Does Non Ratification of the Kyoto Protocol by the US Increase the Likelihood of Monopolistic Behavior by Russia in the Market of Tradable Permits?

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Background: roles of Hot Air and participation of the US on the market of tradable permits

The competitive case

- without US: price close to zero
- ⇒ In the latter case, for Russia and other FSU countries, strong incentive and ability to set a monopolistic price
Curves of demand for permits and associated elasticities
(drawn from GEMINI-E3)
• Monopolistic price:
  – ~ 80 US$90 (100 US$2000) with the US
  – ~ 115 US$90 (143 US$2000) without the US

• Problem is more complex because of:
  – competition from other flexibility mechanisms, in particular CDM
  – possible trade-offs for FSU between immediate sale of permits and banking (for later uses)
  – macro-economic interactions and spill-over effects
Main issues:

• What may be the likely behavior by FSU?
• What are the consequences for other Annex B countries?
• What are the effects on the implementation of the Kyoto Protocol, and the effective abatement of carbon emissions
Plan of the presentation:

• 1. The methodology
• 2. Results of main scenarios:
  – competitive, myopic monopolistic behavior, inter-temporal monopolistic behavior
  – with and without participation of the US
• 3. Main teachings and further developments
1. The methodology

- CGE models offer a relevant framework for assessing this type of policy
- but are not well suited for inter-temporal optimization
- The approach: a mathematical program of inter-temporal optimization calibrated on a CGE model, here GEMINI-E3
1.1. Modeling monopolistic behavior: main variables

• Year to year decision variables by FSU:
  – Supply of permits
  – Carbon abatement

• Long term variables or parameters:
  – Discount rate
  – Value of residual permits at the end of the period

• Other decision variables: supply of other flexible instruments (mainly CDM)

• Macro-economic spill-over effects
  – Available Hot Air
  – Gains or losses from terms of trade
1.2. Modeling monopolistic behavior: notations

$\bar{HA}_t$ : available Hot Air
$q_t$ : emissions abatement by FSU
$d_t$ : demand for flexible instruments by other Annex B countries (incl. or not US)
$s_t$ : abatement realized through the CDM mechanism
$v_t$ : permits sold by FSU ($= d_t - s_t$)
$p_t$ : price of permits
$r_t$ : receipts from the sales of permits ($= p_t v_t$)
$c_t$ : abatement cost in FSU
$g_t$ : Gains from Terms of Trade (or change from a reference situation)
$\pi_t$ : social value of permits
$S_t$ : stock of permits of FSU available at the beginning of year $t$
$S_{T+1}$ : residual stock of permits of FSU at the end of year $T$
$p_{T+1}$ : unit value of permits at the end of year $T$
i : discount rate (supposed constant over time)
1.3. Modeling monopolistic behavior: the mathematical program

\[
\max \left[ \sum_{t=1,T} e^{-it} \left[ r_t + g_t(p_t) - c_t(q_t) \right] + e^{-i(T+1)} p_{T+1} S_{T+1} \right]
\]

under the constraints:

\[(\pi_t) \quad S_{t+1} - S_t - q_t - \overline{HA_t}(r_t) + d_t(p_t) - s_t(p_t) = 0\]

with \(S_1 = 0\)

\[(\mu_t) \quad S_t \geq 0\]

\[\left(\mu_{T+1}\right) \quad S_{T+1} \geq 0\]

\[(\theta_t) \quad q_t \geq 0\]
1.4. Modeling monopolistic behavior: myopic decision rules

• 1. Supply of permits:

\[ \pi = p \frac{1 + \eta}{1 - \zeta - \frac{1}{1 + \varepsilon}} \]

\( \varepsilon \): price elasticity of demand for permits
\( \eta \): effect of receipts from sales of permits on GTT
\( \zeta \): effect of receipts from sales of permits on Hot Air

• 2. Abatement policy

\[ \frac{\partial c}{\partial q} = \pi \]
1.4. Modeling monopolistic behavior: myopic decision rules

- Two possible regimes

- $\pi = 0$
  - : available permits in excess (transferred to later periods)
  - : zero abatement

- $\pi > 0$
  - : all available permits sold
  - : positive abatement (defined by the social value)
1.5. Modeling monopolistic behavior: inter-temporal decision rules

• 1. Same rules for supply of permits and emissions abatement

• 2. Under the condition that the residual stock of permits is always positive, the social value increases at a rate equal to the discount rate (equivalent of Hotelling law)
1.6. Modeling monopolistic behavior: calibration of the optimization program

• Method: analytical scenarios implemented with an CGE (GEMINI-E3)
• From the results: econometric adjustement of the main laws:
  – demand for permits (more precisely F. I.)
  – Emissions abatement
  – available Hot Air
  – Gains from Terms of Trade
• (all functions of the price of permits)
1.6. Modeling monopolistic behavior: calibration of the optimization program

- Examples:
  - Demand for permits (cf supra)
  - Curves of carbon price and marginal abatement cost
1.6. Modeling monopolistic behavior: calibration of the optimization program

- A special case: the potential of the CDM
- Very little available information
- Two alternative assumptions:
  - A « low » assumption: 50 mios t of C profitable at a price of 100 US$90 in 2010
  - A « high » assumption: 150 mios t of C profitable at a price of 100 US$90 in 2010
- (and 2.5% annual growth from 2010 to 2040)
2.1. Results of the optimization program: the case with participation of US

![Equilibrium Price of Permits](image-url)
2.1. Results of the optimization program: the case with participation of US

Equilibrium Price of Permits
Case of high CDM

- Competitive
- Myopic Monopol
- Inter-temporal Monopol (0 Gt in 2040)
2.2. Results of the optimization program: the case without participation of US
2.3. The case without participation of US: inter-temporal monopolistic behavior
(sensitivity of price of permits to the final stock)
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(sensitivity of price of permits to the discount rate)
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Year 2010

- param CDM = 0
- param CDM = 25
- param CDM = 50
- param CDM = 75
- param CDM = 100
- param CDM = 150
2.3. The case without participation of US: inter-temporal monopolistic behavior (sensitivity of emissions abatement to the discount rate)

![Graph showing the relationship between discount rate and emissions abatement for different CDM parameters in Year 2040. The graph includes lines for different CDM values, with the x-axis representing the discount rate and the y-axis representing the emissions abatement.]
2.4. Balance of world emissions and average cost of abatement – Case with participation of US (low potential of CDM)

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
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<tbody>
<tr>
<td>Price of permits ($90)</td>
<td>76</td>
<td>116</td>
<td>152</td>
<td>198</td>
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<tr>
<td>Abat. (Annex B)</td>
<td>597</td>
<td>808</td>
<td>1018</td>
<td>1295</td>
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<tr>
<td>Leakage</td>
<td>-56</td>
<td>-92</td>
<td>-131</td>
<td>-177</td>
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<tr>
<td>CDM</td>
<td>44</td>
<td>69</td>
<td>100</td>
<td>147</td>
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<tr>
<td>World abat. in %</td>
<td>-7.0%</td>
<td>-7.7%</td>
<td>-8.3%</td>
<td>-9.4%</td>
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<tr>
<td>World cost per t of C (in $90)</td>
<td>32</td>
<td>43</td>
<td>51</td>
<td>60</td>
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<tr>
<td>Cost per t of C for</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Annex B except FSU (in $90)</td>
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3. Main teachings and further developments

• Many long run uncertainties:
  – Future of the Kyoto Protocol
  – Technology
  – Behavior by FSU

• In the short run, main uncertainty is the potential of CDM (in particular on the market price of permits)

• Withdrawal of the US and monopolistic behavior by FSU have adverse effects on:
  – Implementation of the Kyoto Protocol
  – Cost borne by Annex B countries (other than FSU and US)

• Desirability of implementing the same approach with other CGE models (under way with model EPPA of MIT)