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GLOBAL WARMING AND CLIMATE POLICIES.

A four parameters model.

- **The model :**
 - **2 goods** : *aggregate consumption good*
: *quantity*.
 - « *environnemental quality* »
- **The preferences parameters of generation t : σ', σ**
 - **Utility function :**
 - $v(x_t, y_t) = \{ [x_t^{((\sigma-1)/\sigma)} + y_t^{((\sigma-1)/\sigma)}]^{(\sigma/(\sigma-1))} \}$
 - $V(x_t, y_t) = [1/(1-\sigma')] [v(x_t, y_t)]^{(1-\sigma')}$
 - **Comment.**
 - **y/x decreases of 1/100, the willingness to pay increases of $(1/\sigma)$ per 100**
 - **Iso-elastic cardinal utility for generation t, constant relative risk aversion σ'**

The four parameters world.

- **Intergenerational (social) welfare : $\underline{\delta}$**
 - $U = [1/(1 - \sigma')] \sum_{t=0}^{\infty} \{(\exp(-\delta t)) [v(x_t, y_t)]^{(1 - \sigma')}\}$
 - **Pure rate of time preferences.. utilitarian. $\delta \rightarrow 0$, « ethical » viewpoint.**
 - Positive (Koopmans).
 - $>$ rate of survival of the planet
- **Economic possibilities : \underline{r} .**
 - **A simplistic view of the growth possibilities : AK model.**
 - **or first take growth rates as given ..**
- **Elasticity of marginal utility or relative risk aversion $\underline{\sigma'}, \underline{\sigma}$**
 - **$\sigma > 1, (< 1)$ moderate, (radical environmentalist.**
 - **$\underline{\sigma}'$ plays a role in the intensity of redistribution towards the poor..**
 - **1,5,3 ?**

Discussion /parameters.

- The concern for environment σ
 - The world is radically different depending on whether σ is greater or smaller than one.
 - Opposes the « radical » environmentalist $\sigma < 1$ and the « moderate » environmentalist $\sigma > 1$.
 - Later, uncertainty bears on σ .
- A world with two goods...
 - Standard discount rate : relative price of the private good period t , vis-à-vis period o
($\exp(-\sum^T r^*(t))$)
 - Ecological discount rate : relative price of the environmental good $\exp(-\sum^T \beta^*(t))$.
 - « Canonical » Ecological Cost benefit Analysis
 - Generation o evaluates an invest (at o), generating an improv of the environl quality for generation t , value measured with *the marginal willingness to pay of generation o* : multiplied by the « ecological discount rate

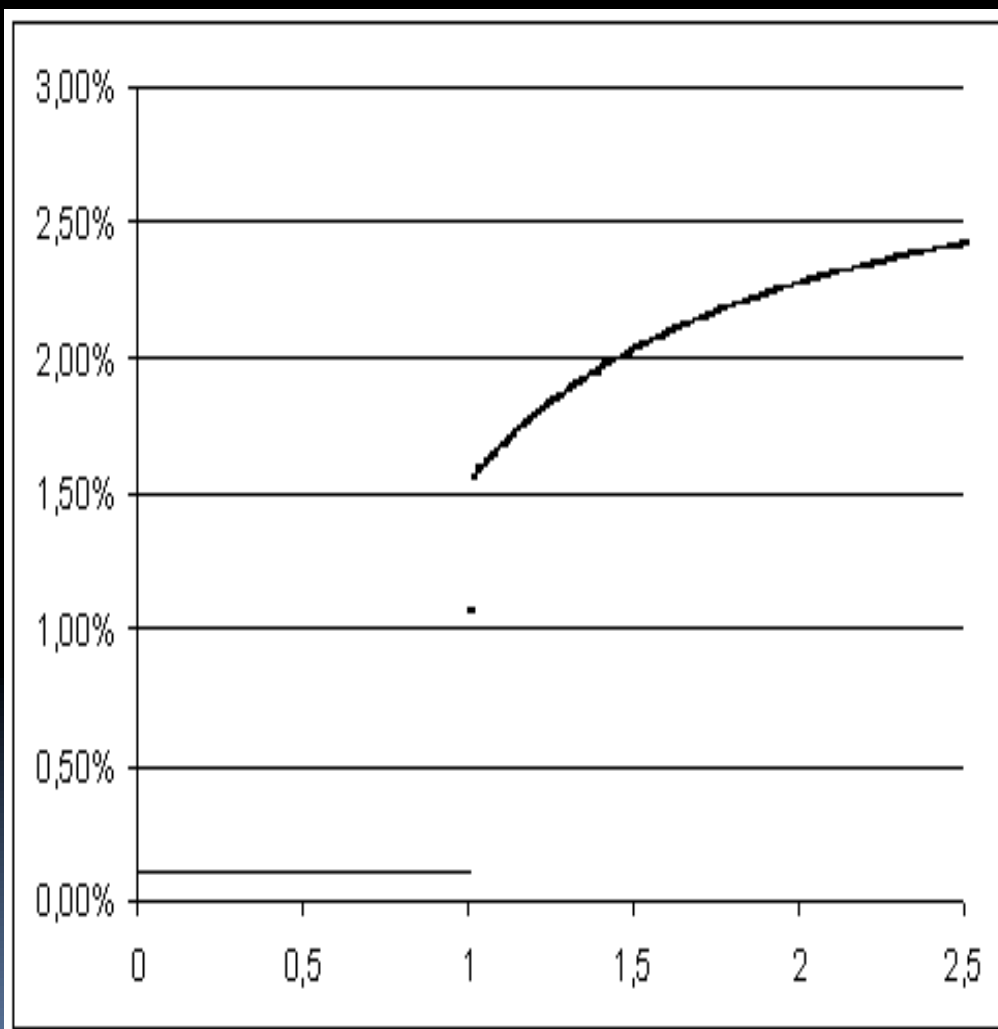
Ecological discount rate from the reform viewpoint.

- ***The reform viewpoint :***
 - *Fixed environmental quality*
 - *Given trajectory of growth rates g*
 - *The long run*
- ***Proposition A : the « moderate » environmentalist.***
 - Standard discount rate : $\text{Min}(g\sigma') + \delta$
 - Ecological long run discount rate :
 - $\lim \rho(T) = \underline{g} [\underline{\sigma}' - (1/\underline{\sigma})] + \delta$
 - $\text{Min}\{g\}[\text{Min}\{\underline{\sigma}'\} - 1/\{\text{Min}\underline{\sigma}\}] : (1)(1,4 - 0,9) = 0,5$
pour cent !
- ***Proposition B : the « radical » environmentalist.***
 - Standard discount rate : $(g/\sigma) + \delta$
 - ecological long run discount rate : $\lim \rho(T) = \delta$

The optimum in the 4-parameters world.

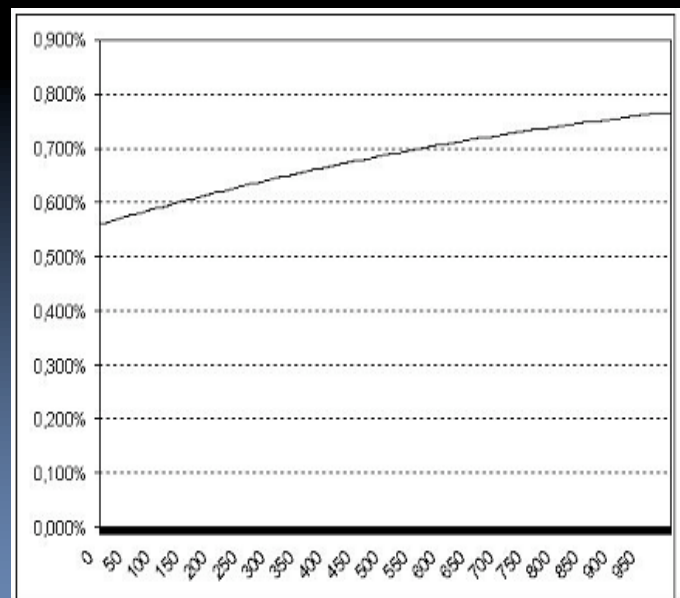
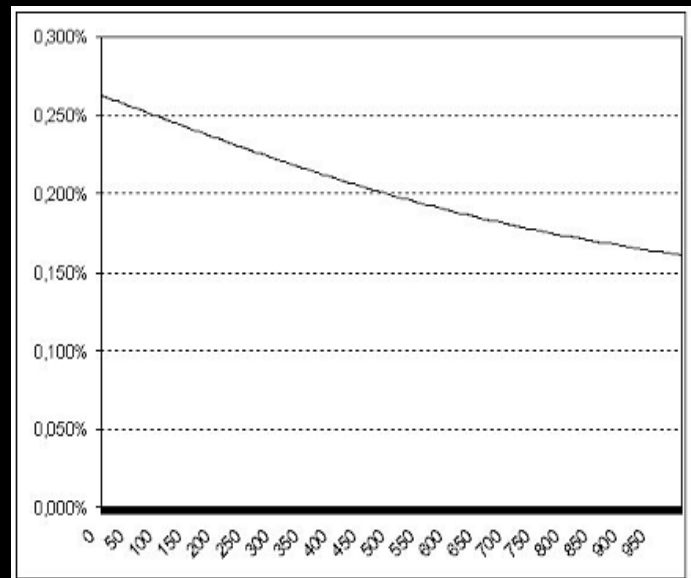
- Constraints.
 - Fixed environmental quality.
 - Fixed interest rate (standard discount rate).
- Results : optimal asymptotic growth with moderate environmental concerns.
 - Asymptotic growth rate : $g^* = (r - \delta) / \sigma'$
 - Ecological discount rate : $B^* = [1 - 1/(\sigma' \sigma)] r + 1/(\sigma' \sigma) \delta$.
- Optimal growth with radical environmental concerns :
 - Asymptotic growth rate : $g^* = \sigma(r - \delta)$
 - Ecological discount rate : $B^* = \delta$.
- Discontinuity and continuity :
 - At each t , the optimal trajectory, as well as the ecological discount rate, is a continuous function of σ

Long run ecological discount rate as a function of sigma.



The dynamics of « ecological discount rates ».

- The dynamic of optimal growth rates ($\sigma'\sigma > 1$)
 - $\sigma < 1$, $g^*(t)$ is increasing.
 - $\sigma > 1$, $g^*(t)$ is decreasing.
- The dynamics of ecological discount rates
 - $\sigma < 1$,
 - $B^*(t)$ is decreasing and converges to δ .
 - $\sigma > 1$,
 - $B^*(t)$ is increasing and converges to $r - (r - \delta) / \sigma' \sigma$
- $\sigma' = 1,5$,
 - $\sigma =$
 - $0,8$,
 - $1,2$,
- $\delta = 0,1$, $r = 2\%$
- Between century one and three, the moderate and the radical environmentalist do not disagree much !



Valuing an irreversible damage to the environment.

- The question :
 - Consider an irreversible damage to the environment
 - Generation 0 is willing to pay x to avoid the damage for itself.
 - How much should it be willing to pay, considering other generations ?
 - The answer is mx , $m > 1$.
- How large is m ?
 - Consider $a = [1 - 1/(\sigma' \sigma)]r + [1/(\sigma' \sigma)] \delta$
 - $m > 1/a$, irrespective of σ .
- Examples :
 - $\sigma' = 1,5$, $\delta = 0\%$, $r = 2\%$, $\sigma = 0,8$,
 - $m > 300$
 - $\sigma' = 1,5$, $\delta = 1\%$, $r = 3\%$
 - $\sigma = 1,2$, bound 52,94, actual m : 61, 49.
 - $\sigma = 0,8$, bound 75, actual m : 86, 68.
 - $\sigma' = 1,5$, $\delta = 0,1\%$, $r = 3\%$,
 - $\sigma = 0,8$, $m = 200$,
 - $\sigma = 1,2$, $m = 75$.

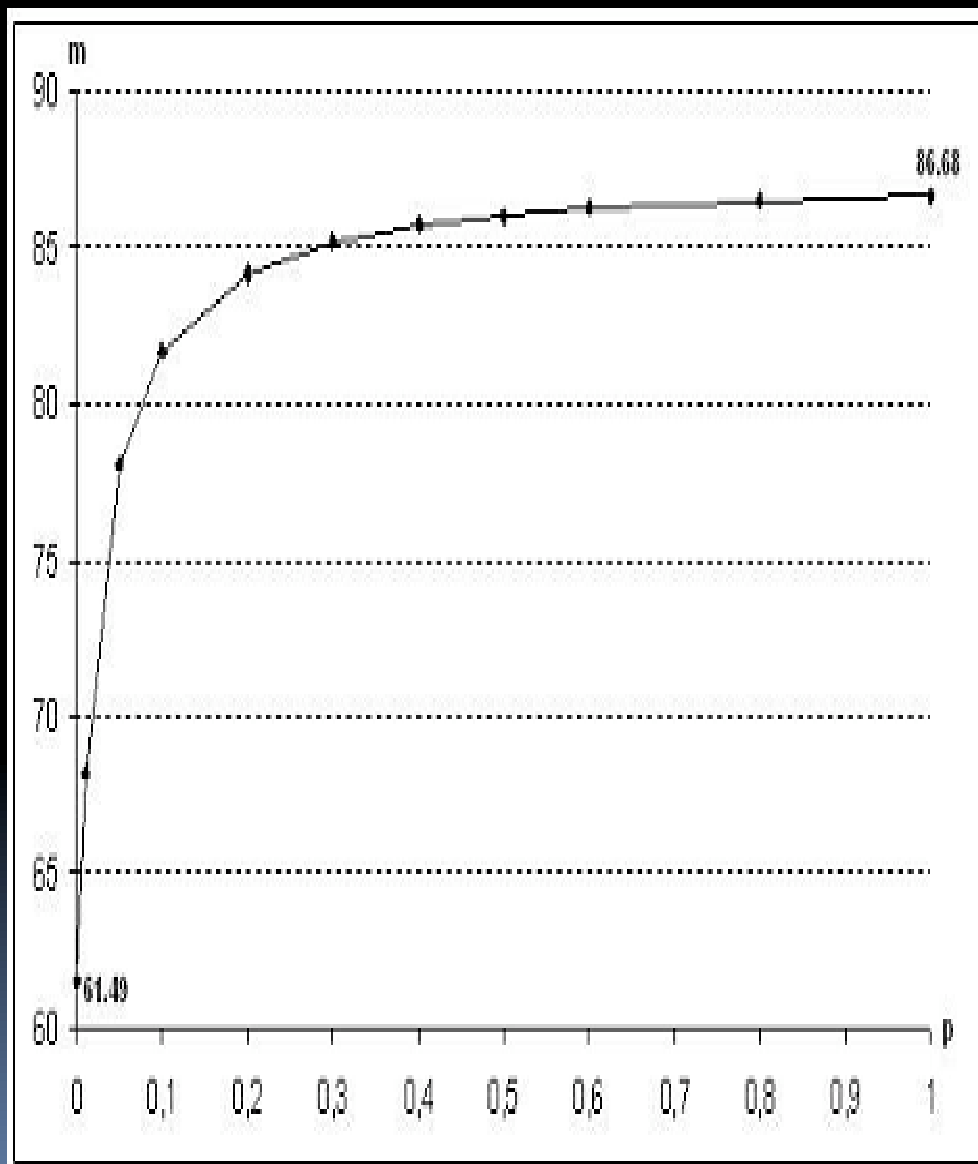
Introducing uncertainty on σ

- Modelling :
 - The elasticity of substitution σ is **uncertain**.
 - **the uncertainty on σ** remains steady until period τ
 - It will be fully revealed at time τ .
- Question 1 : what about the long run « ecological discount rate » ?
 - The long run ecological discount rate is δ .
(WPP)
- Question 2 :
 - Revelation of the uncertainty comes together with an « ecological » accident,
 - the present generation would be willing to pay x for avoiding this accident to itself under the assumption that the moderate environmentalist hypothesis has probability $(1-p)$
 - How much should it be prepared to pay to avoid the « accident » that will concern all generations following τ

Strong precautionary principle.

- Question 2 :
 - Revelation of the uncertainty comes together with an « ecological » accident,
 - the present generation would be willing to pay
 - How much should it be prepared to pay to avoid the « accident » that will concern all generations following τ
- WPP : ecological discount rate tends to delta
- Answer 2 : SPP
 - $a = [1 - 1/(\sigma' \sigma)]r + 1/(\sigma' \sigma) \delta$
 - $m > \exp(-a(h)\tau) f(p, \tau)$
 - $f > ((1-p)/a(h) + p/a(l))$ and concave.
 - $\lim(\tau) [f(p, \tau.)] = a(l)$
- Back of the envelope computation.
 - Above data, $\tau = 100$
 - $m > (1/3) \cdot (0,1)(200) + (0,9)(75) = 30$

m as a function of the probability / «catastrophy»





Kyoto, post Kyoto,
The environment-development Gordian
knot..

THE DESIGN OF CLIMATE POLICIES

Governance : Kyoto.

- **A global problem of unprecedented scale.**
 - Climate a global public good.
 - « Largest market failure ever experienced »
 - And free riding at an unprecedented scale..
- **The world design issue.**
 - How to trigger cooperation ?
 - Long run per capita objectives
 - What to measure ? Emissions, extract. of fossil fuels ?
 - Which tools : prices versus quantities
 - The developing countries issue
- **The Kyoto protocol : key features.**
 - National quotas rigid, based on emissions at a year basis (1990)
 - An international market for permits (exchange of quotas).
 - Voluntary participation (Annex B).

Questions.

- Critical views on the Kyoto « design »
 - Nature as a « merchandise »
 - A quantity policy, too rigid ?
 - A better tax policy...?
 - Two criteria :
 - Trigger participation...
 - Attention to the interactions between climate policy and the markets for fossil fuels..
- Policy questions.
 - Internal policies : cap and trade or carbon tax ?
 - A too limited carbon tax space :
 - The « leakage » problem : a conflict between trade and environment.
 - How to trigger participation of the DC ?

The prices versus quantity debate revisited

INSTITUTIONAL DESIGN

-1

Prices versus quantities : the conventional wisdom

- Note :
 - Kyoto is a « quantity » policy.
 - Harmonised world tax would be a «price » policy ?
- The intellectual debate :
 - Under certainty,
 - equivalent,(modulo participation)
 - See the model below.
 - Under uncertainty :
 - Weitzman's argument (1974) :
 - If the marginal cost is steep and uncertain and the expected marginal benefit of abatement is flat, the price policy is superior.
 - Resp. threshold effect, quantity is superior.

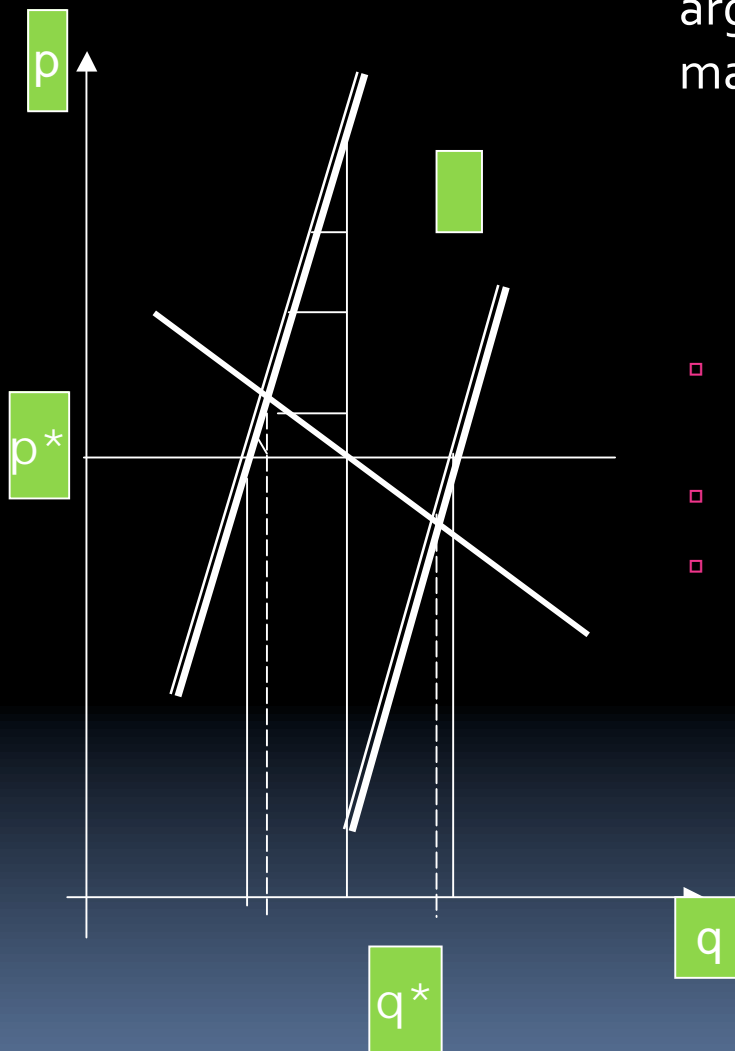
Prices versus quantities

- A simplistic formal model :
- without uncertainty, Notation q : emissions abatement.
- **Nash :**
 - $q^{\circ}(i) : \text{Max} \{U[i, Q^{\circ}(-i)+q(i)]-C(i,q(i))\}, i \in B$
 - $\sum_i q^{\circ}(i) = Q^{\circ}$
- **Kyoto :**
 - Quotas $s(i), i \in B, q^{\circ\circ}(i),$
 - $q^{\circ\circ}(i) : \text{Max} \{t^{\circ\circ}[(q(i)-s(i))-C(i,q(i))], i \in B$
 - $\sum_{i \in B} s(i) = \sum_{i \in B} q^{\circ\circ}(i) = Q^{\circ\circ}$
 - IR ?
 - Market for permits, world carbon price $t^{\circ\circ}$.
- **Harmonized taxation :**
 - $q^{\circ'}(i) : \text{Max} \{t^{\circ'}[(q(i))-C(i,q(i))], i \in B$
 - $\sum_{i \in I} q^{\circ'}(i) = Q^{\circ'}$
 - Welfare : $U(i, Q^{\circ'}) - C(i, q^{\circ'}(i))$

Prices versus quantities

:

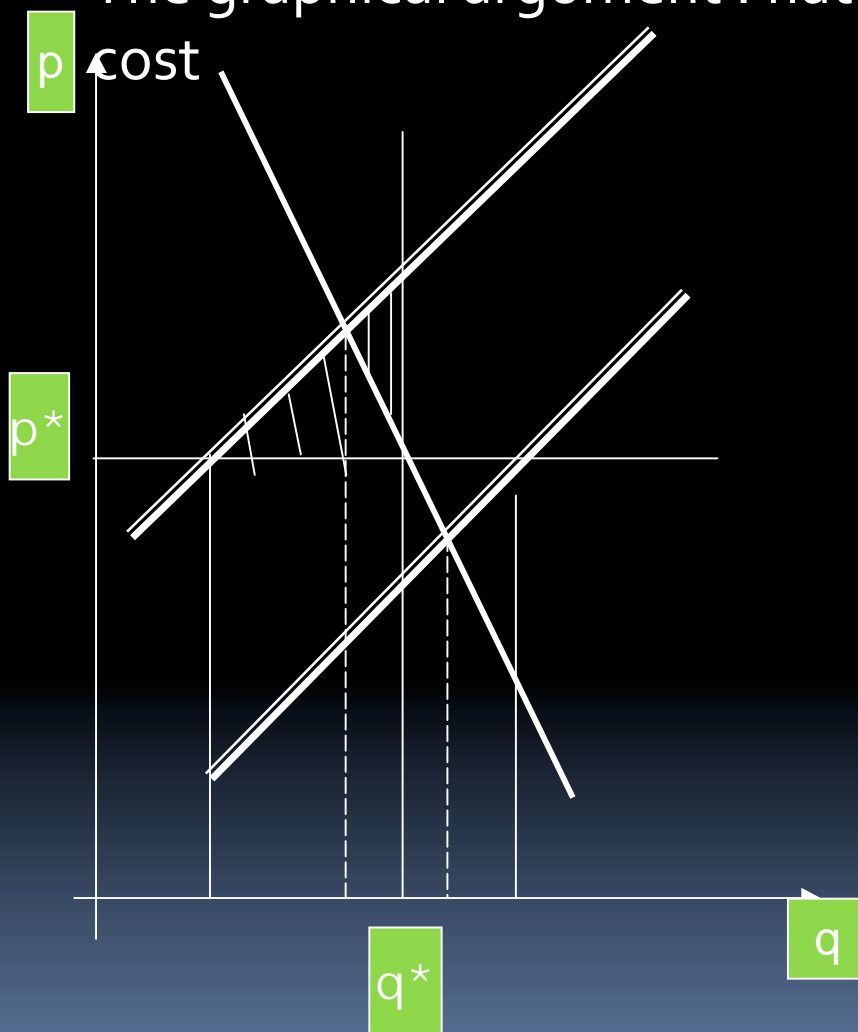
the standard argument



- The graphical argument : flat marginal benefit
 - Optimal price policy : $p=p^*$
 - Optimal quantity policy : $q=q^*$
- Compare losses in both cases
- The intuition.
- Algebra gives differences in welfare : depend on the variance of noise..

Prices versus quantities: the standard argument

- The graphical argument : flat marginal



The conventional wisdom.

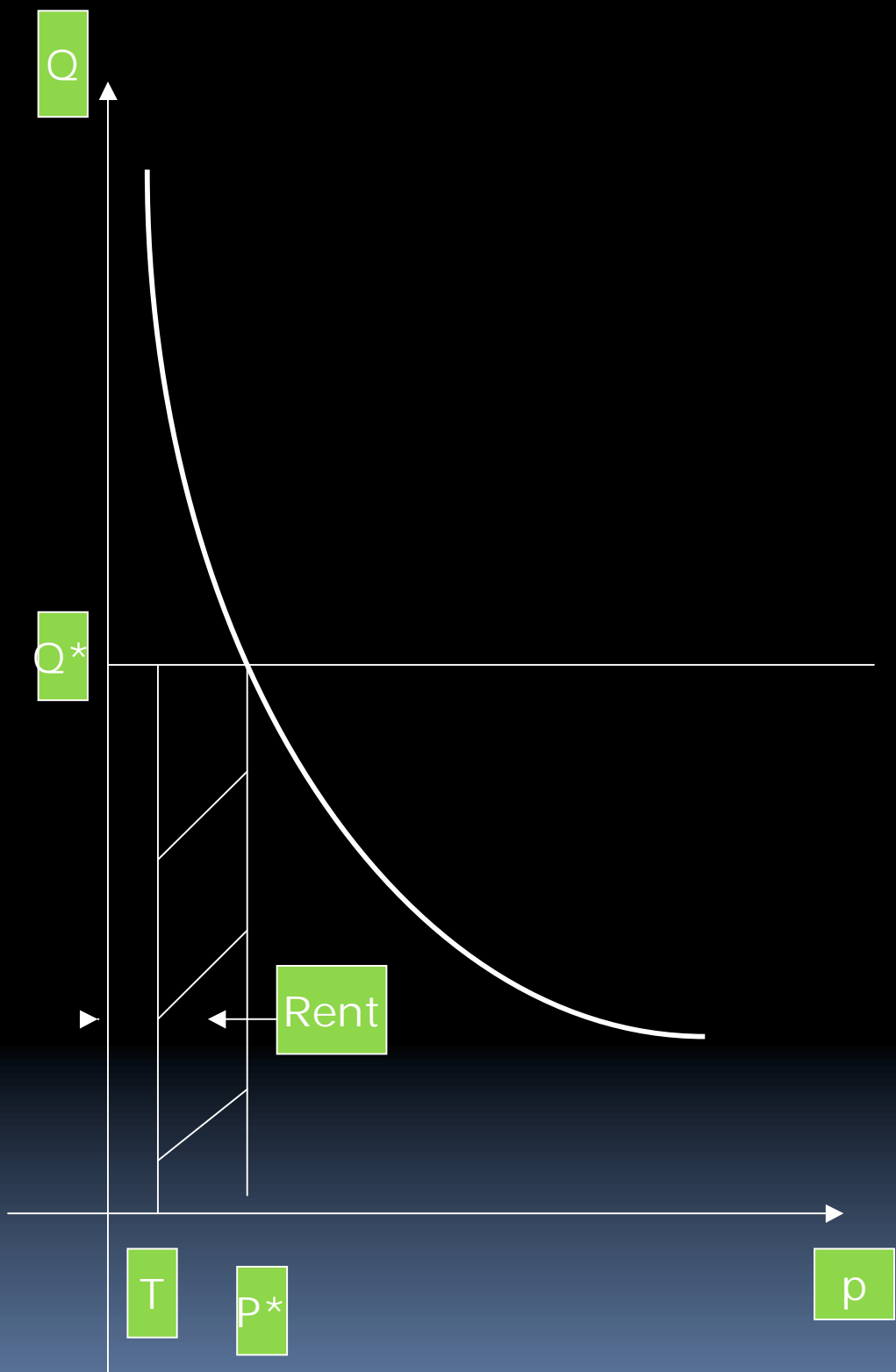
- The one-period analysis.
 - Think of 2008-2012
 - Marginal cost is steep and uncertain ?
 - Stock externality
 - One period abatement small vis-à-vis objectives
 - Social value of abatement cannot change drastically.
 - Price policy is better (tax, safety valve..)
- The multi-period analysis.
 - Many periods : a calibrated model.
 - Newell D. et Pizer W (2000), "Regulating stock externalities under uncertainty", Resources for the future, Washington DC, DP 9910.
- Surprising conclusion ?
 - Quantities are what we are concerned with.
 - But a priori the argument makes qualitative sense,

The conventional wisdom : what is wrong ?.

- What might be wrong :
 - The flatness of the marginal benefit curve may overlook the option value component of benefit.
 - Additional attention may be required.
- What is wrong and may be significantly wrong.
 - There is a time aggregation problem
 - Abatement cost of the last unit in t , much higher than the abatement cost of the first unit at $t+1$.
 - Exaggerates inconveniences of a quantity policy.
 - Reflects a cost modelling problem
 - Key inter-temporal dimension of the abatement problem.
- What is seriously wrong:
 - What we can control is possibly a « harmonized tax », not the user price of carbon
 - The key issue may be how the price of fossil fuels reacts to carbon taxes
 - A subject on which a convincing reflection is lacking....

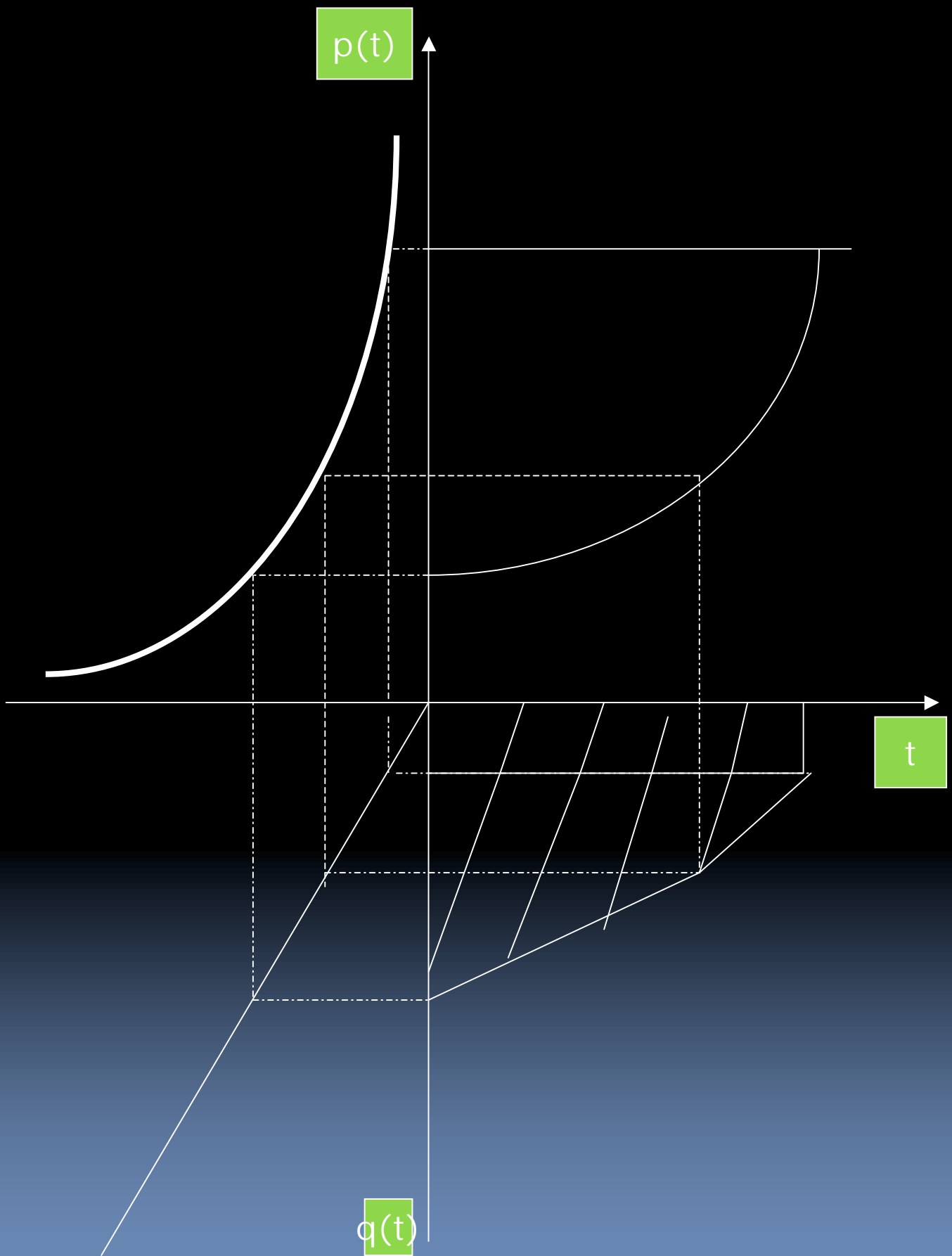
A few additional and more basic remarks on « price policies » : the static model.

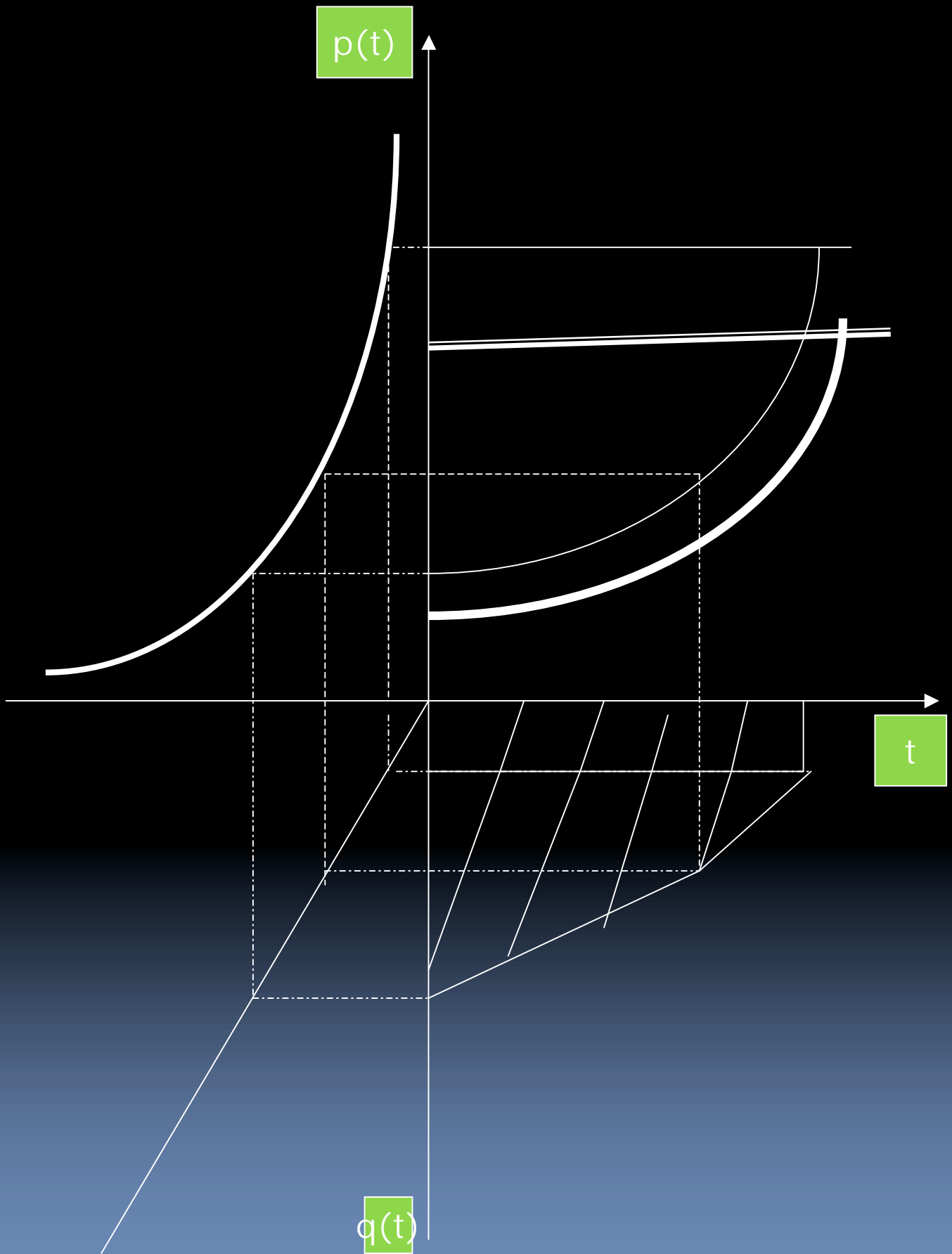
- A key and neglected issue to evaluate the « harmonised taxation » solution.
 - The relationship between the price of fossil fuels and taxation.
- The teachings of the static model
 - The tax leaves the price unchanged, but transfers the rent from the producer to the taxing authority.
 - A tax (or subsidy) does not affect either exhaustion, unless it leads to a zero price for the owner of the resource..
 - Policy assesment.
 - Ineffective on all grounds but distributive.
 - Inferior in some sense to a quantity policy, unless it « de-possesses » the owner.

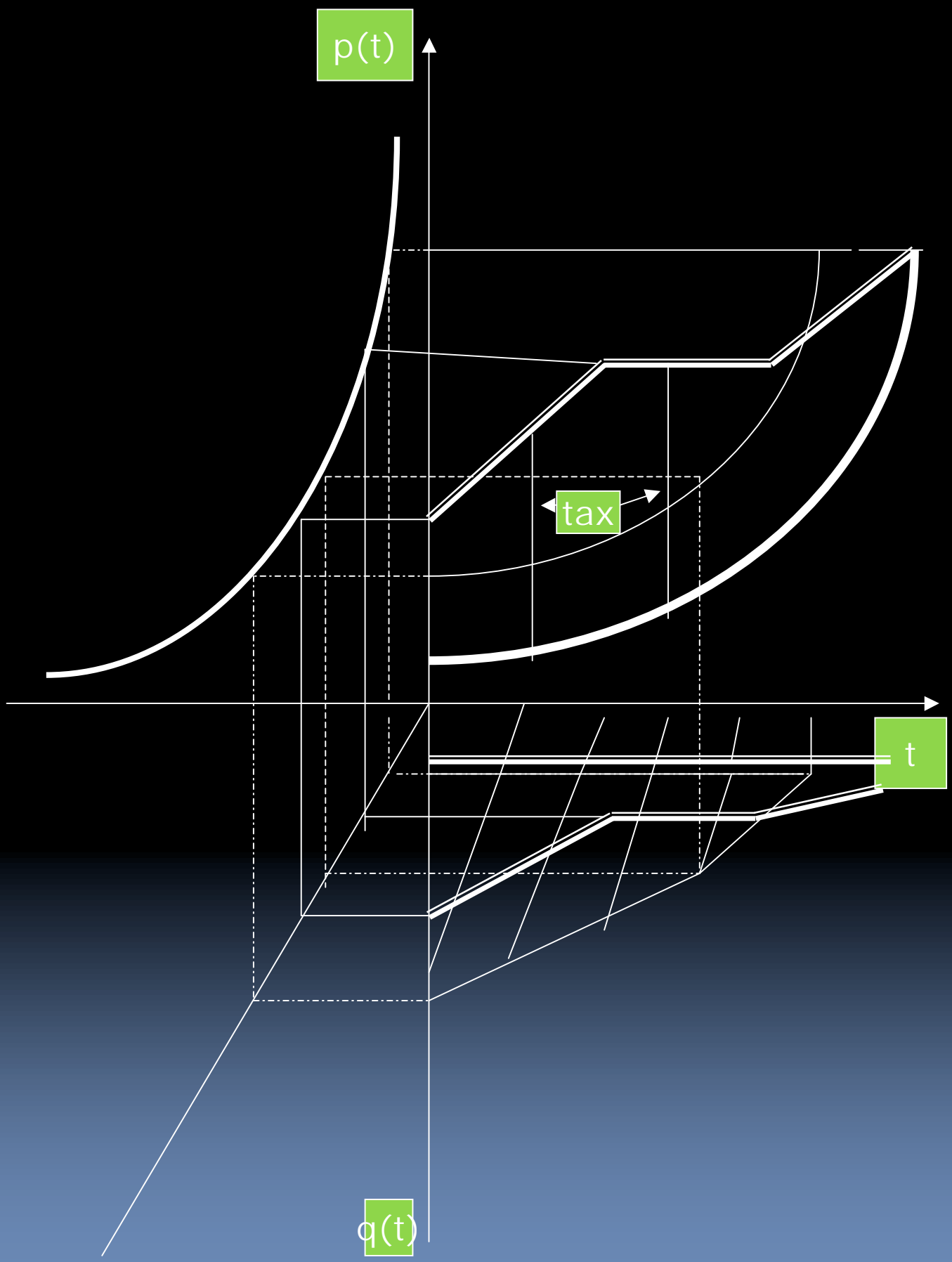


A few additional and more basic remarks on « price policies »: dynamics

- References :
 - Abundant literature some time ago with different emphasis
 - Recent emphasis on the greenhouse effect in
 - Chakravorty, Moreaux, Magné (2004), or Magné-Moreaux (2002) « Long term energies trajectories : assessing the nuclear option in response to global warming”, Université de Toulouse
- Their model :
 - one single (carbon) fossil fuel,
 - a « backstop » technology available later,
 - and non oligoplistic producers, (competitive pricing).
 - Hotelling rule the rate of price increase is the the interest factor)
 - Exhaustible, no production cost.
 - Certainty, « rational » expectations.








Taxation and the price of fossil fuels : some insights on dynamics.

- The dynamic counterpart of the static teachings.
 - Some tax schemes will leave the actual price path unchanged, only transferring rent (it seems always possible to do so)..
 - Some will delay exhaustion; but can prevent it only by « surprise », and by imposing a zero future price for the resource
- Other insights on dynamics :
 - Taxes may help to delay exhaustion, but clever time modulation is required
 - The tax equilibria are not « eductively » stable.
- Provisional Conclusion.
 - Commitment to Taxes is not a substitute of Commitment to Quantities
 - The right control variable would be the price of fossil fuel !
 - The price quantity discussion has to be revisited...

Summing up..

- Price policy : harmonized taxation of carbon dioxide
 - (Eur. initial proposal in the early 90's) ?
- Kyoto, a quantity policy, is less satisfactory ?
- The standard argument is flawed ;
 - interaction of taxation with the price of fossil fuels...
 - You need both prices and quantities



Internal policies : carbon tax versus cap and trade.

The limited area of the carbon price.

CENTRAL ISSUES.

Europe's choices

- Quantities (Europ.bubble...)
 - at the member states and global level.
 - **European bubble changes the burden of ind. countries. solidarity**
 - **Should go with common long run (per capita?) objectives.**
- Common policy for industry.
 - the single market argument
 - harmonized taxation of carbon / industry seems preferable.
 - But leaves, within Kyoto, responsibility to individual countries: subsidiarity
 - Member states must undertake strong policies (housing), outside the industry sector.

THE EUROPEAN EQUATION : THE ETS

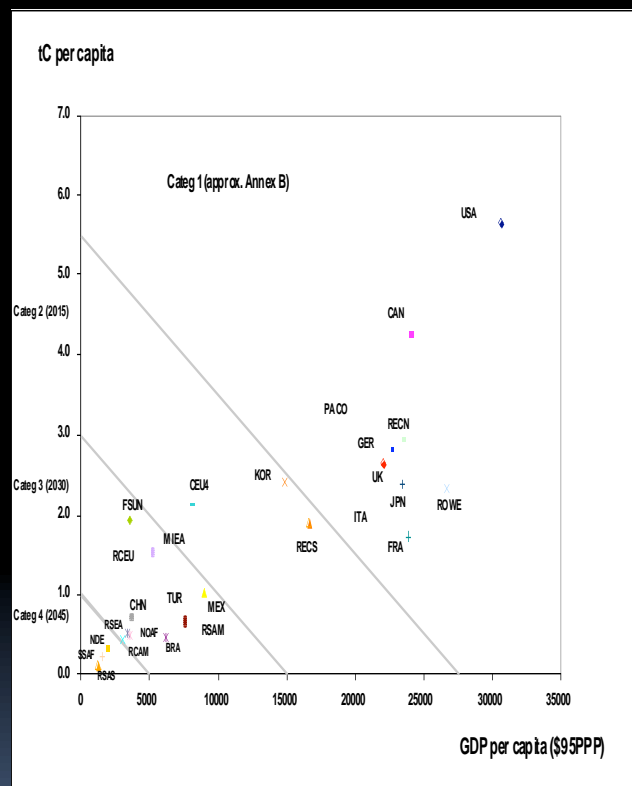
- The european ETS
 - A quantity policy...
 - where taxation is likely to be better (see above) !
 - ...the quantity adjustment being left to internal adjustments of individual countries
- A decision triggered by institutional constraints..
 - A market for permits is not a tax (does not require unanimity).
 - A market for permits allows « grandfathering ». (tax exemption also).
 - Politically right, economically wrong ?
- A market for permits acts like a tax,
 - Differences : flexible tax / than inflexible.
 - In the long run, the europ. consumer will pay for it
 - A tax without receipts if quotas are free.
 - Bad idea according to the « double dividend » argument.

Development, leakages and
competitiveness.

THE LIMITED CARBON TAX AREA.

The basic facts

- GHG emissions come primarily from developed countries...
 - Annex B countries :
 - From 6 T/C per capita, to less than 2T/C, (annual)
 - India, less than 0,5 T per capita
- But total emissions of developing countries are likely to overtake developed countries emissions « soon ».
- Climate regimes and developing countries.



Extending the Kyoto protocol ?

- A limited « carbon tax space » :
 - Str. shortcomings : cheapest actions outside the « carbon tax world ».
 - CDM, a crude attempt to adress the problem.
- Integrating Developing countries be within a K protocol ?
 - A « first best » like solution(IEA, RG) « world » carbon market.
 - Generous (non binding) or one-sided quotas to developing countries.
 - A win-win solution.
- Is it unattainable ?
 - Acceptability by developed C.
 - Acceptability by developing countries.
 - The effectiveness of the price signal .Measurement.
 - The ratchet effect...
 - A solution ? medium term commitments and egalitarian quotas).

BORDER ADJUSTMENT : A SECOND BEST SOLUTION ?

- The Proposition
 - A « carbon tax »:(mimicking a carbon added tax). (for example, Ismer R. Neuhoff K)
 - Tax total imported carbon, detax total exported carbon
- A number of possible variants.
 - Concerning the relevant space (USA, Annex B, Europe).
 - The relevant status, unilateral, threat, delayed implementation.
- A more realistic option: border quota ?
 - With a trading scheme (ETS),
 - Quotas on imports covered by the scheme, reimbursed for exports...
- Economic objections
 - Against the spirit of free trade ?
 - Note that a carbon added tax, if feasible, would raise no more trade objections than VAT !!!
 - The standard « production efficiency » viewpoint implies more than detaxation at the border i.e that « greener » goods should be subsidized !

Are strong climate policies possible within a limited carbon tax space ?

- Example factor 4 :
 - Divide by 4 emissions per capita in 2050...
 - (15-30 percent, 2020, 60+ 2050).
 - Introduce distortions..
 - Internal and competitiveness costs for « virtuous » countries....
 - The « leakage » problem... delocation with weakened standards + transportation costs (IPCC)
- How serious is the competitiveness issue ?
 - Numbers with ton of Co₂ at 30 euros, including electricity input...
 - Cement, (+115/cent), Steel, (15/c), Aluminium (18/c)...
- The environmental issue ?
 - Potentially serious,
 - Few studies, ex. MIT Press book (T,G eds)
- A politically damaging conjunction

THE EUROPEAN EQUATION : THE BORDER TAX ADJUSTMENT .

- Institutional objections
 - WTO compatible ?,
 - Yes but require priced quotas...
- Political objections.
 - The political game with less developed countries..
 - Potential improvements....
 - give back the money collected at the border from goods imported from the rest of the world to developing countries !!(my suggestion)
 - Counter objection :
 - the cost-benefit analysis of climate policies and internal political support.
- Giving free quotas to exposed industries : a flawed solution ?
 - There are indeed arguments for a progressive switch from free to auctioned quotas.
 - But leaving quotas free for exposed industries is an inefficient and costly way to help exposed industries.
 - Inefficient : lump sum subsidy that change average cost but not marginal cost (that will ultimately trigger final prices paid by consumers and outside demand)
 - Costly : giving up fiscal-like money, that could be used to switch towards better internal taxation schemes (lowering taxes on labor...)

Sectoral agreements : a second-best solution ?

- The idea :
 - Center Clean Air Policy,
 - World agreements within different sectors.
 - Steel, Cement, Refineries, Aluminium, Chemistry, Electricity.
 - Not a grand Plan, flexible..
 - Variable carbon price...
- Variants
 - Absolute or intensity..
 - Negotiated with Producers, States ?
- An uncertain implementation.
 - The attribution of quotas
 - Benchmarking or
 - Commitments.
 - Differences of technological performance...
 - How to account for « vintages » of technologies..
 - For the specific conditions and the existing industrial structure