Asymmetries in the Oil-Gasoline Price Relationship

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Energy demand models are often developed on the assumption that consumer behavior is defined by *symmetric responses* to rising or falling prices and income.

It is equally plausible, however, that consumers might react differently to price rises than they would to price falls, be it because of habit formation, the desire to improve life quality or any other reason.

An influential and often quoted paper by Gately and Huntington (2002, *EJ*) eloquently demonstrates why, and how, consumers of energy will respond differently to, not only price cuts and price rises, but also to price rises above the previous maximum and price recoveries below the previous maximum.

Gately and Huntington also demonstrate, on a sample of OECD countries, with annual per capita data over the period 1971-1997, that this might also apply to changes in economy activity. However, overall symmetry for the income responses is generally favoured over asymmetry.

Introduction
Asymmetric Price Transmission/Rockets and Feathers

• The relationship between the international price of oil and the local retail fuel prices has been/is/will be the subject of public debate in many countries.

• The main reason for this concern is the “belief that oil companies and retailers rush to increase prices in local markets as soon as international oil prices rise, but do not respond with the same eagerness when international oil prices fall” [Clerides, 2010, CEPR].

• The economic literature refers to this phenomenon as the Asymmetric Price Transmission (APT) or the Rockets and Feathers (R&F) hypothesis.
Introduction
Asymmetric Price Transmission, Rockets and Feathers, and Forecasting

• **Asymmetric Price Transmission (APT):**
  - Negative and positive input price changes have different impact on output prices (e.g. input price is more reactive to increases than to decreases in output price)
  - Empirical evidence suggests that APT is a feature of several markets

• **Rockets & Feathers (R&F) hypothesis:**
  - R&F is referred to as APT in fuel markets [Bacon, 1991, EE]
  - Fuel prices shoot up like rockets (both in terms of speed and magnitude) in response to positive shocks in crude oil prices, while floating down like feathers in response to negative oil price shocks
  - Empirical literature on R&F focuses mostly with in-sample analyses and results depend on a number of factors (type of data, econometric models, time and spatial aggregation) [Geweke, 2004, FTC]

• **Forecasting:** do asymmetries in the price of oil improve the forecasting performance of models for the spot and retail fuel prices?
Literature

Causes and consequences of APT/R&F

• Causes:
  ▪ Main explanation: Market Power [Borestein et al., 1997, QJE]
  ▪ Other explanations [Brown & Yücel, 2000, EFPR]: Search Costs, Menu Costs, Adjustment Costs, Inventories, Input Price Volatility, Structure of Intermediate Markets, etc.
  ▪ No general consensus:
    ► “Empirical evidence linking market power and APT is mixed” [Eckert, 2013, JES]
    ► “Price asymmetry is as characteristic of competitive as oligopoly market structures.” [Peltzman, 2000, JPE]

• Consequences:
  ▪ Welfare transfers and (if APT is an example of market failures) net welfare losses for consumers [Meyer & von Cramon-Taubadel, 2004, JAgrEc]
  ▪ Policy uncertainty [Brown & Yücel, 2000, EFPR]: the type of intervention and its effectiveness depends on the cause of APT (unclear)
  ▪ Gaps in economic theory: if APT is a general finding, “it would point to a serious gap in a fundamental area of economic theory” [Peltzman, 2000, JPE]
Literature
Empirical evidence of APT/R&F (in-sample analyses)

Selected contributions

- Faber (2015, *EJ*), gasoline market:
  - Two possible *aggregation* issues in studies to asymmetric price responses, namely aggregation *over time* and *over space*
  - The issue of *aggregation over time* has been confirmed by many empirical studies
  - This paper confirms the issue of *aggregation over space* by studying daily retail prices of individual gasoline stations
  - Results show that 38% of the stations respond asymmetrically to changes in the gasoline spot market price
Bakucs et al. (2014, *JAgrEc*), agro-food market:

- Relationship between APT and market structure
- “(...) asymmetries are present in sectors with higher number of fragmented farm producers and less likely to occur with more concentrated farm structures”
- “(...) asymmetries are less likely in the presence of entry barriers to retail trade (...), more likely to occur in the presence of regulations limiting price competition between retailers”

Eckert (2013, *JES*), gasoline market:

- “… most studies, …, have found at least some statistical evidence of asymmetry in the response of retail prices to upstream (wholesale or crude oil) prices.”
- “… retail prices respond differently, and typically faster, to upstream price increases than to decreases.”
Literature
Empirical evidence of APT/R&F (in-sample analyses)

- Frey & Manera (2007, JES), various markets:
  - APT in 87% of cases (total of 87 models in 70 surveyed papers)

- Grasso & Manera (2007, EP), gasoline market:
  - Use of three popular asymmetric models, namely A-ECM, TAR-ECM and TC-ECM
  - Monthly data over the period 1985-2003 for France, Germany, Italy, Spain and UK
  - In general, there is evidence of APT, although the type of market and the number of countries characterized by APT vary across models
  - A-ECM: LR APT in the distribution stage for many countries
  - TC-ECM: LR APT vary across markets and countries
  - TAR-ECM: SR APT at the distribution stage for all countries
Literature

Empirical evidence of APT/R&F (in-sample analyses)

- Meyer & von Cramon-Taubadel (2004, *JAgrEc*), various markets:
  - APT in 48% of surveyed studies (total 205)
  - APT in 79% of surveyed studies relying on A-ECM & TAR-ECM models (total 41)

- Galeotti, Lanza & Manera (2003, *EE*), gasoline market:
  - Comparison across countries using A-ECM
  - Bootstrapped F-statistic of the null hypothesis of asymmetry to overcome the low-power problem of conventional testing approaches
  - Results show widespread differences in both adjustment speeds and SR responses of gasoline prices when the price of oil rises or falls

- Peltzman (2000, *JPE*), various markets:
  - APT in 66% of markets (total 242)
Bachemeir & Griffin (2003, *REStat*) is the only contribution entertaining an out-of-sample analysis:

- Point forecasts of U.S. spot gasoline prices with weekly data
- R&F modeled with A-ECM
- R&F are useless OOS: forecasts from symmetric ECM are as accurate as those from A-ECM

Note: several empirical analyses deal with asymmetric transmission of oil shocks and their role in forecasting macroeconomic aggregates [e.g. Kilian & Vigfusson, 2013, *JBES*]
Are Asymmetries Useful in Forecasting the Oil-Gasoline Price Relation?

by

Andrea Bastianin, University of Milan, Italy and FEEM
Marzio Galeotti, University of Milan, Italy and IEFE, Bocconi
Matteo Manera, University of Milan-Bicocca and FEEM
Empirical questions and main results

- **Point forecasts**: are R&F useful when forecasting gasoline price changes? *(NO)*
- **Direction-of-change/sign forecasts**: are R&F useful when forecasting the sign of gasoline price movements? *(YES)*
- **Probability forecasts**: are R&F useful when forecasting the probability of gasoline price changes? *(YES)*
- **Time-varying forecast accuracy**: is the usefulness of R&F constant through **time** or time-varying? *(Time Varying)*
- **Location of asymmetries**: at which **stage** of the transmission mechanism (i.e. spot, retail, both) are R&F forecasts useful? *(Both, but only for sign and probability forecasts)*
- **Sampling frequency**: at which sampling **frequency** (daily, weekly or monthly) are R&F forecasts useful? *(Mixed findings)*
Motivations

Why an *out-of-sample* (OOS) analysis?

1. **Decision making** is an inherently forward looking activity:
   - Hedging, asset allocation, risk management, stockpiling (inventories and strategic reserves) depend on the OOS performance of models
   - (Profits are highly correlated with some forecast accuracy metrics [Leitch & Tanner, 1991, *AER]*)

2. **Gap in the literature**: with the exception of Bachmeier & Griffin (2003, *REStat*), extant studies perform only in-sample (IS) analyses

3. **Forecasting performance as a diagnostic check**:
   - (IS tests have more power than OOS tests only when there is no model uncertainty and no instabilities [Goyal & Welch, 2008, *RFS]*)
   - R&F models which are accurate IS do not necessarily produce accurate forecasts
   - OOS analyses complement IS tests
Data

• Upstream price: spot price of WTI crude oil (6/86-1/13)
• Downstream prices
  ▪ Gasoline spot prices (daily, weekly, monthly):
    ▶ New York Harbor Conventional Gasoline (6/86-1/13)
    ▶ U.S. Gulf Coast Conventional Gasoline (6/86-1/13)
    ▶ Los Angeles Reformulated RBOB Gasoline (4/03-1/13)
  ▪ Gasoline and diesel retail prices (excl. taxes; weekly, monthly):
    ▶ U.S. Regular All Formulations Gasoline (8/90-1/13)
    ▶ U.S. No 2 Diesel (1/97-1/13)
• Note:

  3 types of fore x 6 mod x [(3 spot x 3 freq) + [(2 retail x 2 freq)]
  = 234 forecasts
Data

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- **Note:**

\[
3 \text{ types of fore } \times 6 \text{ mod x } [(3 \text{ spot } \times 3 \text{ freq}) + [(2 \text{ retail } \times 2 \text{ freq})] = 234 \text{ forecasts}
\]
Upstream price: spot price of WTI crude oil (6/86-1/13)

Downstream fuel prices

- Gasoline spot prices (daily, weekly, monthly):
  - New York Harbor Conventional Gasoline (6/86-1/13)
  - U.S. Gulf Coast Conventional Gasoline (6/86-1/13)
  - Los Angeles Reformulated RBOB Gasoline (4/03-1/13)

- Gasoline and diesel retail prices (excl. taxes; weekly, monthly):
  - U.S. Regular All Formulations Gasoline (8/90-1/13)
  - U.S. No 2 Diesel (1/97-1/13)

Note:

3 types of fore x 6 mod x [(3 spot x 3 freq) + [(2 retail x 2 freq)]

= 234 forecasts
Data
New York Harbor Conventional Gasoline and WTI Crude oil prices

WTI = West Texas Intermediate spot price FOB (USD/b)
NY = New York Harbor Conventional Gasoline Regular spot price FOB (USD/g)
Sample = 2/6/86 - 31/1/13
Data
New York Harbor Conventional Gasoline and WTI Crude oil prices

DWTIP = positive WTI spot price changes
DNYP = positive NY gasoline price changes
Sample = 2/6/86 - 31/1/13
Data
New York Harbor Conventional Gasoline and WTI Crude oil prices

DWTIN = negative WTI spot price changes
DNYN = negative NY gasoline price changes
Sample = 2/6/86 - 31/1/13
## Data

**New York Harbor Conventional Gasoline and WTI Crude oil prices**

<table>
<thead>
<tr>
<th></th>
<th>Full sample</th>
<th>Subsample</th>
<th>Very High WTI Volatility (48 obs)</th>
<th>Medium WTI Volatility (6547 obs)</th>
<th>Very Low WTI Volatility (122 obs)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Correlation between</strong></td>
<td><strong>DWTIP and</strong></td>
<td><strong>DNYP</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation between</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>DWTIP and DNYN</td>
<td>0.50</td>
<td>0.62</td>
<td>0.20</td>
<td>0.45</td>
<td>0.99</td>
</tr>
</tbody>
</table>

<p>| <strong>Correlation between</strong> | <strong>DWTIN and</strong> | <strong>DNYN</strong>     |                                   |                                   |                                  |
| Correlation between    |              |              |                                   |                                   |                                  |
| DWTIN and DNYN         | 0.55         | 0.12         | 0.72                              | 0.49                              | -0.03                            |</p>
<table>
<thead>
<tr>
<th></th>
<th>Full sample</th>
<th>Subsample</th>
<th>Full sample</th>
<th>Subsample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2/6/86-31/1/13 (6959 obs)</td>
<td>5/1/03-31/1/13 (2629 obs)</td>
<td>2/6/86-31/1/13 (6959 obs)</td>
<td>5/1/03-31/1/13 (2629 obs)</td>
</tr>
<tr>
<td>Corr btw DWTIP and DNYP(+1)</td>
<td>0.13</td>
<td>0.01</td>
<td>Corr btw DWTIN and DNYN(+1)</td>
<td>0.21</td>
</tr>
<tr>
<td>Corr btw DWTIP and DNYP(+2)</td>
<td>0.01</td>
<td>-0.05</td>
<td>Corr btw DWTIN and DNYN(+2)</td>
<td>-0.03</td>
</tr>
<tr>
<td>Corr btw DWTIP and DNYP(+3)</td>
<td>0.24</td>
<td>0.25</td>
<td>Corr btw DWTIN and DNYN(+3)</td>
<td>0.40</td>
</tr>
<tr>
<td>Corr btw DWTIP and DNYP(+4)</td>
<td>0.45</td>
<td>0.74</td>
<td>Corr btw DWTIN and DNYN(+4)</td>
<td>0.13</td>
</tr>
<tr>
<td>Corr btw DWTIP and DNYP(+5)</td>
<td>0.43</td>
<td>0.54</td>
<td>Corr btw DWTIN and DNYN(+5)</td>
<td>0.19</td>
</tr>
</tbody>
</table>
Models & Methods
Models to forecast fuel prices

- **Benchmark Model**: symmetric price transmission from crude oil to fuel prices *(no R&F)*
  - (Symmetric) Error Correction Model (ECM)

- **Asymmetric Models**: APT from crude oil to fuel prices *(R&F)*
  - Asymmetric ECM (A-ECM): long & short-run asymmetries
  - SR-A-ECM: only short-run asymmetries
  - LR-A-ECM: only long-run asymmetries
  - Threshold AutoRegressive (TAR) ECM (TAR1): with 1-lag of oil price changes as threshold
  - TAR-ECM (TAR2): with average of most recent lags as threshold

- **Notes**:
  - ECM is nested in asymmetric specifications: restrictions on the parameters of the asymmetric models deliver the ECM
  - Model selection (i.e. no. of lags) is repeated each time a new forecast is issued
  - 45% of sample for (moving window) estimation, 55% for OOS evaluation
Models & Methods
Evaluation of forecasts

• **Accuracy of point forecasts** (of gasoline price changes):
  - Mean Squared Forecast Error (MSFE)

• **Directional accuracy** (ability to predict the sign of price changes):
  - Mean Forecast Trading Returns (MFTR): returns an investor obtains by using a model
  - Success Ratio (SR): % of forecasts with correct sign

• **Accuracy of probability forecasts** (ability to predict the probability of movements):
  - Quadratic Probability Score (QPS): same as MSFE, but for probability forecasts

• **Forecast encompassing test** (only for point and probability forecasts; Carriero & Giacomini, 2011, *JEct*):
  - Aim: test whether param. restrictions are useful OOS (i.e. ECM nested in asym. models)
  - **Global test**: usefulness of R&F forecasts over the entire evaluation sample
  - **Local test**: time-varying usefulness of forecasts from asymmetric models

• **Notes**: 
  - Accurate models deliver low MSFE and QPS and high MFTR and SR
  - (Prob. forecasts obtained by plugging (de-GARCHed) point forecasts in Normal CDF
Models & Methods

The forecast encompassing test

- (Restricted) Symmetric Forecast \((f_{ECM})\): ECM
- (Unrestricted) Asymmetric Forecast \((f_{R&F})\): asymmetric ECMs & TARs
- Combined forecast \((f_C)\): a weighted average of \(f_{R&F}\) and \(f_{ECM}\)
  \[ f_C = \lambda f_{ECM} + (1-\lambda) f_{R&F} \]
  - If \(\lambda = 1\), then \(f_C = f_{ECM}\): R&F are useless to forecast the price of gasoline
  - If \(\lambda = 0\), then \(f_C = f_{R&F}\): R&F are useful to forecast the price of gasoline
  - If \(0 < \lambda < 1\) R&F partially useful: forecast combination better than single \(f_{R&F}\) or \(f_{ECM}\)

- Global test: if \(H_0: \lambda = 1\) is rejected and \(H_0: \lambda = 0\) is not rejected, asymmetries increase forecast accuracy: R&F useful (on the entire evaluation sample)
- Local test: test whether the usefulness of R&F is constant through time or time-varying: \(\lambda_t\) is estimated over a moving window of observations

- Note: \(\lambda\) estimated (OLS or NLS) by regressing actual price changes on \(f_{ECM}\) and \(f_{R&F}\)
## Results

### Point forecasts of the N.Y. gasoline price

#### Panel (a): daily data

<table>
<thead>
<tr>
<th>Model</th>
<th>MSFE</th>
<th>Δ(MSFE)</th>
<th>λ</th>
<th>H₀: λ = 0</th>
<th>H₀: λ = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECM</td>
<td>4.89</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>A-ECM</td>
<td>4.92</td>
<td>0.56</td>
<td>1.48</td>
<td>2.249**</td>
<td>0.724</td>
</tr>
<tr>
<td>SR-A-ECM</td>
<td>4.92</td>
<td>0.44</td>
<td>1.84</td>
<td>2.178**</td>
<td>0.996</td>
</tr>
<tr>
<td>LR-A-ECM</td>
<td>4.90</td>
<td>0.20</td>
<td>1.35</td>
<td>1.612</td>
<td>0.417</td>
</tr>
<tr>
<td>TAR1</td>
<td>4.98</td>
<td>1.75</td>
<td>1.46</td>
<td>3.186***</td>
<td>0.997</td>
</tr>
<tr>
<td>TAR2</td>
<td>5.00</td>
<td>2.24</td>
<td>1.42</td>
<td>2.910***</td>
<td>0.862</td>
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</table>

#### Panel (b): weekly data

<table>
<thead>
<tr>
<th>Model</th>
<th>MSFE</th>
<th>Δ(MSFE)</th>
<th>λ</th>
<th>H₀: λ = 0</th>
<th>H₀: λ = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECM</td>
<td>15.07</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>A-ECM</td>
<td>15.12</td>
<td>0.29</td>
<td>0.59</td>
<td>1.260</td>
<td>-0.885</td>
</tr>
<tr>
<td>SR-A-ECM</td>
<td>15.05</td>
<td>-0.18</td>
<td>0.44</td>
<td>0.813</td>
<td>-1.050</td>
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<tr>
<td>LR-A-ECM</td>
<td>15.16</td>
<td>0.57</td>
<td>1.62</td>
<td>2.003**</td>
<td>0.770</td>
</tr>
<tr>
<td>TAR1</td>
<td>15.43</td>
<td>2.40</td>
<td>1.00</td>
<td>2.905***</td>
<td>0.007</td>
</tr>
<tr>
<td>TAR2</td>
<td>15.55</td>
<td>3.15</td>
<td>0.99</td>
<td>3.190***</td>
<td>-0.032</td>
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</table>

#### Panel (c): monthly data

<table>
<thead>
<tr>
<th>Model</th>
<th>MSFE</th>
<th>Δ(MSFE)</th>
<th>λ</th>
<th>H₀: λ = 0</th>
<th>H₀: λ = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECM</td>
<td>35.18</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>A-ECM</td>
<td>33.71</td>
<td>-4.15</td>
<td>0.17</td>
<td>0.687</td>
<td>-3.443***</td>
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<tr>
<td>SR-A-ECM</td>
<td>33.62</td>
<td>-4.42</td>
<td>0.14</td>
<td>0.619</td>
<td>-3.839***</td>
</tr>
<tr>
<td>LR-A-ECM</td>
<td>35.64</td>
<td>1.31</td>
<td>1.59</td>
<td>1.457</td>
<td>0.540</td>
</tr>
<tr>
<td>TAR1</td>
<td>38.38</td>
<td>9.10</td>
<td>0.92</td>
<td>3.959***</td>
<td>-0.330</td>
</tr>
<tr>
<td>TAR2</td>
<td>44.90</td>
<td>27.64</td>
<td>0.89</td>
<td>9.376***</td>
<td>-1.195</td>
</tr>
</tbody>
</table>
Results
Point forecasts of the N.Y. gasoline price: $\lambda_t$ and A-ECM

ECM VS A-ECM (monthly data): local usefulness of R&F

- Estimates of $\lambda_t$ closer to 1 than to 0 until mid 2004
- both 0 and 1 in 95%CI (i.e. test is inconclusive)
- **R&F useless**: optimal forecast combination assigns weight = 1 to $f_{ECM}$
Results
Point forecasts of the N.Y. gasoline price: $\lambda_t$ and A-ECM

- Estimates of $\lambda_t$ close 0 after the burst of the oil price bubble in 2008
- 0 in 95% CI, 1 outside 95% CI
- **R&F useful**: optimal forecast combination assigns weight = 1 to $f_{A-ECM}$
Results

Point forecasts of the N.Y. gasoline price: $\lambda_t$ and TAR-ECM

ECM VS TAR2 (monthly data): local usefulness of R&F

- Estimates of $\lambda_t$ close to 1
- 1 always in 95% CI, 0 outside
- **R&F useless**: optimal forecast combination assigns weights = 1 to $f_{ECM}$
# Results

Sign forecasts of the N.Y. gasoline price

## Panel (a): daily data

<table>
<thead>
<tr>
<th>Model</th>
<th>MFTR</th>
<th>Δ(MFTR)</th>
<th>SR</th>
<th>Δ(SR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECM</td>
<td>1.512</td>
<td>-</td>
<td>76.896</td>
<td>-</td>
</tr>
<tr>
<td>A-ECM</td>
<td>1.514</td>
<td>0.148</td>
<td>77.059</td>
<td>0.211</td>
</tr>
<tr>
<td>SR-A-ECM</td>
<td>1.517</td>
<td>0.308</td>
<td>77.004</td>
<td>0.141</td>
</tr>
<tr>
<td>LR-A-ECM</td>
<td>1.516</td>
<td>0.231</td>
<td>77.221</td>
<td>0.423</td>
</tr>
<tr>
<td>TAR1</td>
<td>1.488</td>
<td>-1.609</td>
<td>76.327</td>
<td>-0.740</td>
</tr>
<tr>
<td>TAR2</td>
<td>1.508</td>
<td>-0.250</td>
<td>76.490</td>
<td>-0.528</td>
</tr>
</tbody>
</table>

## Panel (b): weekly data

<table>
<thead>
<tr>
<th>Model</th>
<th>ECM</th>
<th>Δ(MFTR)</th>
<th>SR</th>
<th>Δ(SR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECM</td>
<td>2.926</td>
<td>-</td>
<td>76.893</td>
<td>-</td>
</tr>
<tr>
<td>A-ECM</td>
<td>2.868</td>
<td>-1.989</td>
<td>76.240</td>
<td>-0.849</td>
</tr>
<tr>
<td>SR-A-ECM</td>
<td>2.910</td>
<td>-0.526</td>
<td>77.154</td>
<td>0.340</td>
</tr>
<tr>
<td>LR-A-ECM</td>
<td>2.886</td>
<td>-1.362</td>
<td>77.024</td>
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</tr>
<tr>
<td>TAR1</td>
<td>2.901</td>
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<tr>
<td>TAR2</td>
<td>2.913</td>
<td>-0.437</td>
<td>76.762</td>
<td>-0.170</td>
</tr>
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</table>

## Panel (c): monthly data

<table>
<thead>
<tr>
<th>Model</th>
<th>ECM</th>
<th>Δ(MFTR)</th>
<th>SR</th>
<th>Δ(SR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECM</td>
<td>7.376</td>
<td>-</td>
<td>81.818</td>
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</tr>
<tr>
<td>A-ECM</td>
<td>7.487</td>
<td>1.511</td>
<td>83.523</td>
<td>2.083</td>
</tr>
<tr>
<td>SR-A-ECM</td>
<td>7.483</td>
<td>1.450</td>
<td>83.523</td>
<td>2.083</td>
</tr>
<tr>
<td>LR-A-ECM</td>
<td>7.455</td>
<td>1.071</td>
<td>82.386</td>
<td>0.694</td>
</tr>
<tr>
<td>TAR1</td>
<td>7.519</td>
<td>1.940</td>
<td>82.386</td>
<td>0.694</td>
</tr>
<tr>
<td>TAR2</td>
<td>6.914</td>
<td>-6.263</td>
<td>80.114</td>
<td>-2.083</td>
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</tbody>
</table>
## Results

### Probability forecasts of the N.Y. gasoline price

#### Accuracy of probability forecasts: NY

##### Panel (a): daily data

<table>
<thead>
<tr>
<th>Model</th>
<th>QPS</th>
<th>Δ(QPS)</th>
<th>λ</th>
<th>H₀: λ = 0</th>
<th>H₀: λ = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECM</td>
<td>0.38141</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-ECM</td>
<td>0.38097</td>
<td>-0.115</td>
<td>-0.313</td>
<td>-0.587</td>
<td>-2.463**</td>
</tr>
<tr>
<td>SR-A-ECM</td>
<td>0.38116</td>
<td>-0.065</td>
<td>-0.281</td>
<td>-0.394</td>
<td>-1.796*</td>
</tr>
<tr>
<td>LR-A-ECM</td>
<td>0.38124</td>
<td>-0.045</td>
<td>-0.088</td>
<td>-0.114</td>
<td>-1.409</td>
</tr>
<tr>
<td>TAR1</td>
<td>0.38151</td>
<td>0.028</td>
<td>0.876</td>
<td>2.656***</td>
<td>-0.377</td>
</tr>
<tr>
<td>TAR2</td>
<td>0.38303</td>
<td>0.424</td>
<td>1.415</td>
<td>4.566***</td>
<td>1.339</td>
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</tbody>
</table>

##### Panel (b): weekly data

<table>
<thead>
<tr>
<th>Model</th>
<th>QPS</th>
<th>Δ(QPS)</th>
<th>λ</th>
<th>H₀: λ = 0</th>
<th>H₀: λ = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECM</td>
<td>0.36703</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-ECM</td>
<td>0.36609</td>
<td>-0.256</td>
<td>-0.092</td>
<td>-0.159</td>
<td>-1.893*</td>
</tr>
<tr>
<td>SR-A-ECM</td>
<td>0.36578</td>
<td>-0.341</td>
<td>-0.348</td>
<td>-0.564</td>
<td>-2.182**</td>
</tr>
<tr>
<td>LR-A-ECM</td>
<td>0.36754</td>
<td>0.140</td>
<td>1.728</td>
<td>1.415</td>
<td>0.596</td>
</tr>
<tr>
<td>TAR1</td>
<td>0.36869</td>
<td>0.452</td>
<td>1.085</td>
<td>2.442**</td>
<td>0.192</td>
</tr>
<tr>
<td>TAR2</td>
<td>0.36559</td>
<td>-0.392</td>
<td>0.221</td>
<td>0.622</td>
<td>-2.191**</td>
</tr>
</tbody>
</table>

##### Panel (c): monthly data

<table>
<thead>
<tr>
<th>Model</th>
<th>QPS</th>
<th>Δ(QPS)</th>
<th>λ</th>
<th>H₀: λ = 0</th>
<th>H₀: λ = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECM</td>
<td>0.29534</td>
<td>-</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>A-ECM</td>
<td>0.28984</td>
<td>-1.861</td>
<td>-1.026</td>
<td>-1.442</td>
<td>-2.847***</td>
</tr>
<tr>
<td>SR-A-ECM</td>
<td>0.28939</td>
<td>-2.014</td>
<td>-1.217</td>
<td>-1.681*</td>
<td>-3.061***</td>
</tr>
<tr>
<td>LR-A-ECM</td>
<td>0.29652</td>
<td>0.400</td>
<td>2.370</td>
<td>1.173</td>
<td>0.678</td>
</tr>
<tr>
<td>TAR1</td>
<td>0.29697</td>
<td>0.553</td>
<td>0.806</td>
<td>1.382</td>
<td>-0.334</td>
</tr>
<tr>
<td>TAR2</td>
<td>0.32316</td>
<td>9.423</td>
<td>1.421</td>
<td>3.302***</td>
<td>0.979</td>
</tr>
</tbody>
</table>
Results
Probability forecasts of the N.Y. gasoline price: $\lambda_t$ and A-ECM

- Estimates of $\lambda_t$ closer to 0 than to 1 until mid 2009
- 0 in 95%CI and 1 outside 95%CI
- **R&F useful**: optimal combination of Prob. forecasts = A-ECM
Results
Probability forecasts of the N.Y. gasoline price: $\lambda_t$ and A-ECM

ECM VS A-ECM (monthly data): local usefulness of R&F

- Estimates of $\lambda_t$ closer to 1 than to 0
- **R&F useless**: optimal combination of Prob. for. = ECM
## Results

### Summary of results

#### Panel (a): Point Forecasts (MSFE reductions due to R&F)

<table>
<thead>
<tr>
<th></th>
<th>Spot</th>
<th></th>
<th></th>
<th>Retail</th>
<th></th>
<th></th>
<th>Spot &amp; Retail</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#</td>
<td>%</td>
<td></td>
<td>#</td>
<td>%</td>
<td></td>
<td>#</td>
<td>%</td>
</tr>
<tr>
<td>Daily</td>
<td>2 / 18</td>
<td>11,1</td>
<td></td>
<td>- / -</td>
<td>-</td>
<td></td>
<td>- / -</td>
<td>-</td>
</tr>
<tr>
<td>Weekly</td>
<td>2 / 18</td>
<td>11,1</td>
<td>4 / 12</td>
<td>33,3</td>
<td>6 / 30</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly</td>
<td>6 / 18</td>
<td>33,3</td>
<td>1 / 12</td>
<td>8,3</td>
<td>7 / 30</td>
<td>23,3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>10 / 54</td>
<td>18,5</td>
<td>5 / 24</td>
<td>20,8</td>
<td>13 / 78</td>
<td>16,7</td>
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</table>

#### Panel (b): Directional Accuracy (SR increases due to R&F)

<table>
<thead>
<tr>
<th></th>
<th>Spot</th>
<th></th>
<th></th>
<th>Retail</th>
<th></th>
<th></th>
<th>Spot &amp; Retail</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#</td>
<td>%</td>
<td></td>
<td>#</td>
<td>%</td>
<td></td>
<td>#</td>
<td>%</td>
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<tr>
<td>Daily</td>
<td>13 / 18</td>
<td>72,2</td>
<td></td>
<td>- / -</td>
<td>-</td>
<td></td>
<td>- / -</td>
<td>-</td>
</tr>
<tr>
<td>Weekly</td>
<td>9 / 18</td>
<td>50</td>
<td>9 / 12</td>
<td>75</td>
<td>18 / 30</td>
<td>60</td>
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</tr>
<tr>
<td>Monthly</td>
<td>13 / 18</td>
<td>72,2</td>
<td>9 / 12</td>
<td>75</td>
<td>22 / 30</td>
<td>73,3</td>
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</tr>
<tr>
<td>Total</td>
<td>35 / 54</td>
<td>64,8</td>
<td>18 / 24</td>
<td>75</td>
<td>40 / 78</td>
<td>51,3</td>
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</table>

#### Panel (c): Probability Forecasts (QPS reductions due to R&F)

<table>
<thead>
<tr>
<th></th>
<th>Spot</th>
<th></th>
<th></th>
<th>Retail</th>
<th></th>
<th></th>
<th>Spot &amp; Retail</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#</td>
<td>%</td>
<td></td>
<td>#</td>
<td>%</td>
<td></td>
<td>#</td>
<td>%</td>
</tr>
<tr>
<td>Daily</td>
<td>9 / 18</td>
<td>50</td>
<td></td>
<td>- / -</td>
<td>-</td>
<td></td>
<td>- / -</td>
<td>-</td>
</tr>
<tr>
<td>Weekly</td>
<td>7 / 18</td>
<td>38,9</td>
<td>4 / 12</td>
<td>33,3</td>
<td>11 / 30</td>
<td>36,7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly</td>
<td>10 / 18</td>
<td>55,6</td>
<td>6 / 12</td>
<td>50</td>
<td>16 / 30</td>
<td>53,3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>26 / 54</td>
<td>48,1</td>
<td>10 / 24</td>
<td>41,7</td>
<td>27 / 78</td>
<td>34,6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusions
Should we care about R&F eventually?

- **Point Forecasts**: R&F generally useless
- **Directional Accuracy**: R&F generally useful
- **Probability Forecasts**:
  - R&F useful at daily and monthly frequencies for spot prices and at monthly frequency for retail prices
  - Median $\lambda$ close to 0.5: combination of the symmetric ECM and asymmetric models might improve probability forecasts
- **Time Dimension**: for all frequencies and prices the relative usefulness of predicting with symmetric (no R&F) and asymmetric (R&F) models is time-varying
Fast-ups and Slow-downs in European Gasoline Markets: A Tale of Two Speeds

by

Andrea Bastianin, University of Milan, Italy and FEEM
Marzio Galeotti, University of Milan, Italy and IEFE, Bocconi
Matteo Manera, University of Milan-Bicocca and FEEM
Further Developments

• Empirical papers in the R&F literature apply (many variants of) A-ECM

• Asymmetric responses of gasoline prices to movements in oil prices are just one side of the coin

• The other side of the coin involves *duration dependence* and, more generally, the *definition and dating of fast-ups and slow-downs*
Further Developments

Duration dependence

• Are fast-ups and slow-downs more likely to end as they become older (i.e. positive duration dependence)?

• Is it possible to explain the length and the amplitude of fast-ups and slow-downs? Is R&F a *tale* of two speeds?

• Which covariate (e.g. oil, macro, speculation, survey expectations) can explain the hazard rate of fast-ups and slow-downs?
Further Developments

Defining and dating fast-ups and slow-downs

- Definition of phases and turning points (refer to the vast literature on forecasting and dating business cycle turning points)
- Dating algorithms
- Explanatory variables
Some dating algorithms

- **Bry-Boschan dating algorithm**
  - Non-parametric algorithm that selects local extrema, given a set of thresholds (i.e. min duration and amplitude of cycles)

- **Barrier algorithm (Lunde & Timmerman, 2005)**
  - This algorithm looks at “completion time structures”, i.e. the time distance (duration) between price movements of a given magnitude. How long does it take for the price of gasoline to go up or down by a given amount?

- **Signed gasoline returns**
  - Use the indicator \( d = \mathbb{I}(\text{gasreturns}>0) \) to identify fast-ups and slow-downs and calculate durations