Searching for the Green Paradox

Christophe McGlade

Research Associate

UCL Institute for Sustainable Resources

UKERC

UK Energy Research Centre

Researching pathways to a low carbon future

Overview of talk

- Background to the Green Paradox
- TIAM-UCL and scenarios implemented
- Results
  - Focus on the effects of varying the introduction of climate policies
- Conclusions

Overview of the green paradox

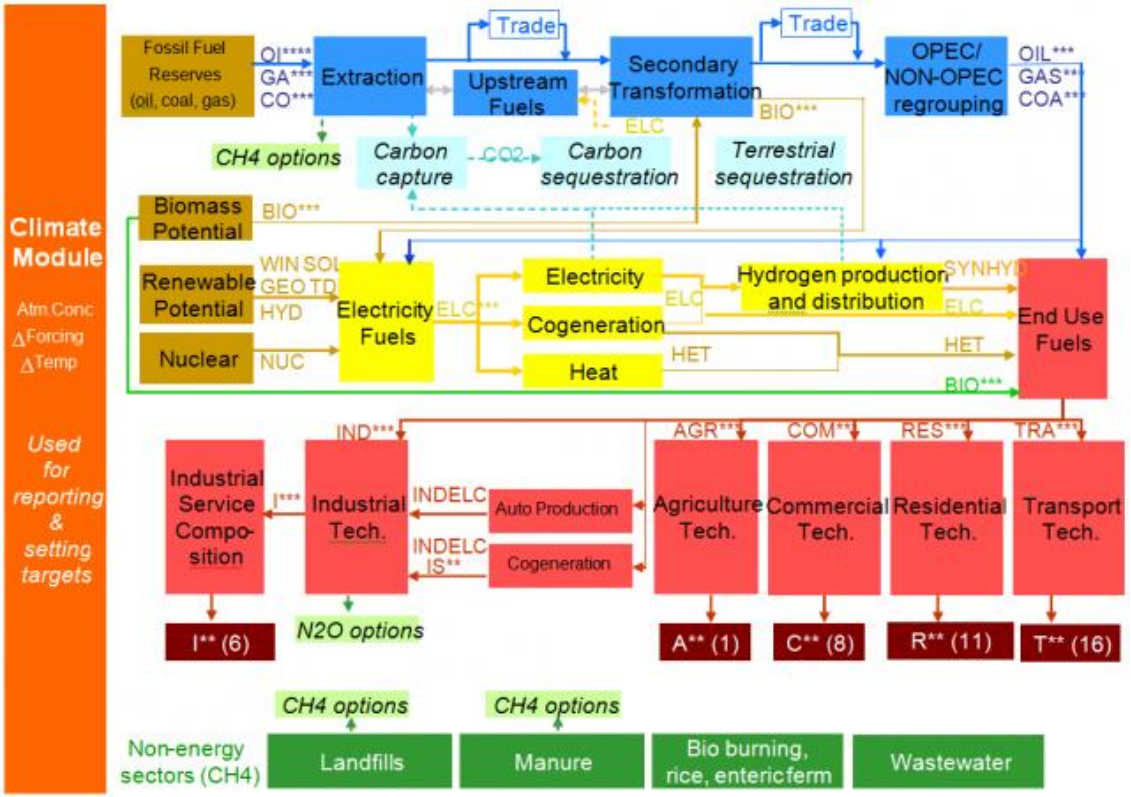
- First proposed by Sinn (2008), the green paradox suggests that some policies aimed at reducing future CO_2 emissions can perversely cause them to increase
- Based on the following logic:
  - Policy measures aimed at increasingly reducing the demand for CO_2-intensive goods and activities will reduce their value in the long term
  - These policies therefore encourage owners of fossil fuels to extract more in the near term
  - Fossil fuel prices consequently fall and consumption increases
  - Increase in fossil fuel consumption leads to an increase in CO_2 emissions in the near term
- Complimentary way of thinking about this:
  - Increasingly strict CO_2 abatement policy reduces the scarcity rent of fossil fuels
  - Optimal rate of extraction shifted forward in time
- Green Paradox is an example of intertemporal carbon leakage,
  - Additive to spatial carbon leakage
  - So any countries not implementing a CO_2 tax would doubly benefit

Green paradox literature

- Has been written about quite extensively e.g.:
  - Michielsen (2014), **Brown backstops versus the green paradox**, JEEM.68(1)
  - van der Ploeg & Withagen (2012**) Is there really a green paradox?** JEEM.64(3)
  - Di Maria & van der Werf (2012). **Imperfect environmental policy and polluting emissions: the green paradox and beyond**, Int. Rev. Environ. Resour. Econ.6 (2)
  - Gerlagh (2011**) Too much oil?** CESifo Econ. Stud.57(1)
  - Eichner & Pethig (2011). **Carbon leakage, the green paradox and perfect future markets**. Int. Econ. Rev. 52(3)
  - Edenhofer & Ottmar (2011) **When do increasing carbon taxes accelerate global warming? A note on the Green Paradox** Energy Policy.39(4)
  - Hoel (2010) **Is there a Green Paradox?** CESifo Working Paper 3168
  - Sinn (2008) **Public policies against global warming: a supply side approach.** Int. Tax Public Finance 15(4)
  - Sinn (2008). **Das grüne Paradoxon,** Plädoyer für eine illusionsfreie Klimapolitik. Econ-Verlag,Berlin.
- These (and many others) have discussed the situations under which the green paradox can arise, but have generally only examined it with theoretical/toy models
- We want to use a more empirical model to explore when it does and does not occur. For example:
  - While an increasingly strict CO_2 abatement policy may reduce the scarcity rent of fossil fuels (increasing consumption)
  - CO_2 tax also increases effective fossil fuel price (decreasing consumption)
  - Which wins will depend on the scenario under consideration

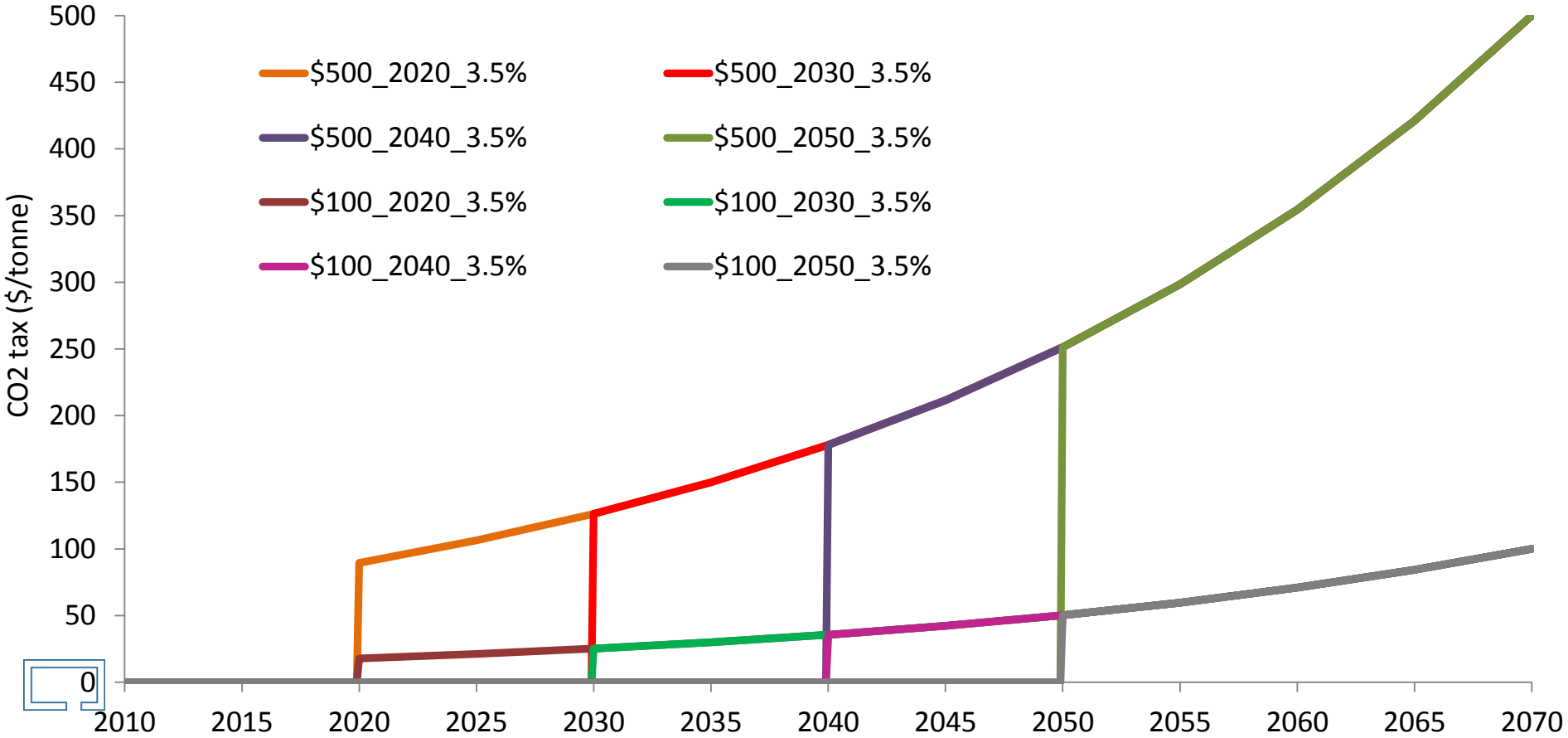
TIAM-UCL

- TIMES Integrated Assessment Model (TIAM)
- Dynamic partial equilibrium model approach with inter-temporal objective function minimising global welfare costs
  - Annualised capital costs, O&M costs, fuel costs, taxes/subsidies, salvage values, demand changes
- Technologically detailed bottom-up energy system model

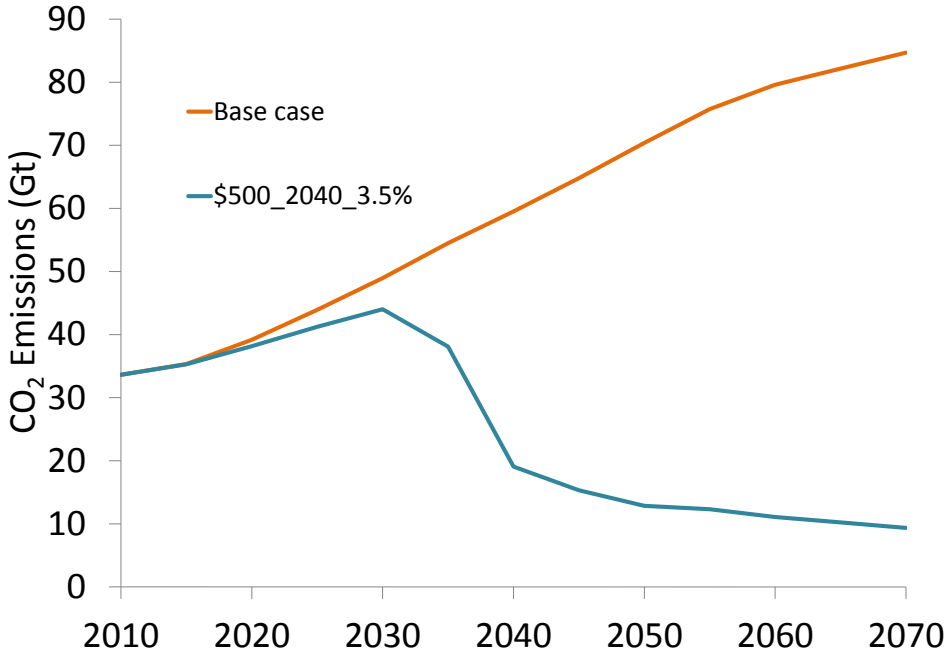


Varying start date of CO_2 tax

- No models looking at the green paradox to date have discussed whether energy system temporal dynamics affect likelihood of occurrence

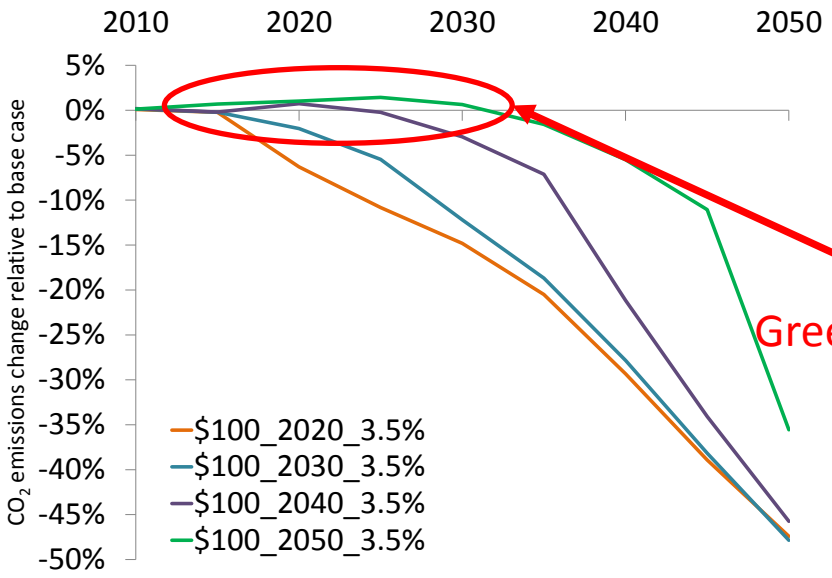


Significant divergence between CO_2 emissions profiles



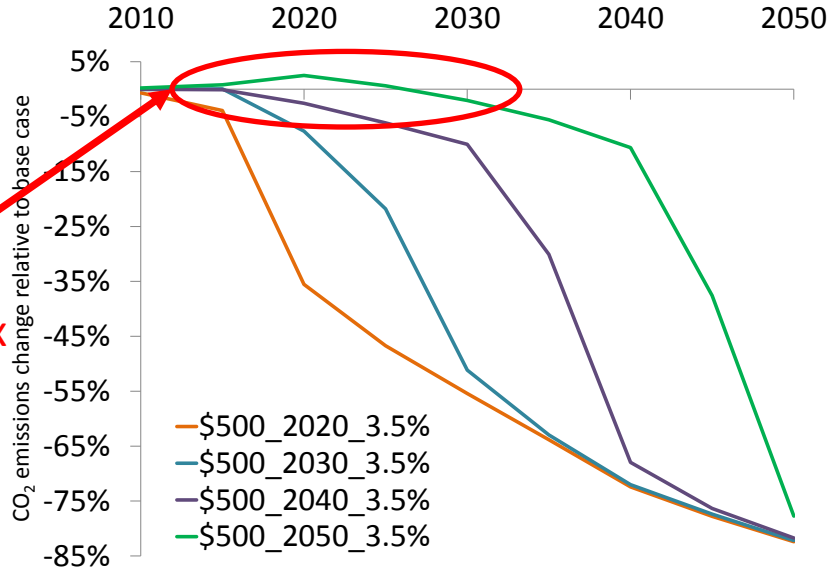
- Since we are most interested in near-term emissions rises, it is much easier to see relative changes in emissions rather than looking in absolute terms

Emissions when varying tax introduction date



Change in CO_2 emissions between $100 CO_2 tax scenarios and base case

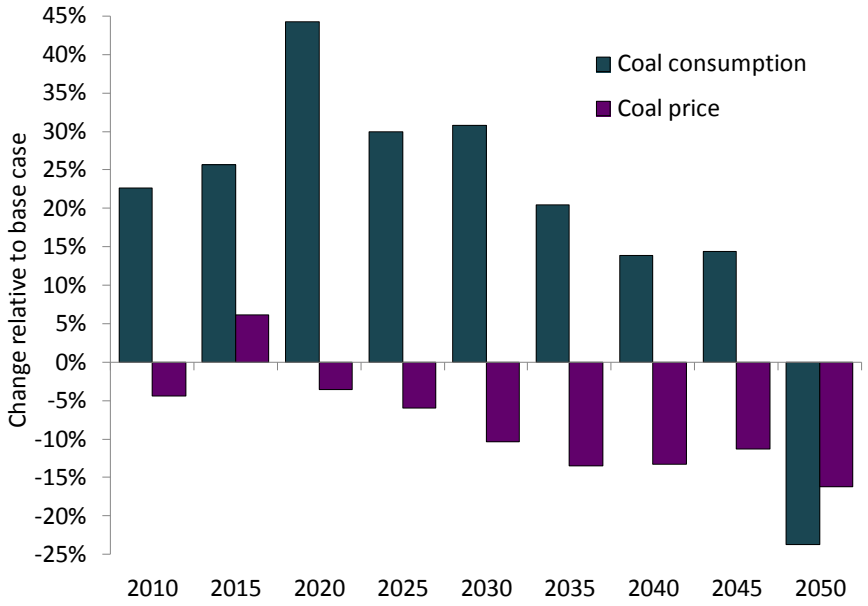
Green paradox



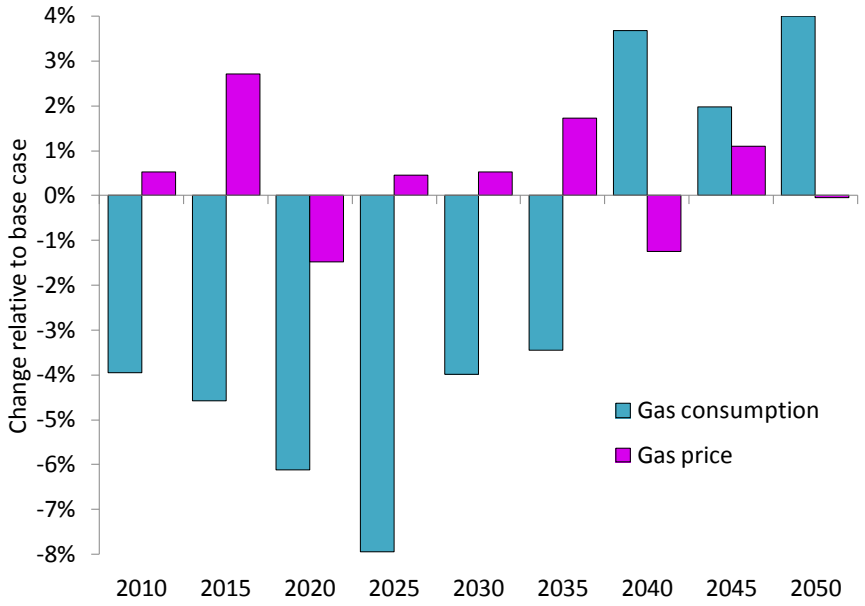
Change in CO_2 emissions between $500 CO_2 tax scenarios and base case

- Emissions can be seen to be greater in some scenarios with a CO_2 tax up to around 2030 – this is the green paradox
- BUT this occurs only if there is a significant delay in implementing the CO_2 tax
- And the increase is small especially compared with later reductions resulting from the introduction of the CO_2 tax

Why is effect in near term so small?



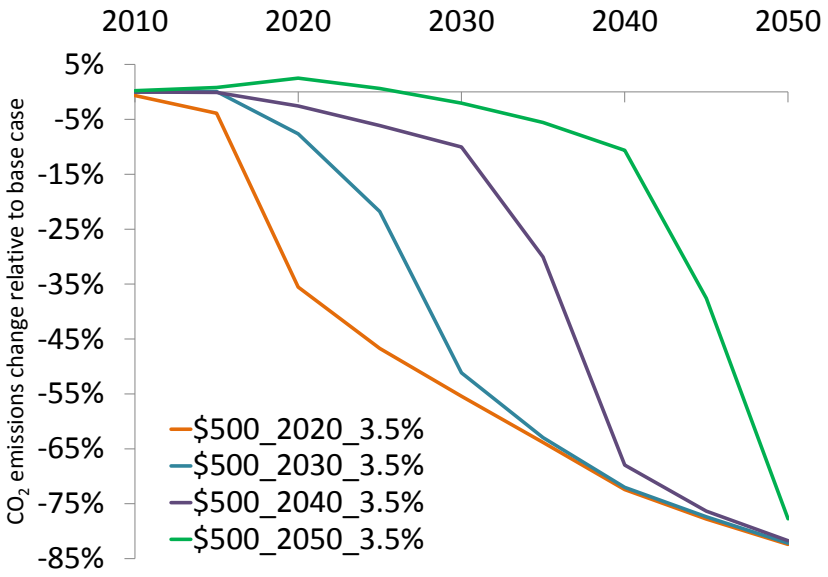
Difference in UK coal consumption between the base case and $500_2050_3.5 scenarios



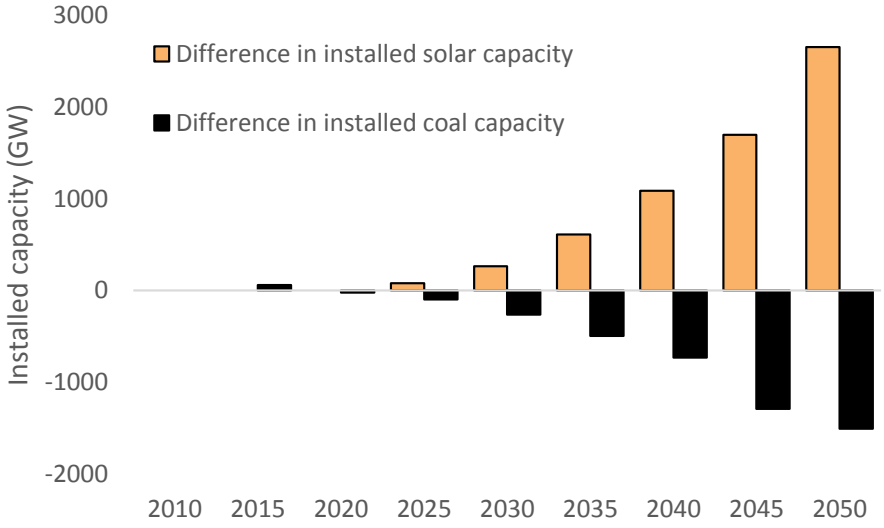
Difference in UK gas consumption between the base case and $500_2050_3.5 scenarios

- Supply-side effects: increases in coal consumption in near term are not purely additional

Why is effect in near term so small?



Change in CO_2 emissions between the base case and \$500 CO_2 tax scenarios



Differences in total installed capacity between the base case and \$500_2050_3.5 scenario

- Demand-side effects: anticipation of future tax means that investment decisions are modified long before the tax is actually introduced

Conclusions

- The green paradox emerged under a range of scenarios constructed using TIAM-UCL (which was found to be quite an effective tool to investigate its potential)
- Without a significant delay between the start of the model period and introduction of a rising CO_2 tax, the green paradox did not arise
- The green paradox effect was found to be small compared to the subsequent reductions in emissions because of the CO_2 tax
- As discussed in more detail in the paper, this arises because increases in coal consumption are offset by a reduction in gas consumption supply and because of demand-side anticipation of the policies to be implemented
- Paper also identifies factors to be considered when discussing the green paradox that are usually overlooked:
  - the 'volume effect', that cumulative production of each of the fossil fuels can be less than the total resource available
  - the need to consider each of the fossil fuels separately, and
  - the influence of CO_2 taxes on the production costs of the fossil fuels

Thank you

christophe.mcglade.09@ucl.ac.uk

www.bartlett.ucl.ac.uk/sustainable

Mathematical background

- The green paradox is based upon principles behind Hotelling rule, namely that the price of a commodity over time can be given by:

$$p(t) = c + \underbrace{\lambda(\tilde{A})e^{rt}}_{Hotelling\ rent}$$

with c the marginal cost of production, r the resource holder's discount rate and A the total availability of the fossil fuel

- When a rising CO_2 tax is introduced, this is modified to

$$\acute{p}(t) = c + \left(\acute{\lambda}(\tilde{A}) + \tau_0\right)e^{rt} + \tau_0\left(e^{\theta t} - e^{rt}\right)$$

with τ_0 the initial tax rate and θ the rate at which the tax rises

- If θ = r the third term is equal to zero, the temporal dynamics of the system do not change
- if θ > r then the third term increases over time and so, compared to a case with no taxation, the price rises faster over time: producers will extract more resource earlier and less later