dynamics of oil price disturbance and the exchange rate of the U.S. dollar using a two-step regression approach over a twenty-year period. Studies by Tiwari, Dar and Bhanja (2013) and Ding and Vo (2012) suggest that there is bi-directional volatility interaction between the two while Uddin et al. (2013) find that exchange rate change affects the oil price in the short run. Therefore, the following hypothesis is developed:

Hypothesis 2. The exchange rate fluctuations Granger-caused the prices of imported crude oil.

On the other hand, studies by Basher et al. (2012) and Narayan et al. (2008) have shown that in the short run the oil price shocks tend to depress the U.S. dollar exchange rates while Lizardo and Mollick (2010) show that in the long run real oil price changes affect the value of the U.S. dollar. Chen and Chen (2007) and Bénassy-Quéré et al. (2007) find that the causality runs from oil price to the U.S. dollar in the long run. Furthermore, Coudert et al. (2007) show that causality runs from oil prices to the exchange rates. As they investigate the channels through which oil prices affect the dollar exchange rate, they report that the link between the two variables is transmitted through the U.S. net foreign asset position. Turhan et al. (2012) investigate the role of oil prices in explaining the dynamics of selected emerging country exchange rates. Using daily data series, their study concludes that a rise in oil prices leads to a significant appreciation in emerging economy's currencies against the U.S. dollar, and that oil price dynamics changed significantly in the sample period. Overall, existing literature finds that oil price shocks affect exchange rate fluctuations. Hence,

Hypothesis 3. The prices of imported crude oil Granger-caused the exchange rate fluctuations.

2.3. Variance decomposition and impulse response

Many studies have used the methods of variance decomposition and impulse response functions to estimate the response of one shock to a specific variable. Jones and Kaul (1996) show that in general oil prices affect stock prices. Their study finds that for the U.S. and Canada this reaction can be accounted for entirely by the impact of the oil shocks while the results for Japan and the UK were inconclusive.

However, Apergis and Miller (2009) find that international stock market returns did not respond significantly to oil market shocks from eight advanced countries. There are also other studies by Basher and Sadorsky (2006) and Cong et al. (2008) on the short-run dynamics between oil prices and stock prices. As such, the focus of this study is to connect exchange rate changes to imported crude oil prices, and vice versa. Thus, the following hypothesis is advanced.

Hypothesis 4. The variance decomposition and impulse response among them are significant.

2.4. The impact of crisis

Vo and Ding (2011) examine the oil and the foreign exchange market relationship at the risk level employing multivariate stochastic volatility model and the multivariate conditional correlation GARCH (generalized autoregressive conditional heteroskedasticity) framework to investigate the volatility interactions between the two in an attempt to extract information intertwined in both markets for risk prediction. They find that the volatility in each market is very persistent and varies over time in a predictable manner, conditioned on past information. In addition, the volatility in the oil market Granger-causes the volatility in the foreign exchange markets but not the other way around. Reboredo (2012) and others find that oil price-exchange rate dependence is generally weak during turbulent time such as financial crisis. Reboredo and Rivera-Castro (2013) also find that oil prices led to exchange rates and vice versa in the crisis period but not in the pre-crisis period. During the period under this study, the crude oil price peaked at $140 per barrel on June 30, 2008. This extreme price volatility is accounted via the last hypothesis shown below.

Hypothesis 5. The extreme price volatility in June 2008 has impacted exchange rates.

The next section describes the empirical model used. Section 4 provides data sources and description. The econometric procedures and results are analyzed in Section 5, followed by conclusions and implications in the last section.

3. Empirical specification

Without imposing theoretical restrictions on endogeneity among variables, a vector autoregression (VAR) procedure is appropriate for establishing the dynamics between the U.S. crude oil prices and exchange rates. These two variables are treated as endogenous jointly and are assumed to have no restrictions on the structural relationships in our analysis.