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

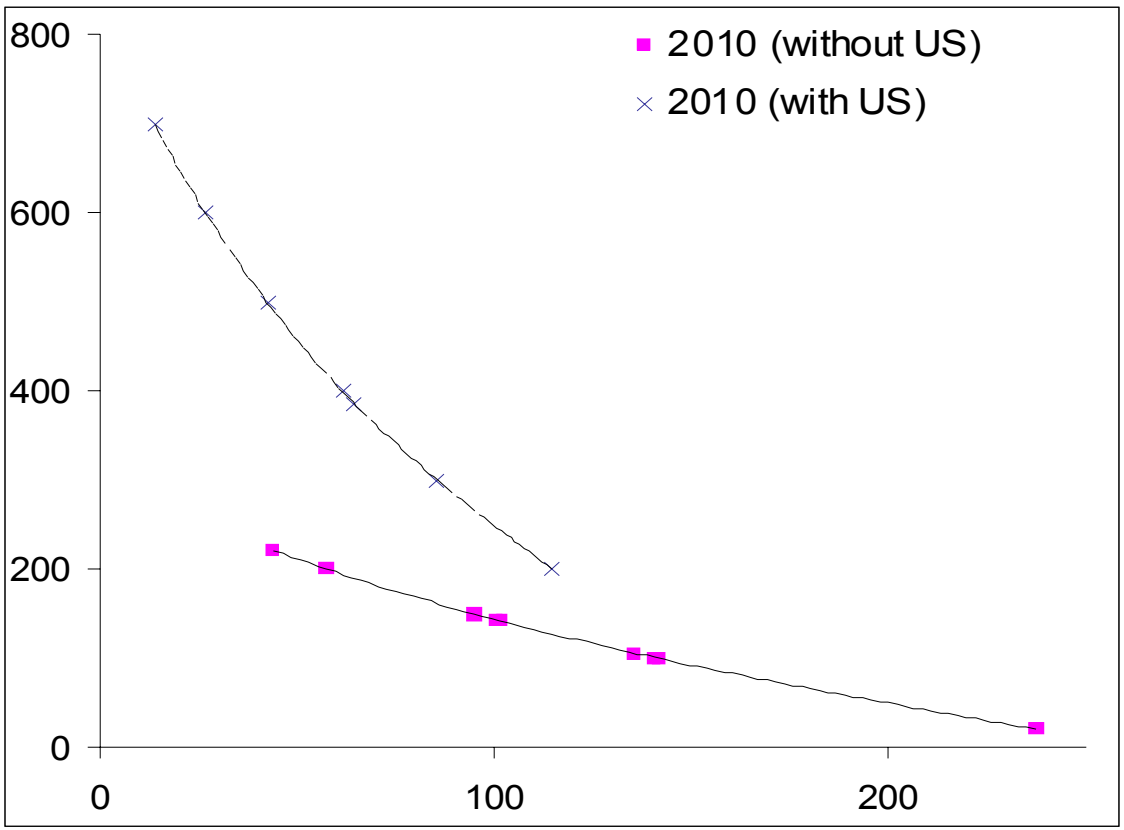
Alain L. BERNARD
Ministry of Equipment, Transportation and Housing

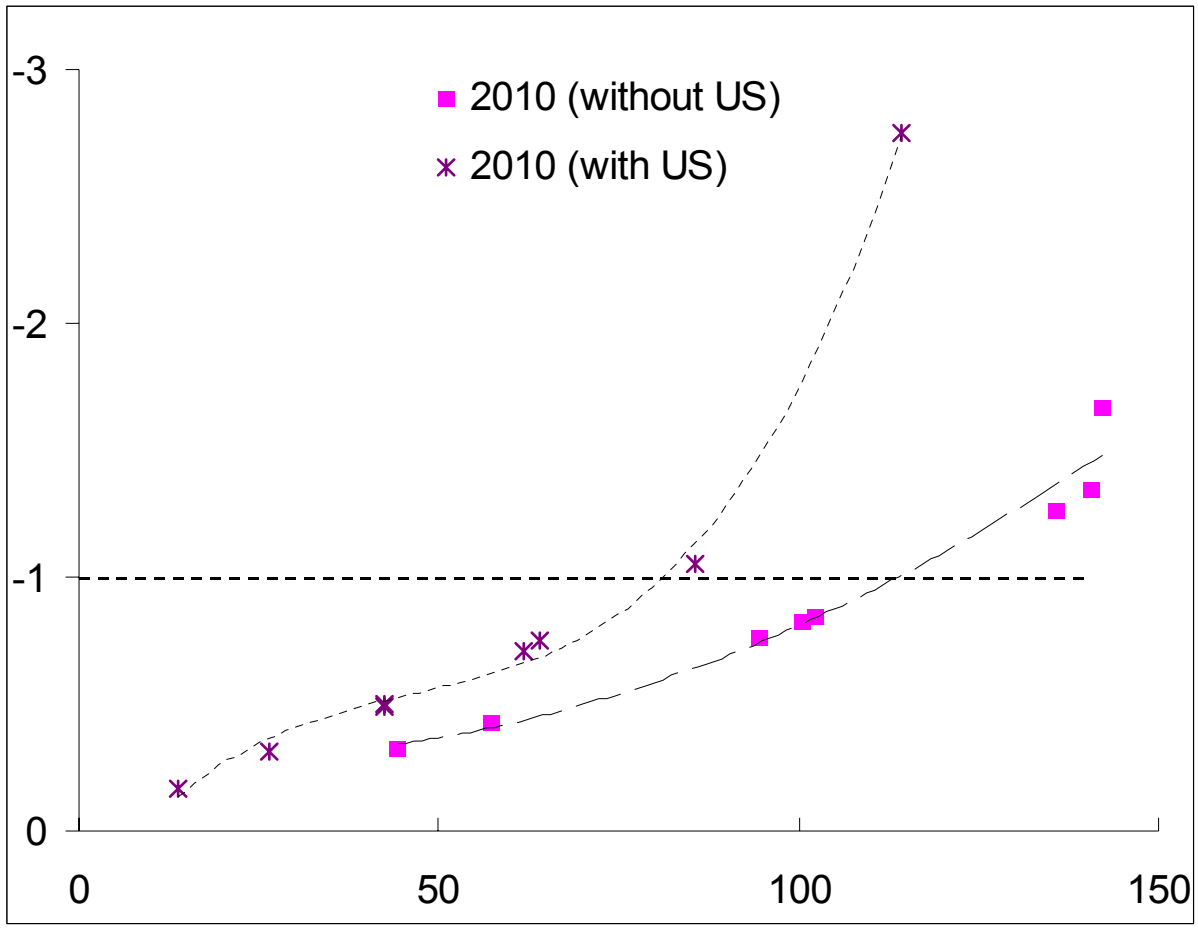
Marc VIELLE
CEA – IDEI – LEERNA

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

- with US: equilibrium price in 2010 around 50 US$90 (62 US$2000)
- without US: price close to zero
- $\Rightarrow$ 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)




-3
-2
-1
0
0
50
100
150
2010 (without US)
2010 (with US)

- 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

$\overline{HA_t}$: 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)

π_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:

$$(\pi_t) \qquad S_{t+1} - S_t - q_t - \overline{HA}_t(r_t) + d_t(p_t) - s_t(p_t) = 0$$

with $S_1 = 0$

$$(\mu_t) \qquad S_t \geq 0$$

$$(\mu_{T+1}) \qquad S_{T+1} \geq 0$$

$$(\theta_t) \qquad q_t \geq 0$$

1.4. Modeling monopolistic behavior: myopic decision rules

- 1. Supply of permits:

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

ε : price elasticity of demand for permits

η : effect of receipts from sales of permits on GTT

ζ : 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

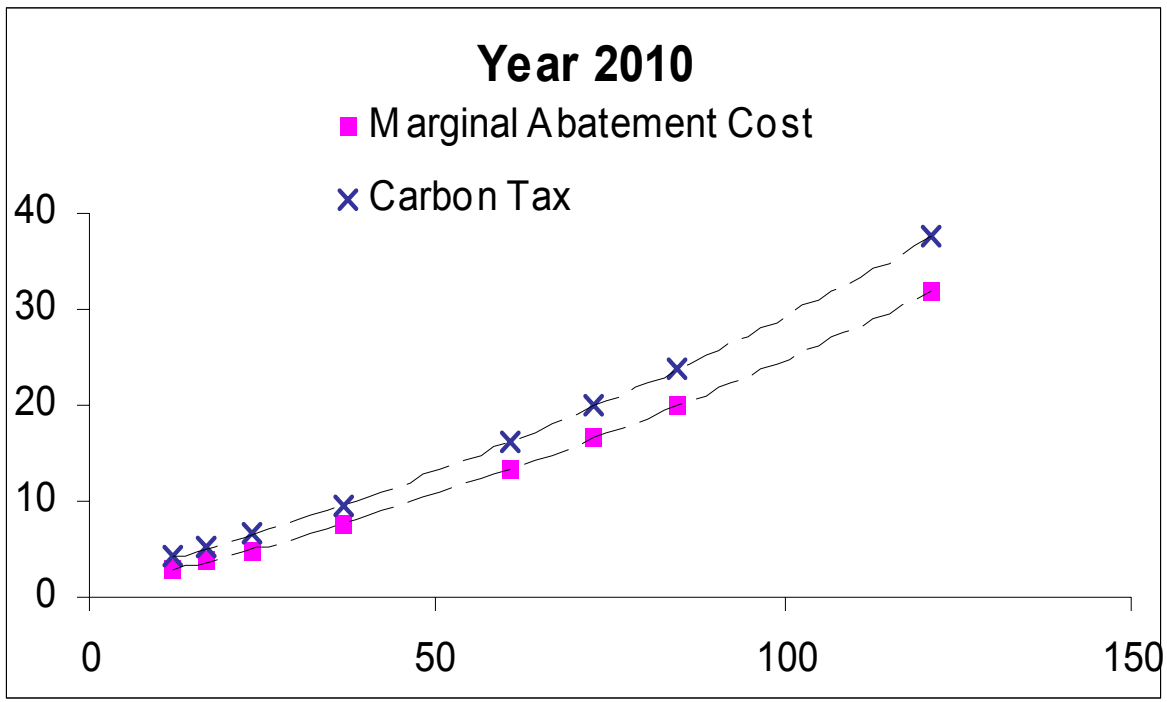
- 1. Same rules for supply of permits and emissions abatement
- 2. Under the condition that the residual stock of permits is always positive, the social value increases at a rate equal to the discount rate (equivalent of Hotelling law)

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

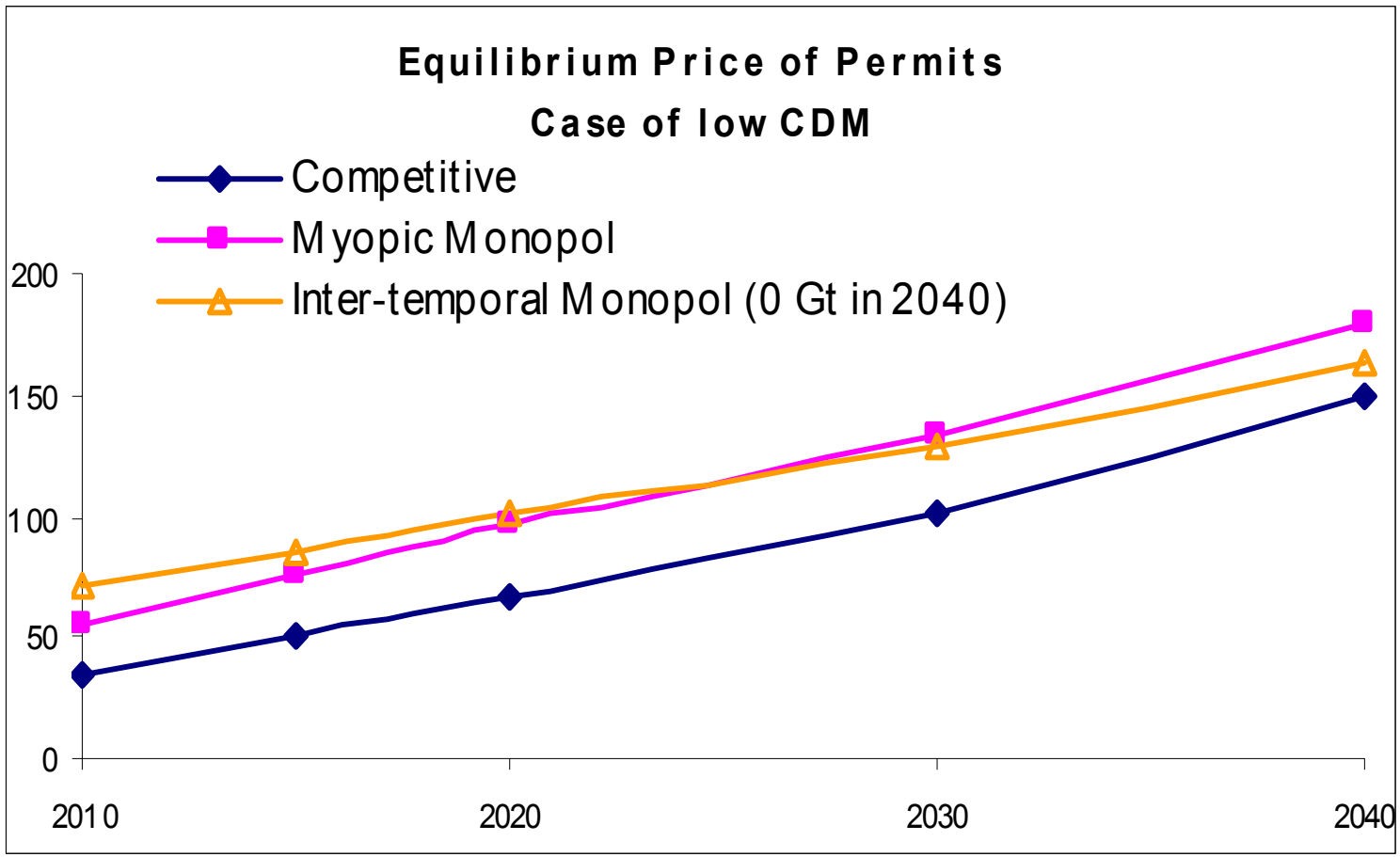
- Examples:
  - Demand for permits (cf supra)
  - Curves of carbon price and marginal abatement cost



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



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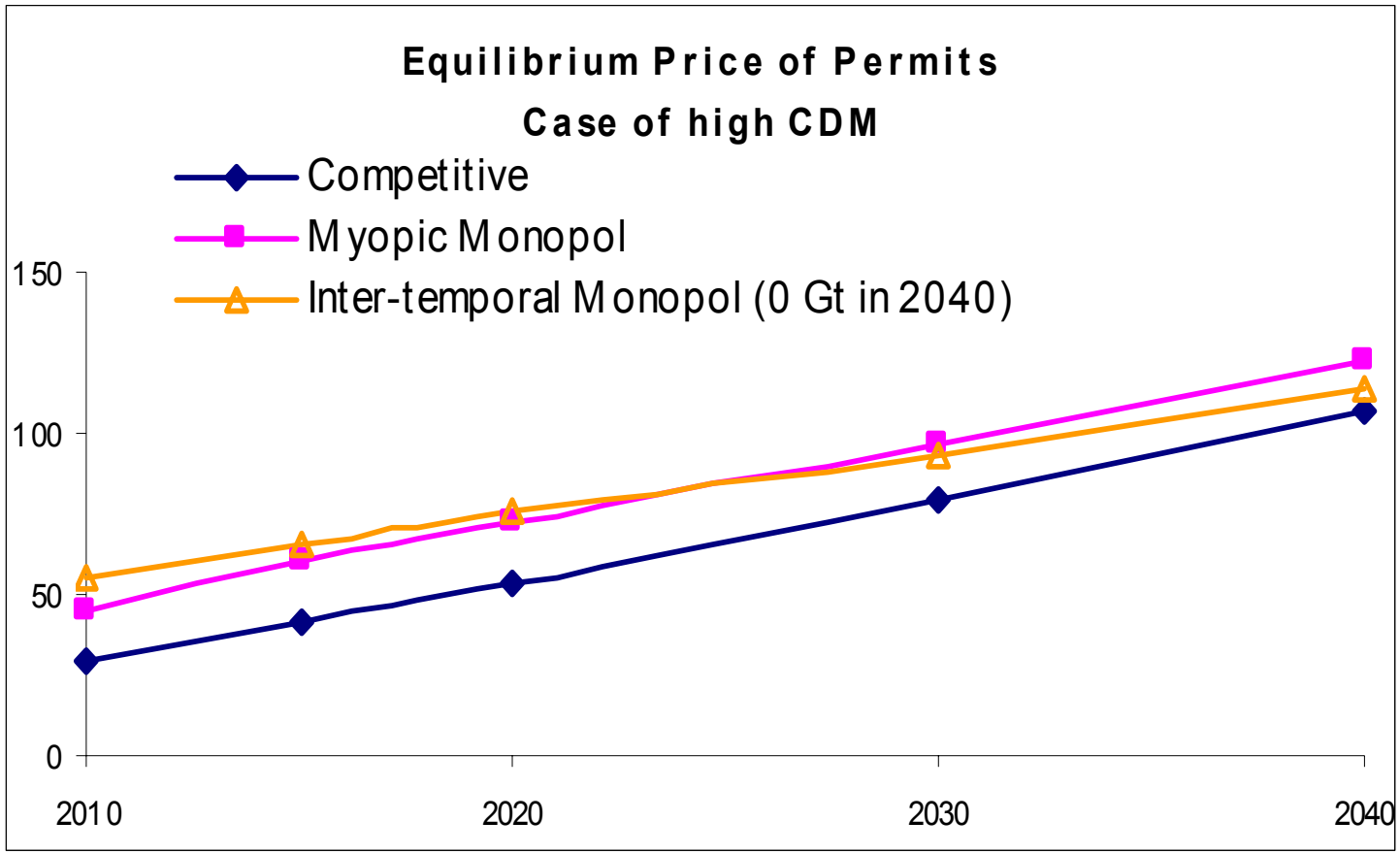
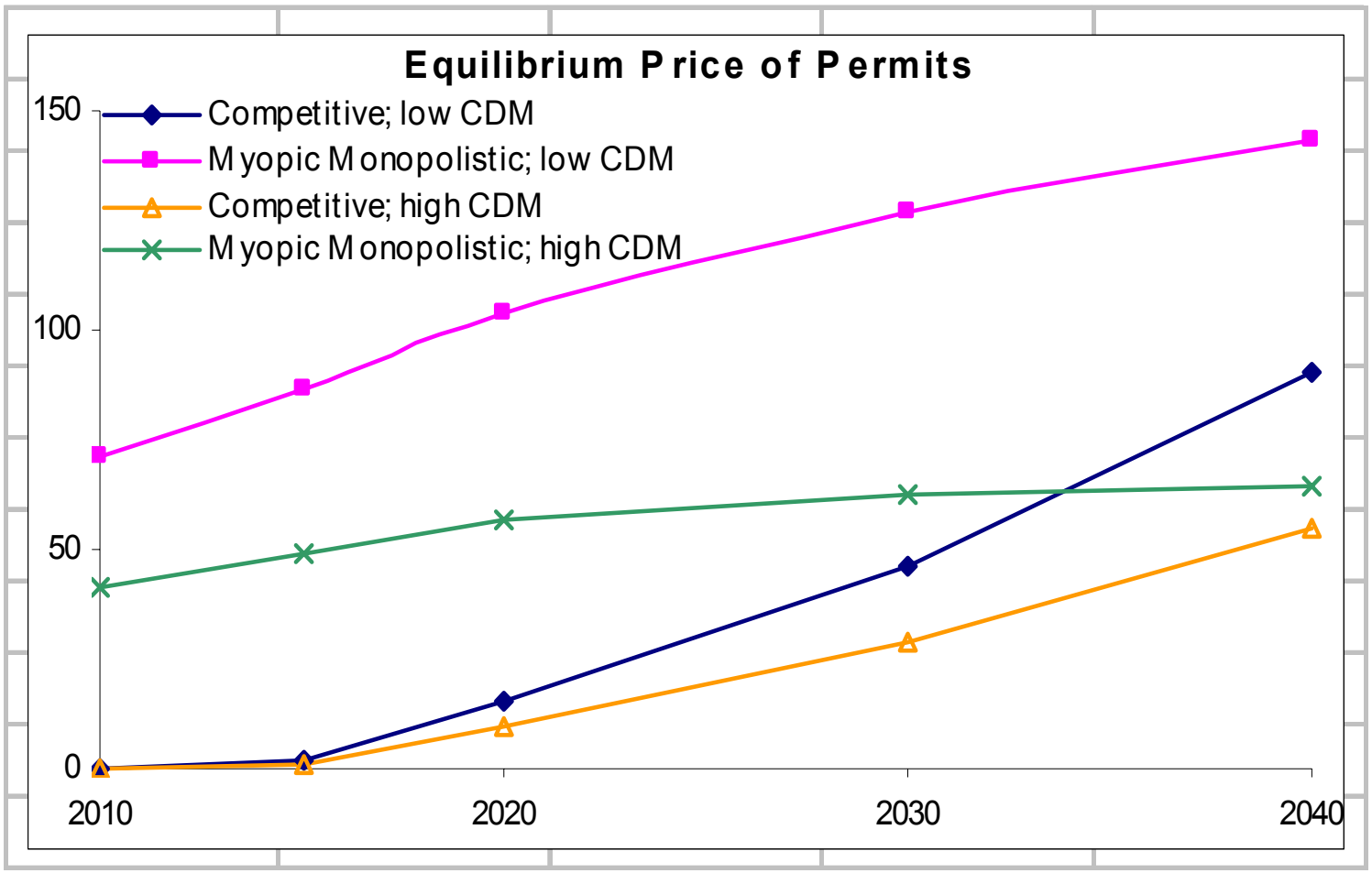
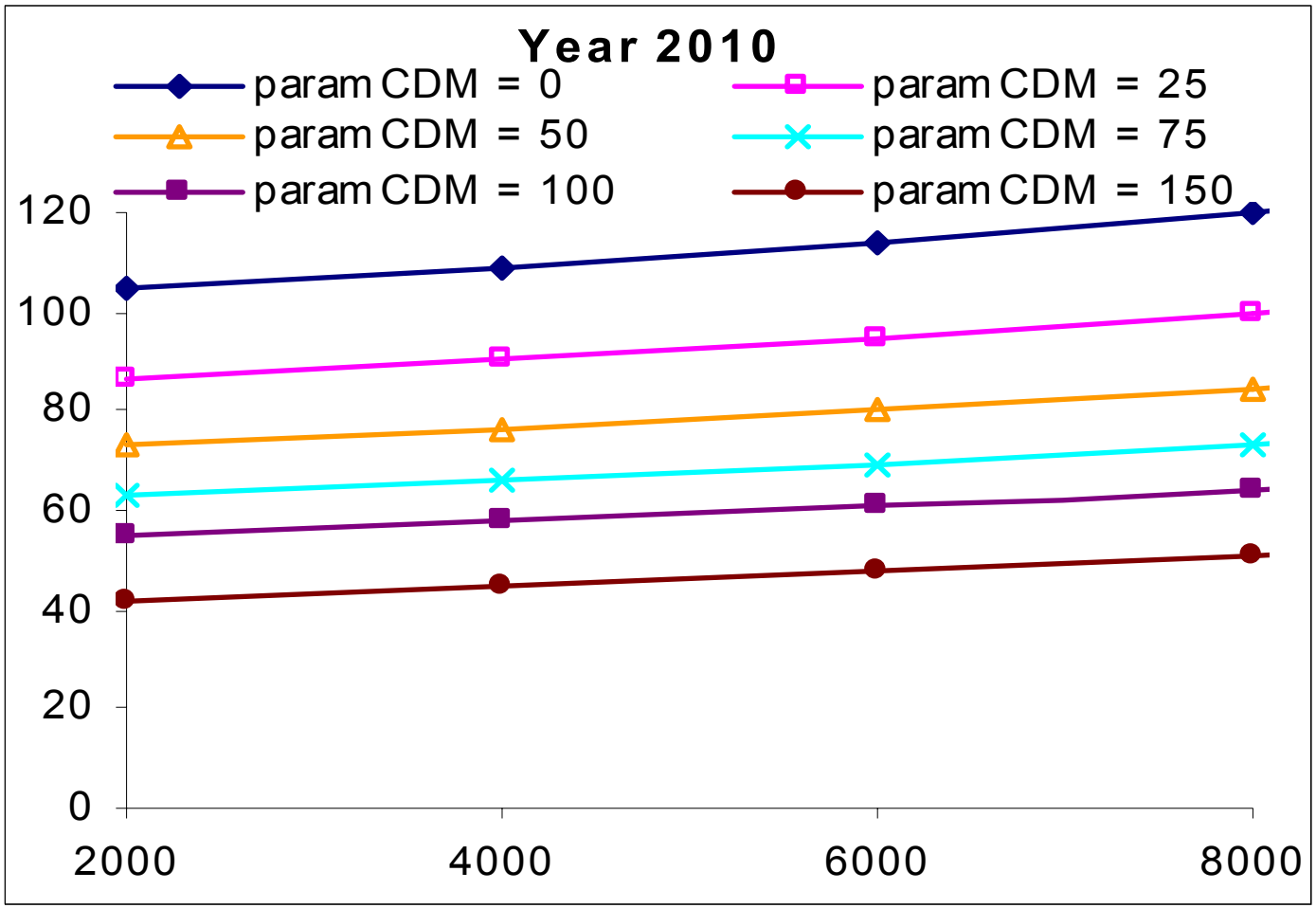


2.2. Results of the optimization program: the case without participation of US



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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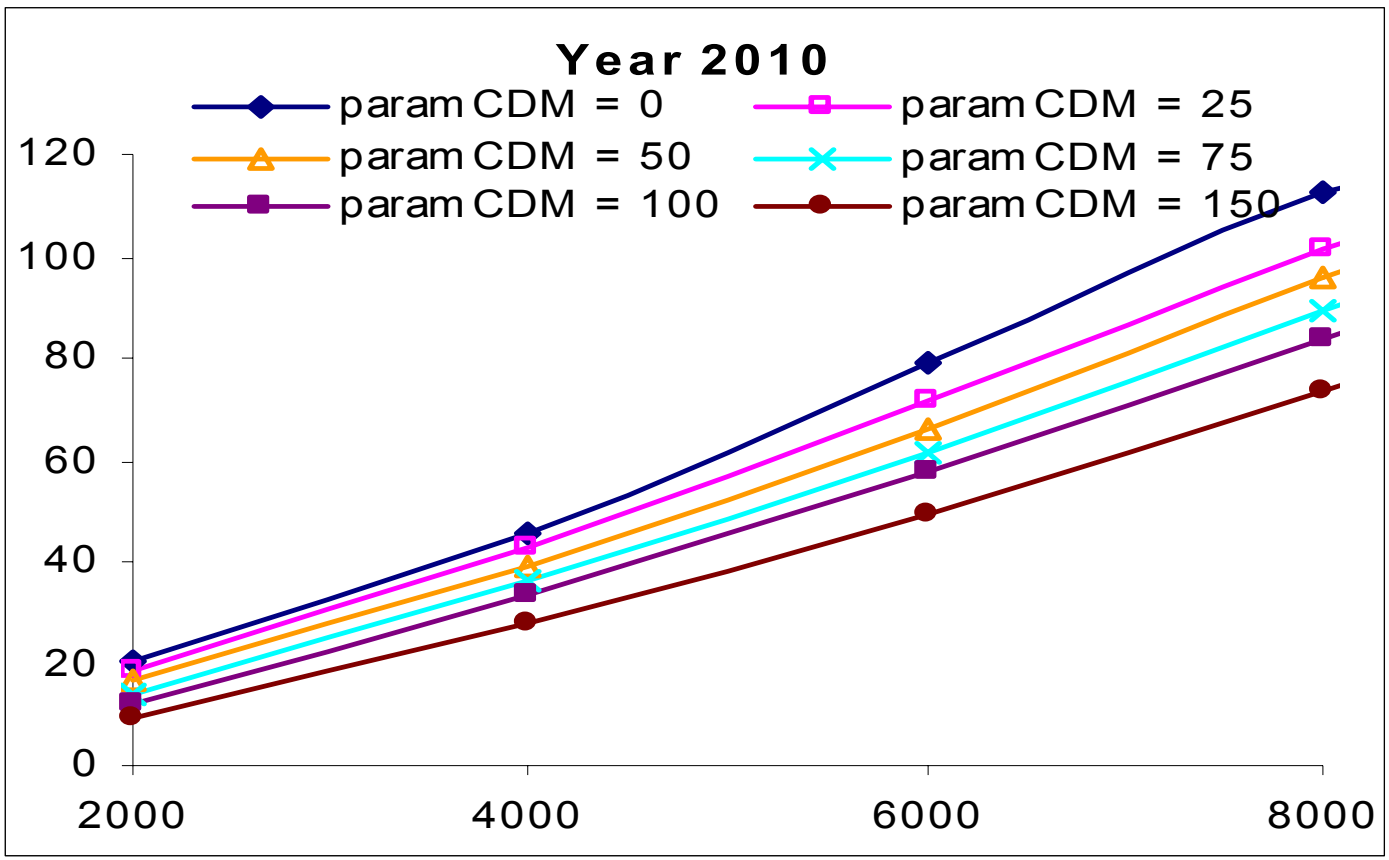

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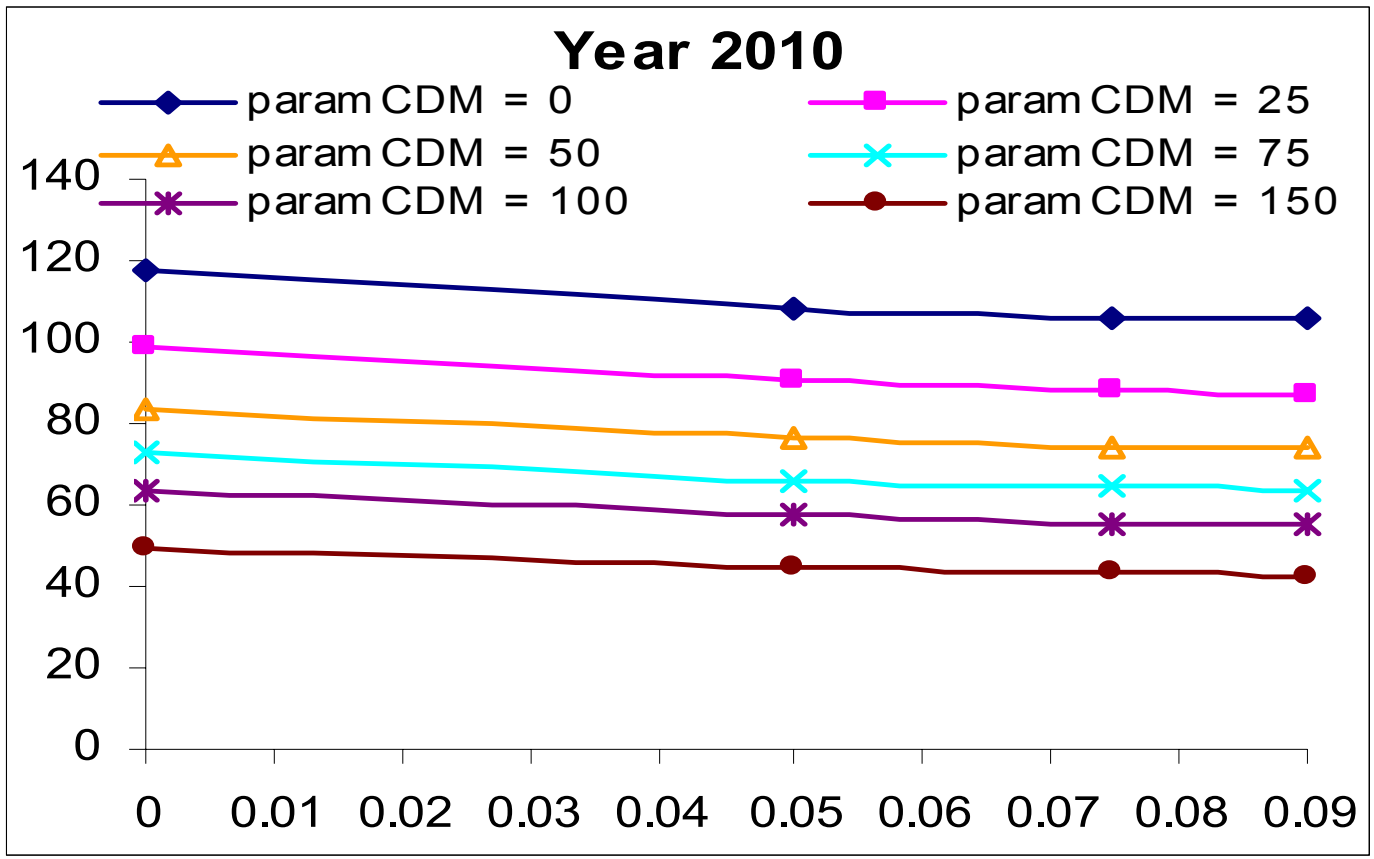
(sensitivity of price of permits to the discount rate)



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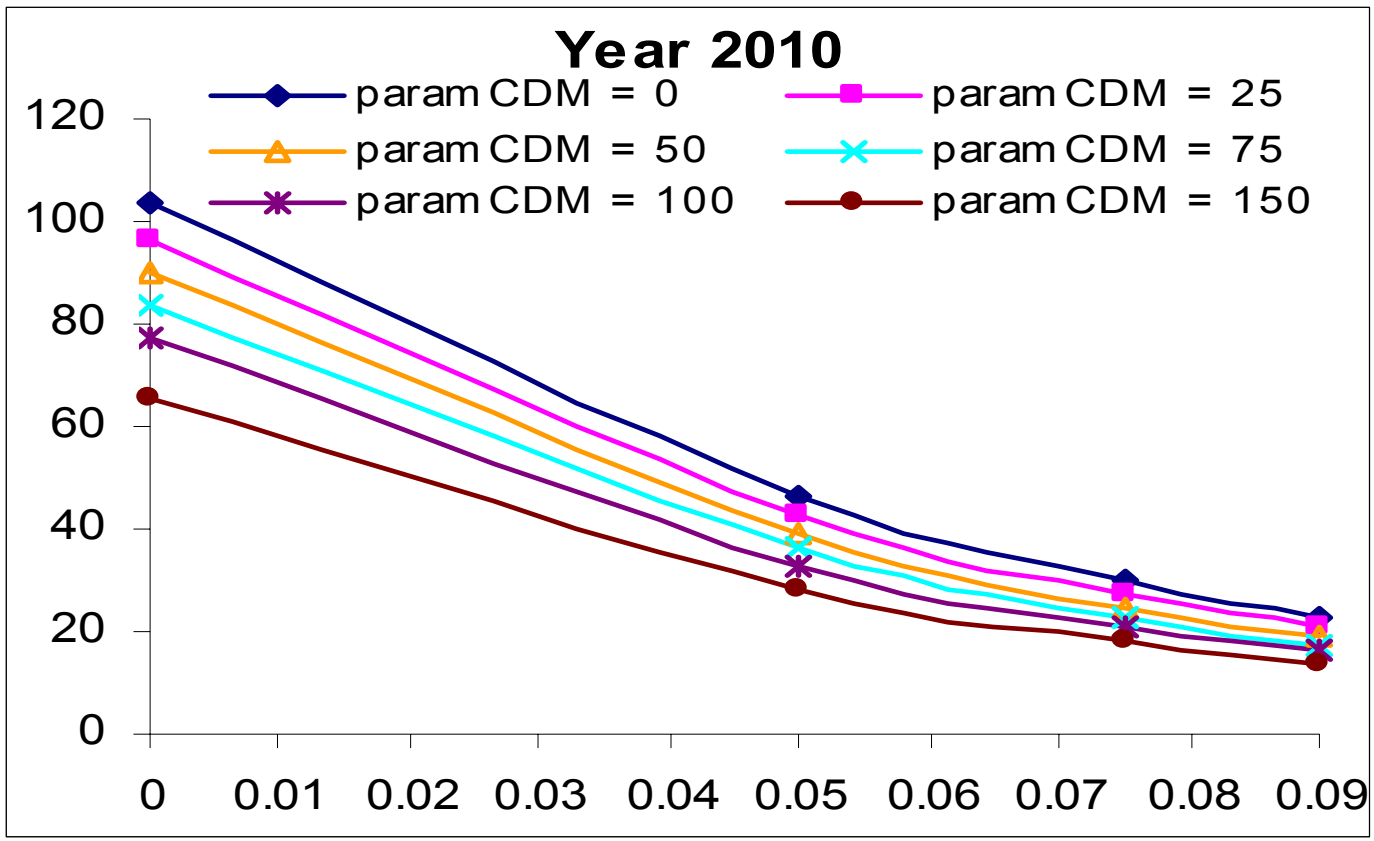

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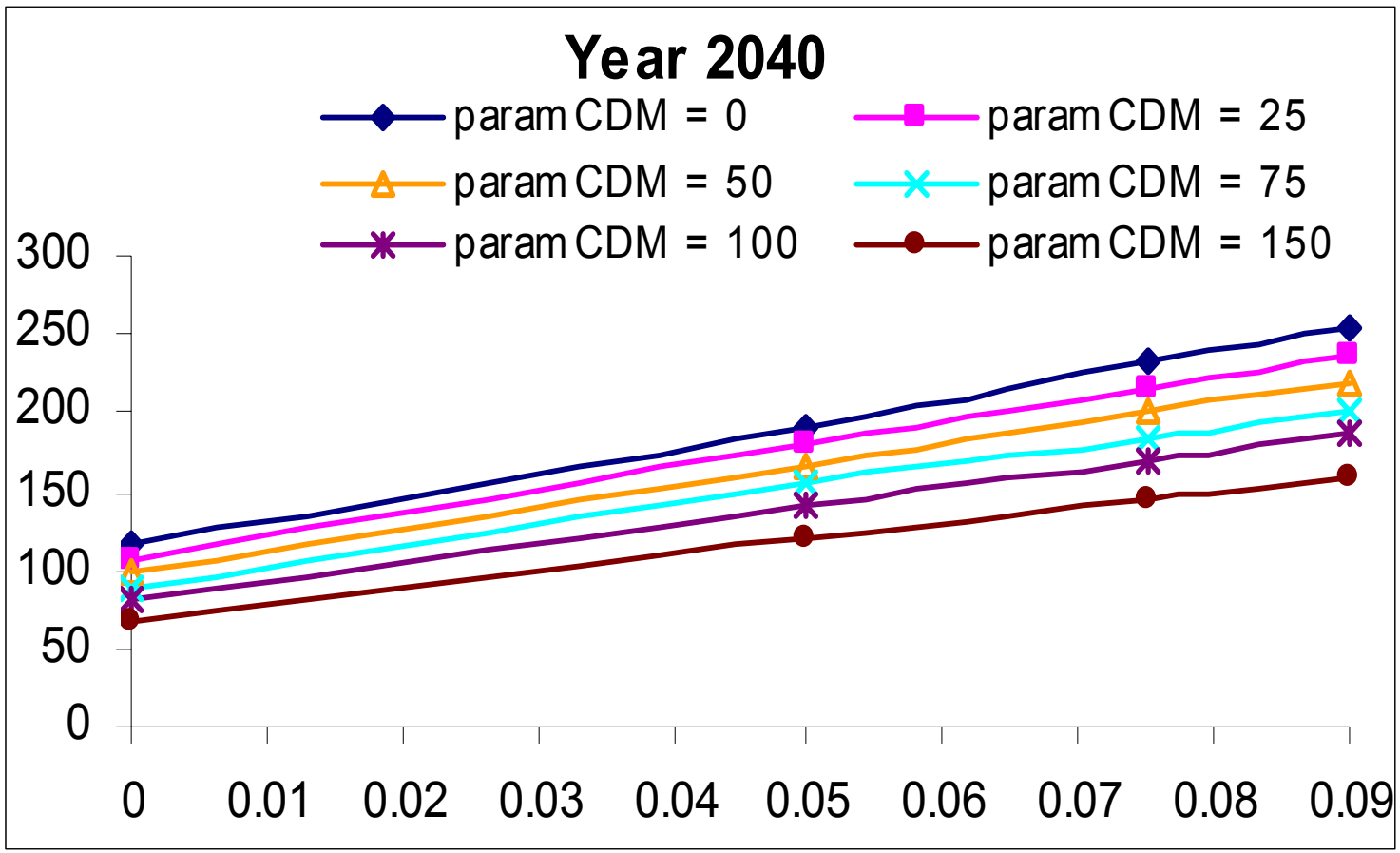

2.4. Balance of world emissions and average cost of abatement – Case with participation of US (low potential of CDM)

	2010	2020	2030	2040
Price of permits ($90)	76	116	152	198
Abat. (Annex B)	597	808	1018	1295
Leakage	-56	-92	-131	-177
CDM	44	69	100	147
World abat. in %	-7.0%	-7.7%	-8.3%	-9.4%
World cost per t of C (in $90)	32	43	51	60
Cost per t of C for				
Annex B except FSU (in $90)	72	98	114	129

2.4. Balance of world emissions and average cost of abatement – Case without participation of US (low potential of CDM)

	2010	2020	2030	2040
Price of permits ($90)	75	111	140	164
Abat. (Annex B)	180	245	333	446
Leakage	-50	-80	-110	-138
CDM	44	68	97	135
World abat. in %	-2.1%	-2.3%	-2.7%	-3.3%
World cost per t of C (in $90)	26	32	32	27
Cost per t of C for				
Annex B except FSU (in $90)	116	172	193	194

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)