Climate change policy and its effect on market power in the gas market

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EPRG Spring Research Seminar

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http://www.electricitypolicy.org.uk
Electricity prices

- Electricity spot prices have moved sharply up
  – EU baseload prices €35 => €70+/MWh 12/04-3/05
- so have gas prices
  – UK gas prices from < €15=>50/MWh mid-end 05
  – UK yr-ahd pk el €50=>90+/MWh 12/04-7/05
- and EUAs are now reflected in prices
  – wholly unsurprising to economists if not lawyers
- Value of EUAs = €60 billion at €20/EUA
Source: Platts; DTI

Start of ETS

Futures Dec 2007
Futures Dec 2006
OTC Index
Monthly averages by half-hour for November UKPX

Source: UKPX
cost and prices in British electricity market

Source: Platts and UKPX

- Monthly ahead gas cost
- Gas+EU4A cost
- Weekly average baseload price
Weekly average baseload spot prices 2004-5

Source: Platts, UKPX, EEX, zfk

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Euros/MWh


UK gas cost + EUA

UK

FR

DE

NL

cost coal + EUAs

140

120

100

80

60

40

20

0
Spark spread net of EUA

Source: Platts
30-Day Moving Average Clean Spark and Dark Spreads: NL, DE

Source: Platts
Forward base year contracts - France and Germany Aug 2005-May 2006
Forward 2007 annual prices - France and Germany 2006

- FR peak less gas EUA
- DE peak less gas EUA
- FR base less gas EUA
- DE base less gas EUA
- coal EUA cost
- EUA cost in CCGT
Fuel used in electricity generation by major producers

Source: DTI
Load profile Tues 4 October 2006

Electricity Supply Build-Up

GWh per day

0 5 10 15 20 25 30

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47

NUCLEAR  FRENCH I/C  RENEWABLES  GAS  COAL  OIL  PUMPED STORAGE  OCGT
Load profile Tues 29 November 2006

Electricity Supply Build-Up

- NUCLEAR
- FRENCH I/C
- RENEWABLES
- GAS
- COAL
- OIL
- PUMPED STORAGE
- OCGT

GWh per day

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Load profile Tues 6 December 2006

Electricity Supply Build-Up

GWh per day

NUCLEAR
FRENCH I/C
RENEWABLES
GAS
COAL
OIL
PUMPED STORAGE
OCGT
Weekday moving 24 hr av coal and gas generation Britain 1 Oct-9 Dec 05

GWh/24 hours


gas output
coal output
Impact of ETS on gas pricing

• Suppose gas price increases
  – initially: demand falls (fuel switch gas => coal)
  – demand for EUAs rises => EUA price ↑
  => partially offsets advantage of coal
  => reduces demand reduction for gas
  => reduces elasticity of demand for gas
  => increases market power of gas suppliers
  • Gazprom, and suppliers with protected markets
Demand for gas

Demand for gas if EUA price constant

Demand for gas if EUA price varies

EUA price rise induces some switch back to gas

Price rise

Initial demand fall (gas-coal)

Demand for gas in ESI

Price of Gas

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Carbon link amplifies partial impact of gas price change

\[ \frac{dp}{dg} = \frac{h_g h_c e_c}{h_c e_c - h_g e_g} = h_g \left( \frac{1}{1 - h_g e_g / h_c e_c} \right) > h_g. \]

\( h_f \) = heat rate of fuel \( f \) (MWh/MWhe), \( e_f = \text{tCO}_2/\text{MWh} \), 
\( p = \) price of electricity, \( g = \) price of gas 
\( e.g \) \( h_g = 2, h_c = 2.65, e_g = 0.2, e_c = 0.34, \) multiplier = 1.8
Load duration curve and shares of generation from each fuel

\[ D(t) \]

\[ b + \mu T \]

\[ K^* + K_g \]

\[ K_1 + K_g \]

\[ b \]

\[ K_1 \]

\[ b + \mu \]

Load duration curve and shares of generation from each fuel:

- Marginal coal
- Gas output
- Coal output

\( t \) fraction of the year demand greater than...
Effect of gas price on gas demand

Let $\eta$ be elasticity of supply of EUAs to ESI

Ratio of elasticity of gas demand with ($\varepsilon^*$) and without ($\varepsilon$) ETS

$$\frac{\varepsilon^*}{\varepsilon} = \left(\frac{\eta}{\eta + \phi}\right), \quad \phi \equiv \left(\frac{K_1 \partial E}{E \partial K_1}\right) \left(-s \frac{\partial K_1}{K_1 \partial s}\right).$$

where $K_1$ is capacity of cheap coal, $E$ is total ESI emissions, $s$ is price of EUA

Note Lerner Index ($p-c)/p = 1/\varepsilon$
Table 1 Parameters for calibrating the model to Britain, 2005

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>gas heat rate</td>
<td>$h_g$</td>
<td>2</td>
</tr>
<tr>
<td>coal base heat rate</td>
<td>$h_0$</td>
<td>2.5</td>
</tr>
<tr>
<td>rate of change of HR</td>
<td>$\alpha$</td>
<td>0.025 per GW</td>
</tr>
<tr>
<td>CO$_2$ per MW gas</td>
<td>$e_g$</td>
<td>0.2 tonnes/MWh</td>
</tr>
<tr>
<td>CO$_2$ per MW coal</td>
<td>$e_c$</td>
<td>0.34 tonnes/MWh</td>
</tr>
<tr>
<td>min demand</td>
<td>$b$</td>
<td>25 GW</td>
</tr>
<tr>
<td>Slope of load duration</td>
<td>$\mu$</td>
<td>30 GW</td>
</tr>
<tr>
<td>gas capacity</td>
<td>$K_g$</td>
<td>20 GW</td>
</tr>
<tr>
<td>coal capacity</td>
<td>$K_c$</td>
<td>40 GW</td>
</tr>
<tr>
<td>Price of gas</td>
<td>$g$</td>
<td>16 €/MWh</td>
</tr>
<tr>
<td>Price of coal</td>
<td>$c$</td>
<td>6 €/MWh</td>
</tr>
<tr>
<td>EUA price</td>
<td>$s$</td>
<td>20 €/tonne CO$_2$</td>
</tr>
</tbody>
</table>

This gives a value of $\phi = 0.55$. If $\eta = 0.1$, then gas demand elasticity falls to $2/3$ and Lerner index increases by 50%.
Policy implications

- Imposing extra constraint on market reduces demand elasticities and amplifies market power.
- If the price of EUAs is independent of gas demand then there is no multiplier effect.
- There are other reasons for setting carbon price rather than quantity:

  *Prices vs Quantities* (Weitzman, 1974)
Permits vs Taxes (or constant prices)

Weitzman: Taxes superior to permits unless MB of abatement more curved than MC

CO$_2$ is a stock pollutant
  – CO$_2$ damage today effectively same as tomorrow
  => marginal benefit of abatement essentially flat
  – marginal cost of abatement rises rapidly
  – hazard of global warming very uncertain, as are the future abatement costs

*Carbon tax superior to tradable permits*

Start of ETS

Futures Dec 2007
Futures Dec 2006
OTC Index
Other estimates of C taxes

- EUA €20/t CO$_2$ = €73.3/tC
- Tax for global optimum ~ €10-220/tC
  - Karp and Zhang €8- 55/tC
- Old EU carbon tax = $5/bbl = €50/tC
- But political economy favours (and EU Directive requires) grand-fathered allocation of permits

So how to get to a fixed price from the ETS?
Stabilising the price of carbon

- banking over longer periods helps
- floors and ceilings: c.f. US NO$_x$
- NAPs continue with decreasing coverage
- CEC offers extra EUAs at fixed price
  - revenue raising, reduces budgetary problems
  - allows long-term carbon contracts
  - allows CfDs for low-carbon generators
  - basis for import tariff on embodied carbon?
Conclusion

• present ETS imposes a quantity constraint
  – this reduces demand elasticity for gas
  => enhances market power of gas producers
• fixing CO$_2$ price better than fixing quantity
  – stock pollutant whose damage insensitive to date
=> CEC fixes CO$_2$ price by selling EUAs
  – avoids enhancing market of gas producers
  – generates revenue, allows long-term CO$_2$ contracts
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