Use of JODI Data in Energy Modeling

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Outline

• An overview of energy models
• Importance of data
  – JODI oil
  – JODI gas
• Outlook and expectations
An overview of energy models
Principal dimensions of energy modeling

• **Quantitative methods:** the future is projected as some mathematical / statistical functions of historical data

• **Qualitative techniques:** based on expert judgment

• **Short-Term forecasts:** projections for the following 1-2 years
  - Quarters and months are required
  - Functions of data most times not-linear; data include seasonal and trend components

• **Medium/Long-Term forecasts:** for the upcoming 5/20-30 years
  - Basically long-term trend-related yearly projections
Quantitative methods

• General pros and cons
  – Stationary time series are required for applied models; for most of the cases this requirement is not given. Usage of transformed time series but this is also a challenge
  – Theoretical background is often not existing, especially when fitting complex functions on historical data (Over fitting)
  – If successfully fit, they could enhance forecasting (accuracy, statistically sound confidence intervals, simulations,...)
  – Objectiveness

• 3 main categories of quantitative approaches
  – Time series
  – Econometric models
  – Equilibrium models
Quantitative methods

- **Time series methods**
  - Moving averages
  - Seasonality and trend filters
  - Smoothing techniques
  - AR(I)MA models
  - Extrapolation
  - Any other method that would fit the underlying oil-related process

- **Econometric models**
  - Regression (parametric and non-parametric)
  - ARMAX models

- **Equilibrium models**
  - Supply/demand and prices as part of an overall/partial equilibrium
  - For Medium/Long-Term forecasts
Quantitative methods – additional concepts

- Inclusion of forecasting accuracy procedures
  - Confidence intervals
  - Simulations
- Applications of other methods
  - Artificial intelligence
  - Data mining and pattern recognition techniques
  - Probabilistic forecasting
Qualitative techniques

- Delphi method
  - Relies on expert panels. Combined and collective knowledge as the basis for forecasts
  - Useful in cases where quantitative models are either too complex and/or cannot be established. Based to a large extend also on quantitative knowledge
  - Often subjective and depends on the structure of the panel used

- Forecasting by analogy
  - Modeling of variables in similar terms to other variables, which are known
  - Improved accuracy as compared to the Delphi method
  - Analogies sometimes unknown
Qualitative techniques

- Technology forecasting
  - Assumption of technological characteristics as the base for forecasts
  - Combined forecasts – extrapolation and growth curves
  - Useful tool when combined with other methods

- Scenario building
  - Analysis of possible future events under consideration of alternative outcomes
  - Usually optimistic and pessimistic scenarios
  - Development paths become observable; valuable information
Importance of JODI oil data
Important JODI oil flows

• Demand
  - Demand forecasts are based on consumption data subject to a certain time lag, among other factors – the accuracy of the base year is essential in estimating the year ahead

• Non-OPEC supply
  - Non-OPEC supply forecast is based on a bottom-up approach, adding growth projections to an existing baseline – the base is essential in estimating the year ahead

• OPEC production
  - Added to non-OPEC supply, global supply indicates the status of the market (loose vs. tight) when compared to total world oil demand

• Global stocks
  - Oil inventories should reflect interaction between supply and demand forces – the global picture of stocks is the ultimate tool for checking supply and demand numbers
Advantages of using JODI oil data

- **Demand**
  - Around 83% of total demand is covered in JODI data base, including some of the new consuming countries

- **Crude oil production**
  - Large coverage, about 92% of total crude oil production is covered in JODI data base

- **Inventories**
  - In addition to the OECD, a few non-OECD countries are also covered

- **JODI data - official & direct information**
Advantages of using JODI oil data

- **Refinery**
  - Around 86% of total refinery intake and output are covered in JODI database

- **Trade**
  - Large coverage, about 88% of total oil exports and imports are covered in JODI database

- **Time lag**
  - Improvement in time lag, two months for many countries
Advantages of using JODI oil data

OPEC production: difference between average SS and (JODI)

- Diff. between JODI and S.S (kb/d) (LHS)
- Diff. between JODI and S.S (%) (RHS)

Countries: Algeria, Angola, Ecuador, Iraq, Kuwait, Libya, Qatar, Saudi Arabia
Shortcomings of JODI oil data

- World oil demand
  - Lack of data for the main consuming countries (China, Russia, Singapore, UAE...)
  - Considerable revisions in reporting organizations/agencies using JODI oil data
  - Large discrepancy among reporting organizations/agencies using JODI oil data, even for countries for which data is available in JODI (Indonesia, Thailand, Malaysia,...)
Shortcomings of JODI oil data

World oil demand, \( mb/d \)

2013 revisions in reporting agencies using JODI oil data

Discrepancies in reporting agencies using JODI oil data

World oil demand, \( mb/d \)

OPEC

EIA

IEA

11th Regional JODI Training Workshop, 23-25 March 2015, Vienna, Austria
Shortcomings of JODI oil data

- Global supply
  - Total crude production
    - Insufficient coverage provides a poor base in estimating the period ahead (1.0% missing ~ 0.7 mb/d)
    - Revisions in historical data by organizations/agencies
    - Discrepancy among various sources
  - OPEC production
    - Large variation in OPEC crude production among sources
Shortcomings of JODI oil data

Non-OPEC supply, \( mb/d \)

2013 revisions in reporting agencies using JODI oil data

Discrepancies in reporting agencies using JODI oil data

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OPEC 54,2
EIA 54,1
IEA 54,6
Shortcomings of JODI oil data

OPEC production: August 2014

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A Concrete Outcome of the Consumer - Producer Dialogue
Shortcomings of JODI oil data

- **Inventories**
  - Lack of major non-OECD countries’ data (China, Russia)
  - Inaccuracy of some non-OECD data (South Africa)

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<th>Stock level (mb)</th>
<th>3Q13</th>
<th>4Q13</th>
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<td></td>
<td>15</td>
<td>166</td>
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<td>Days of cover</td>
<td>25</td>
<td>277</td>
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</table>

- Discrepancy between global stock changes and balance (Supply - Demand)
Shortcomings of JODI oil data

- **Inventories**
  - Total oil stocks and supply/demand balance are interrelated through the following equation:
    - Change in total stocks = supply – demand
  - The global picture of stocks is the ultimate tool for checking the supply and demand numbers. However, the lack/inaccuracy of stocks data makes this difficult

![Stocks change & miscellaneous, mb/d](image1)

![Stocks change & miscellaneous vs. OECD stocks change, mb/d](image2)
Importance of JODI gas data
Why collect natural gas data

• Provide timely data on major flows, which are relevant to market
  – Production
  – Consumption
  – Storage
• Natural gas consumed to a large extent by households (~ 1/3)
• Seasonality in natural gas demand
• Natural gas demand weather dependent
• Swings in natural gas production
• Importance of natural gas storage as demand cannot absorb produced volumes throughout the year
• Natural gas as substitute for oil (fuel oil, gas/diesel oil)
  – US, Japan, India
Importance of natural gas data

- Natural gas importance to increase in future world energy demand mix

Source: OPEC World Oil Outlook 2014
Importance of natural gas data

- Increasing trade worldwide

Source: BP
Importance of natural gas data

- Natural gas trade movements in Europe

Source: Cedigaz
Relevance of natural gas data to oil market

- Energy markets inter-related
- Competitions between energy markets, i.e. oil, natural gas, coal and other tighter
- Petroleum products from gas plants
  - LPG
  - Gasoline
  - Naphtha
  - Gas diesel oil
- Gas to liquids plants
- Oil supply/demand balance being increasingly influenced by other primary commodities, most importantly gas
Relevance of natural gas data to oil market

- US shale gas production

![Graph showing US shale gas production from 2007 to 2011. The y-axis represents billion cubic feet, and the x-axis represents the years 2007 to 2011. The graph shows a significant increase in production from 2007 to 2011.](source:EIA/DOE)
Relevance of natural gas data to oil market

- Fuel substitution: Electricity generating fuels in Japan

### March 2010 to March 2011

- Oil: 25%
- Nat. Gas: 29%
- Nuclear: 8%
- Coal: 10%
- Other: 29%

### Current

- Oil: 27%
- Nat. Gas: 20%
- Nuclear: 11%
- Coal: 42%
- Other: 20%
Relevance of natural gas data to oil market

- Chinese energy demand mix

<table>
<thead>
<tr>
<th>Year</th>
<th>Coal</th>
<th>Oil</th>
<th>NG</th>
<th>Total</th>
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<tr>
<td>2000</td>
<td>13.4</td>
<td>4.7</td>
<td>0.4</td>
<td>19.6</td>
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<tr>
<td>2013</td>
<td>40.3</td>
<td>10.1</td>
<td>2.3</td>
<td>56.7</td>
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</tbody>
</table>

Change: 201% 115% 427% 174%

Energy Mix: 71% 18% 9%
Outlook and expectations
Oil data

- Improvements in JODI data to promote usage
  - More effort needed to report on some missing countries
  - Cross check data before updating data base
  - Consistency in reporting different time-series

- Reporting organizations/agencies need to use official JODI data
- Avoid estimation of the reporting sources using JODI data
- Reduce discrepancies between the reporting sources (0.5% ~ 0.5 mb/d)
**Gas data**

- Natural gas is projected to gain further importance in the world’s energy mix
- Oil and natural gas are becoming increasingly dependent over time – trend is expected to continue in the future
- Timely natural gas data - an advantage to almost all energy related research
- Strong seasonality in natural gas usage implies necessity in collecting monthly data - notably the main flows, production, demand and storage
Thank you

For more information at www.jodidata.org