MARGINAL COST CURVES FOR CONVENTIONAL AND UNCONVENTIONAL NATURAL GAS PRODUCTION

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IAEE Annual Conference, New York, 16 June 2014
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• Some preliminary results
• Conclusions
Rationale

1. Structural shifts in the natural gas industry:
   1. Deregulation and liberalization
   2. Technological innovation (shale gas)
   3. Globalization of trade
   4. Emergence of new ‘consumption centres’

2. Emergence of quantitative gas market modelling research to assess the impact of these shifts on trade, welfare etc.

3. Reliance on data inputs, particularly
   - Production cost, or marginal cost of gas production

4. Publically data on marginal production costs is fragmented and inconsistent, often outdated

5. The quality of data inputs is very important - -> ‘Rubbish in Rubbish out’
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Estimating marginal cost of production

• 3 Steps:
  1. Resource estimation
  2. Production rate analysis
  3. Gas production cost components & cash flow analysis
1. Resource Estimation:
   - Available methods (based on stages of gas production):
     • Volumetric Method
     • Production Decline Curve Analysis
     • Material Balance
     • Well-testing/Pressure Transient Analysis and Rate Transient Analysis
   - Volumetric method is only applicable for our case to assess hydrocarbons in place prior to acquiring sufficient pressure and other production-related information
   - Application of all other methods are more appropriate in situation of an already producing well

2. Undiscovered gas resources for majority of production regions are available from USGS and other sources
Estimating marginal cost of production

2. Production rate analysis:
   - Available methods:
     • Theoretical (Darcy's law describing the flow of a fluid through a porous medium)
     • Empirical (DCA, material balance method, and pressure and rate transient analysis)
Estimating marginal cost of production

Production estimation Methodology – Theoretical method:

Data required:

- Initial reserves available for extraction (see step 1)
- Cross-sectional area of flow of gas (e.g., pipeline) – standardised
- Depth of a reservoir - - > relatively easy to find
- Intrinsic permeability of medium in the well -- > some dataset available showing the relationship between different source rocks and their permeability (see e.g., Utah Geological Survey 2012)
- Initial bottom-well pressure - - > some dataset available showing relationship between depth and BHP (see e.g., EIA, 1994; 1997)
- Temperature of the bottom-well - - > some dataset available showing relationship between depth and BHP (see e.g., EIA, 1994; 1997)
Estimating marginal cost of production

Sample Model Output: Production decline curve from a well
Estimating marginal cost of production

Production estimation Methodology – Empirical method (DCA):

Data required:

• Initial production rate - -> empirical estimation (e.g., correlation between depth of a reservoir and its initial production rate)

• Initial decline rate - -> empirical estimation (e.g., correlation between depth of a reservoir and its initial decline rate)

• ‘Arps b’ – for conventional gas this is more or less established parameter (sensitivity could also be performed); for shale gas there are reported data from major US shale gas producers by shale plays
Gas production cost components & cash flow analysis

1. Identify cost components (well configuration, depth-based costs, drilling costs, processing costs, etc.) for well development and gas extraction

2. Identify individual parameters and approximate figures for each of the cost components identified (Eg. cost per well, average well length etc.)

3. Develop the gas production profile of the wells using the daily production data derived from the decline curve analysis

4. Perform cash flow analysis from the production profile and the cost components obtained earlier

5. Compute OPEX and plot the marginal cost curve using the above computed data
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Marginal cost curve for Bowland Shale gas (UK)

- Bowland Shale play is said to be similar to the Barnett shale play (BGS)
- Using publically available data:
  - distribution of per-well initial production rates for the Barnett shale play
  - Completion and O&M costs for a shale well for Europe (see e.g., EC JRC report)
- Carry out calculations based on empirical approach to determine production rates as described above (previous slides)

Note: preliminary analysis; quote at your own risk
Conclusions

- Differences between shale gas and conventional gas
  - Permeability: measure of a reservoir’s capacity to transmit fluids
  - Difference in costs: for the same commercial production rate more wells have to be drilled for shale gas than for conventional gas

- The choice between theoretical and empirical approaches to analyse production rates depends on available data:
  - Empirical approach requires less data

- As for shale gas resource estimation, the US is the only country with enormous shale gas production experience and information. Therefore, examining the UK and Europe shale gas production potential could only be carried out based on geological analogy (similarities in key petrophysical characteristics)

- Since very limited information is available for estimation of shale gas in the UK, we should incorporate uncertainty in the analysis
References

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- EIA, 1997, “Oil and Gas Resources of the West Siberian Basin, Russia”