Can Oil Prices Forecast Exchange Rates?

Domenico Ferraro, Ken Rogoff and Barbara Rossi

June 2011
Motivation

Can Oil Prices Forecast Exchange Rate Movements?

- Crude oil represents a substantial component of Canada's total exports.
- Canada has a sufficiently long history of market-based floating exchange rate.
- Canada is a small-open economy, and crude oil price fluctuations serve as an observable and essentially exogenous terms-of-trade shock, although we check robustness with other countries/commodity prices.
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- Focus on Canada for three reasons:

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Figure 1(a). Oil Price Model. Forecasting Ability in Daily Data

Diebold-Mariano Rolling Test – Daily Data

- Benchmark RW w/o drift
- Benchmark RW w/ drift
- 5% Critical value

In-sample window size as fraction of total sample size
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- Can Oil Prices Forecast Exchange Rate Movements?
- In DAILY data, YES!

Figure 1(a). Oil Price Model. Forecasting Ability in Daily Data

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 Rossi (Duke)  Oil Prices & Exchange Rates  June 2011
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- On the contrary, in-sample fit is stronger in monthly and quarterly data than in daily data
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- for the South African Rand-U.S. dollar exchange rate and gold prices we also find significance with both contemporaneous and lagged commodity prices.
- for the Australian-U.S. dollar and oil prices and the Chilean Peso-U.S. dollar exchange rate and copper prices, we find strong and significant predictive ability only with contemporaneous commodity prices as predictors.
Our results are related to literature on high frequency effects of macro news announcements: Andersen et al., 2003, Faust et al., 2007, Kilian and Vega, 2008.
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Our results are also related to studies on the **in-sample fit** of commodity currencies and commodity prices at **monthly/quarterly frequencies**:

Amano and Van Norden (1998a,b) and Chen and Rogoff (2003) for in-sample fit of real exchange rates/commodity indexes

Issa, Lafrance and Murray (2008) and Cayen, Coletti, Lalonde and Maier (2010) for in-sample fit and instabilities / factor analysis

Our results focus on **out-of-sample forecasting**, and document short-lived effects identifiable only at high frequencies
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- Evidence of predictive ability at longer horizons: Mark, 1995; Chinn and Meese, 1995; Engel, Mark and West, 2007; Faust, Rogers and Wright (2003); Kilian and Taylor (2003).

Our paper focuses instead on short-horizon predictive ability, for which the empirical evidence in favor of the economic models has been more controversial.

We focus on linear models but we check performance of nonlinear models: see Hamilton (2003), Kilian and Vigfusson (2011), etc. for nonlinear relationships between oil and output, and Alquist, Kilian and Vigfusson (2011) for forecasting oil prices.
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I. Can Realized Oil Prices Forecast Exchange Rates?
II. Can Lagged Oil Prices Forecast Exchange Rates?
III. Other Commodities/Exchange Rates
IV. Are Non-linearities Important?
Roadmap

I. Can Realized Oil Prices Forecast Exchange Rates?
   
   YES!
   
   Why are we able to find predictive ability?
   
   - Choice of Fundamental?
   - Frequency or Number of Observations?
   - Is it stable?
   - How about in-sample fit?

II. Can Lagged Oil Prices Forecast Exchange Rates?

III. Other Commodities/Exchange Rates

IV. Are Non-linearities Important?
Can Realized Oil Price Changes Forecast Exchange Rates?

The Regression:

\[ \Delta s_t = \alpha + \beta \Delta p_t + u_t, \quad t = 1, \ldots, T \]

\( \Delta s_t \) = first difference of the log of the Canadian/U.S. Dollar exchange rate (Barclays)

\( \Delta p_t \) = first difference of the log of the oil price (West Texas Intermediate)

\( u_t \) = unforecastable error term

We consider three frequencies: quarterly, monthly and daily.

12/14/1984 to 11/05/2010, end of period.
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Can Realized Oil Price Changes Forecast Exchange Rates?

**The Strategy:**

\[
\Delta s_t = \alpha + \beta \Delta p_t + u_t, \quad t = 1, \ldots, T
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- Roll "post out-of-sample" forecasts: see Meese-Rogo (1983) and Andersen et al. (2003)
  - Choose an estimation window, \( R \)
  - Estimate parameter using last \( R \) observation
  - Get forecast using realized fundamentals, and forecast error
  - Mimic forecaster in real time and roll through the data

Predictive ability assessed by Diebold and Mariano's (1995) benchmarks are random walk without and with drift.
The Strategy:

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- Benchmarks are random walk without and with drift
Figure 1(a). Oil Price Model. Forecasting Ability in Daily Data
Can Realized Oil Price Changes Forecast Exchange Rates in Monthly/Quarterly Data? Barely...

Figure 1(b). Oil Price Model. Forecasting Ability in Monthly and Quarterly Data
Why Can We Find Predictive Ability? Is it the Fundamental?

Is it the choice of the fundamental? What if we use interest rates?

- \( \Delta s_t = \alpha + \beta i_t + u_t, \ t = 1, \ldots, T, \)

\(\Delta i_t\) = logarithm of the interest rate differential

\(u_t\) = unforecastable error term

Canadian short-term interest rate is the daily overnight money market rate (Bank of Canada) and the U.S. short-term rate is the daily Federal funds effective rate.
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- Fundamental plays a big role: no predictive ability with interest rates!
Predictive Ability mainly after 2004 in Daily data, very little or none in Monthly/Quarterly data...
Why Predictive Ability? Is it the Frequency or the Number of Observations?

- Calculate the test in a way to make them comparable
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<tr>
<td><strong>Panel A. Comparing Daily and Monthly Data</strong></td>
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<tr>
<td>Daily Data</td>
<td>-4.1829</td>
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<td>(0.0000)</td>
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<tr>
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<td>-2.7254</td>
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### Table 1(a). Frequency Versus Number of Observations

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- It is the frequency, not the number of observations!
Both oil prices and the exchange rate are denominated in US Dollars
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Consider oil prices and Canadian Dollar/British Pound exchange rate
Both oil prices and the exchange rate are denominated in US Dollars

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Consider oil prices and Canadian Dollar/British Pound exchange rate

Table 1(b). Oil Prices and the Canadian Dollar/British Pound

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It is not a dollar effect!
Robustness: Recursive Estimation

Results are robust to the use of a recursive window estimation procedure

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<td>-8.642</td>
<td>-8.687</td>
</tr>
</tbody>
</table>
Roadmap

I. Can Realized Oil Prices Forecast Exchange Rates?
II. Can Lagged Oil Prices Forecast Exchange Rates?
III. Other Commodities/Exchange Rates
IV. Are Non-linearities Important?
Can Lagged Oil Prices Forecast Exchange Rates?

- The Regression:

\[ \Delta s_t = \alpha + \beta \Delta p_t + u_t, \quad t = 1, \ldots, T \]

\( \Delta s_t \) is the first difference of the logarithm of the Canadian/U.S. dollar exchange rate,

\( \Delta p_t \) is the first difference of the logarithm of the oil price,

\( u_t \) is the unforecastable error term.
The Regression:

\[ \Delta s_t = \alpha + \beta \Delta p_{t-1} + u_t, \quad t = 1, ..., T, \]
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Can Lagged Oil Prices Forecast Exchange Rates?

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- \( u_t \) = unforecastable error term
Can Lagged Oil Price Changes Forecast Exchange Rates in Daily Data?

Figure 5(a). Oil Price Model. Forecasting Ability in Daily Data
Yes, after taking into account instabilities in the relative forecasting performance.
Can Lagged Interest Rate Differentials Forecast Exchange Rates?

Never!

Figure 5(d). The Interest Rate Model. Forecasting Ability in Daily, Monthly and Quarterly Data

Panel A: Diebold-Mariano Rolling Test - Daily Data

Panel B: Diebold-Mariano Rolling Test - Monthly Data

Panel C: Diebold-Mariano Rolling Test - Quarterly Data
Roadmap

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Other Commodities: Norwegian Krone, contemp. price

Very strong predictive ability in daily data with contemp. prices
Other Commodities: Norwegian Krone, lagged price

- Predictive ability with realized fundamentals robust, with lagged price sporadic
Other Commodities: S.A. Rand and Gold, contemp.

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Predictive ability with realized fundamentals robust, with lagged p sporadic
Other Commodities: Chilean Peso and Copper, contemp.

- Very strong predictive ability in daily data with contemp. prices
Other Commodities: Chilean Peso and Copper, contemp.

- Only predictive ability with realized fundamentals

Figure 8(e). Chilean Peso and Copper. Fluctuation Test, Contemp. Model
Other Commodities: Australian $ and Oil, contemp.

**Figure 9(a). Austr. $ and Oil.**
Daily Data, Contemp. Model

**Figure 9(b). Austr. $ and Oil.**
Monthly and Quarterly Contemp. Model

- Very strong predictive ability in daily data with contemp. prices
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Roadmap

I. Can Realized Oil Prices Forecast Exchange Rates?
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Consider a model with **Asymmetries** (Kilian and Vigfusson (2009), Alquist, Kilian and Vigfusson (2011))
Are Non-linearities Important?

Consider a model with **Asymmetries** (Kilian and Vigfusson (2009), Alquist, Kilian and Vigfusson (2011))

The exchange rate response is asymmetric in oil price increases and decreases:

$$\Delta s_t = \alpha_+ + \beta_+ \Delta p_t + \gamma_+ \Delta p_t^+ + u_t$$  \hspace{1cm} (1)

where $\Delta p_t^+ = \begin{cases} 
\Delta p_t & \text{if } \Delta p_t > 0 \\
0 & \text{otherwise.} 
\end{cases}$
Consider a model with **Threshold effects** (Hamilton):

\[
\Delta s_t = \alpha q + \beta q \Delta p_t + \gamma q \Delta p_t^q + u_t
\]

where \(\Delta p_t^q\) is the change in oil prices if \(\Delta p_t > 80\)th quantile or \(< 20\)th quantile 0 otherwise.
Consider a model with **Threshold effects** (Hamilton):

“large” changes in oil prices have additional predictive power for the nominal exchange rate:

\[
\Delta s_t = \alpha_q + \beta_q \Delta p_t + \gamma_q \Delta p^q_t + u_t
\]

where

\[
\Delta p^q_t = \begin{cases} 
\Delta p_t & \text{if } \Delta p_t > 80th \text{ quantile of } \Delta p_t \text{ or } < 20th \text{ quantile} \\
0 & \text{otherwise.}
\end{cases}
\]
Non-linearities: Contemporaneous Price Model – Daily data

- Some predictability in Threshold models but only for very large window sizes

Figure 10(a). Asymmetric and Threshold Models. Forecasting Ability in Daily Data
Non-linearities: Contemp. Price Model, Monthly a& Quarterly data

Figure 10(b). Asymmetric and Threshold Models. Forecasting Ability in Monthly and Quarterly Data

Diebold–Mariano Rolling Test – Monthly And Quarterly Data

- Benchmark: Asymmetric oil price model – Monthly data
- Benchmark: Threshold oil price model – Monthly data
- Benchmark: Asymmetric oil price model – Quarterly data
- Benchmark: Threshold oil price model – Quarterly data
- 5% Critical value

- Non-linear models are never better and sometimes signif. worse
Non-linear models are never better and sometimes significantly worse.
Non-linearities: Lagged Price Model – Monthly and Quarterly data

- Non-linear models are never better and sometimes signif. worse
Our empirical results suggest that oil prices can predict the Canadian/U.S. dollar nominal exchange rate at daily frequency out-of-sample. However, the predictive ability is not evident at quarterly and monthly frequencies.

When using contemporaneous realized daily oil prices, the predictive ability is robust to the choice of the in-sample window size and it does not depend on the sample period under consideration. When using lagged oil prices, the predictive ability is more ephemeral and only shows up in daily data after allowing the relative forecasting performance of the oil price model and the random walk to be time-varying. Both out-of-sample and in-sample analyses suggest that frequency of the data is important to detect the predictive ability of oil prices.
Conclusions

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Conclusions and Future Work

- **Non-linearities do not significantly improve** upon the simple linear oil price model.
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- Overall, reason why existing literature has been unable to find evidence of predictive power in oil prices is that they focused on low frequencies where the short-lived effects of oil price changes wash away.

At the same time, our results also raise interesting questions. Does the Canadian/U.S. dollar exchange rate respond to demand or supply shocks to oil prices? See Kilian (2009). However, unfeasible at the daily frequency. We leave these issues for future research.
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