

The economics of oil shortages and climate change policy

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Outline

What can economics bring to the debates on addressing climate change?

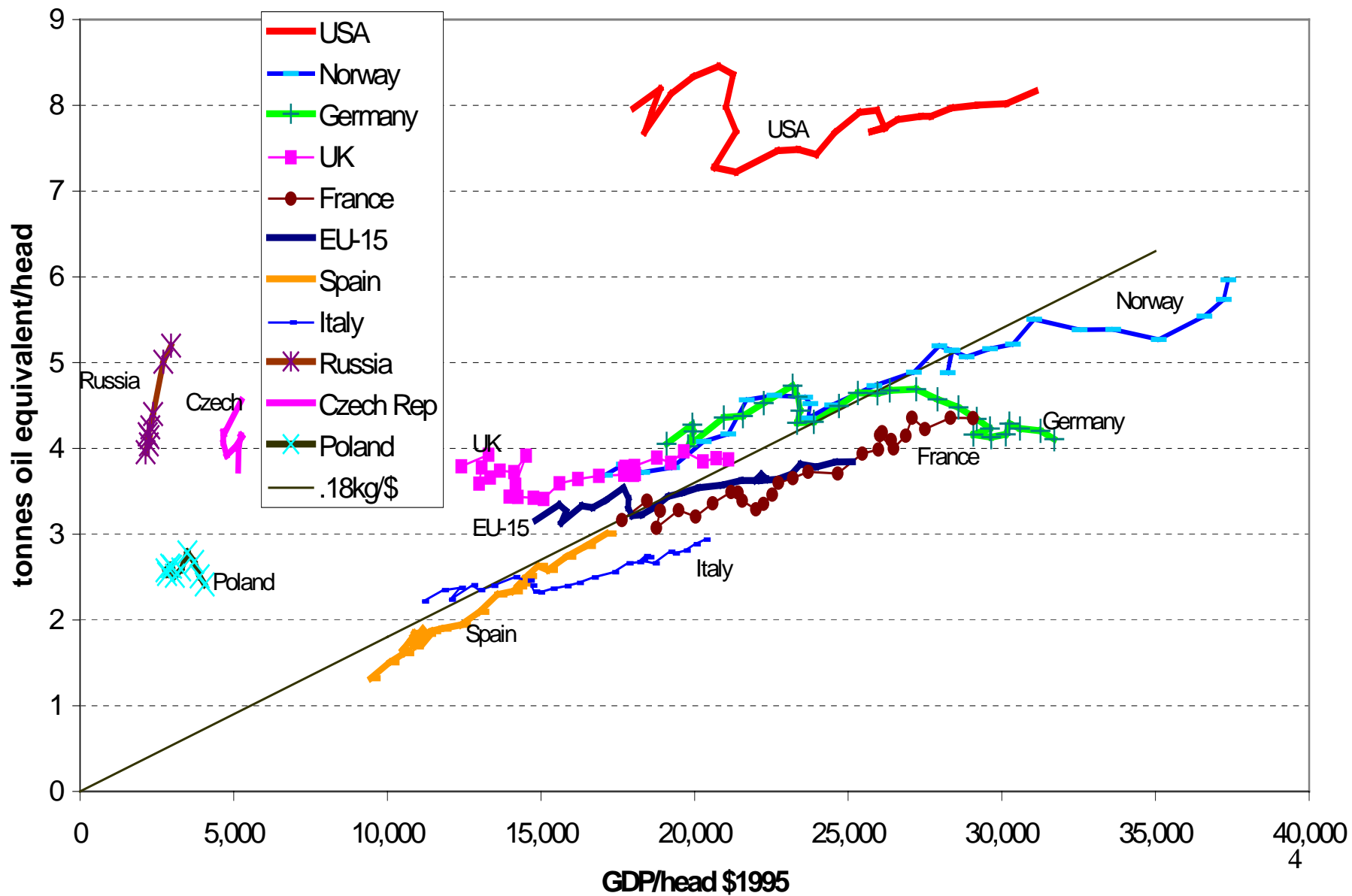
- Exhaustible resource theory: prices and rents
- Oil - exemplar of an exhaustible resource
- Mitigating Climate Change
 - The EU Emissions Trading System and its flaws
 - the case for a carbon tax/price
- Effect of carbon tax on climate change
- Problems: prisoners' dilemmas
- Solutions - incentives for compliance

Fuels, GHG and markets

- Fossil fuels: main source of anthropogenic CO₂
 - Oil is an exhaustible resource
- ⇒ competitive markets can price for scarcity
- but oil markets are not competitive
 - and they suffer from a massive market failure

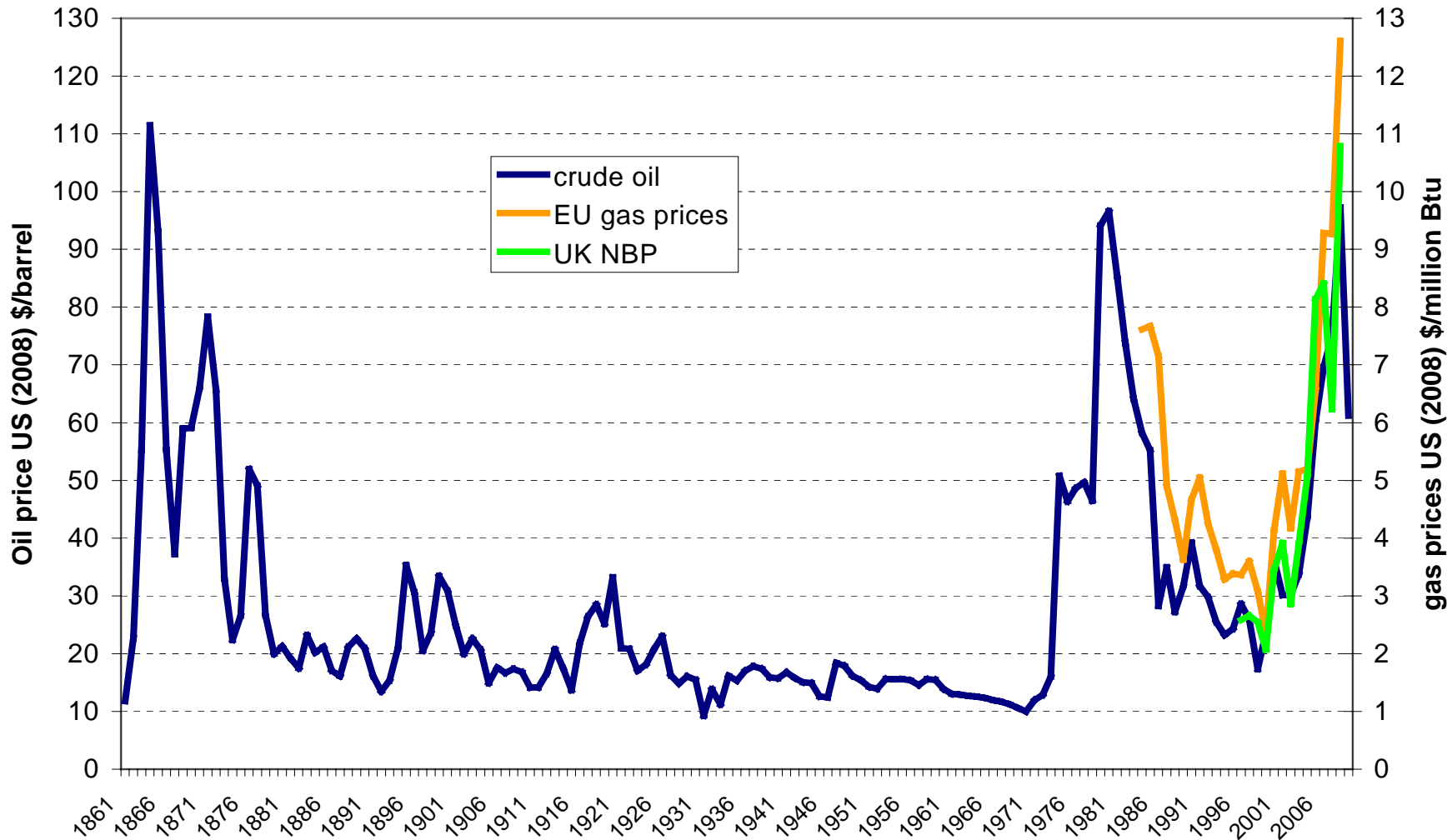
GHG emissions are a global public bad
“greatest .. market failure ever seen” (Stern)

Energy use/hd vs GDP/hd 1972-99



How does one explain market prices of oil?

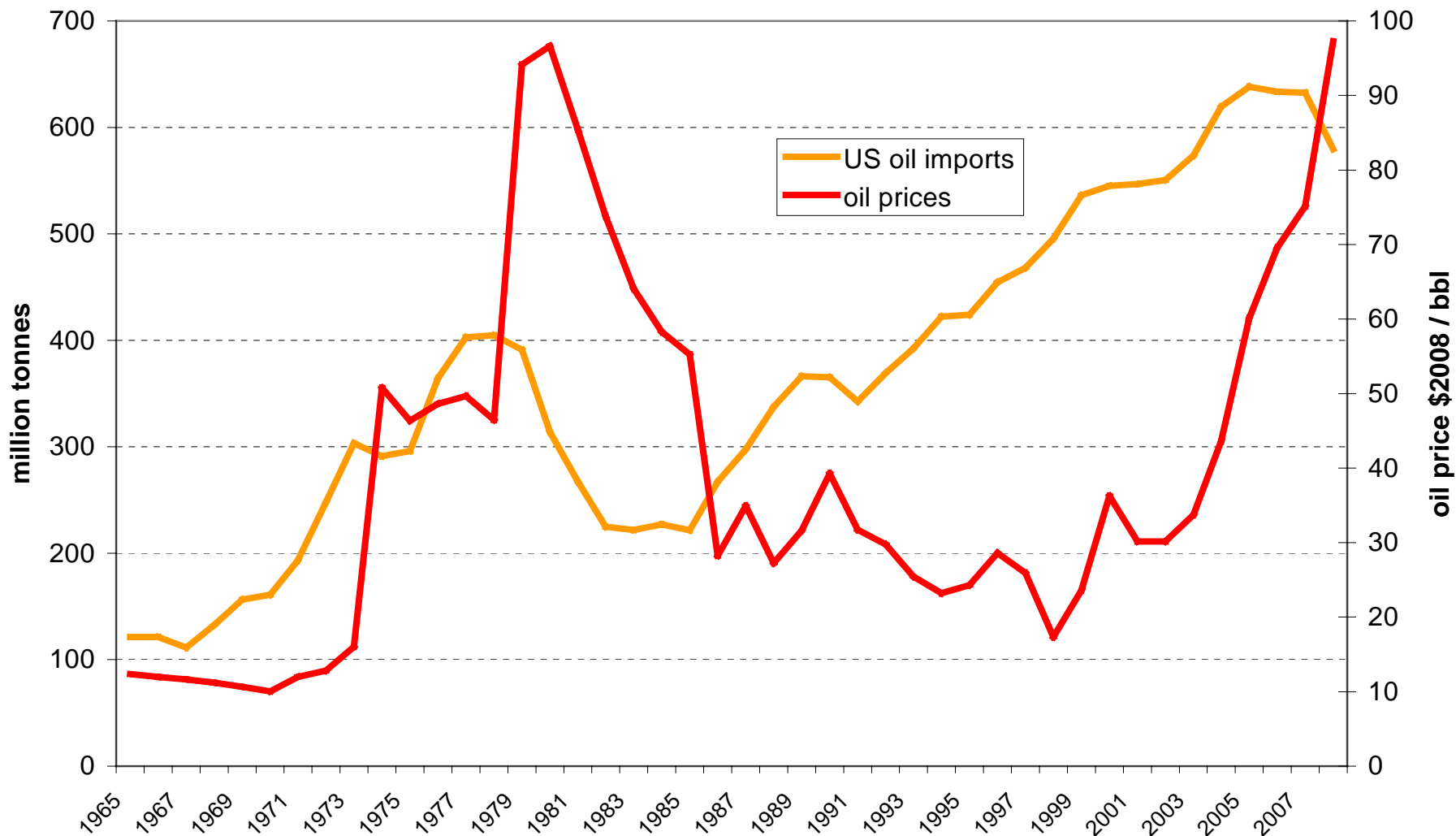
Real crude oil prices 1861-2009 and gas prices 1984-2008



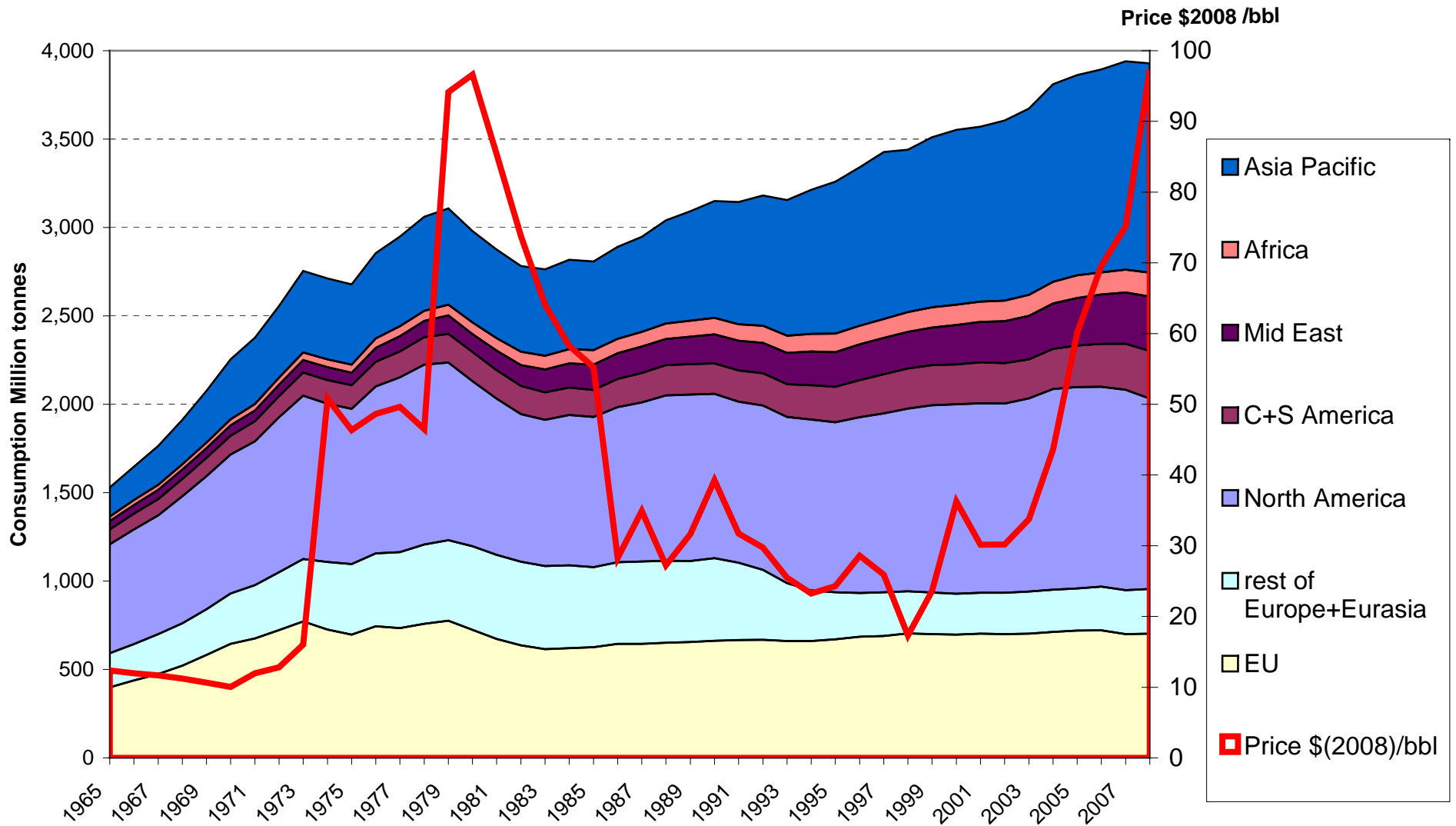
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What caused the oil shocks?

US oil imports and oil prices



Regional oil consumption 1965-2008



Exhaustible Resource Theory

Competitive case, no externalities

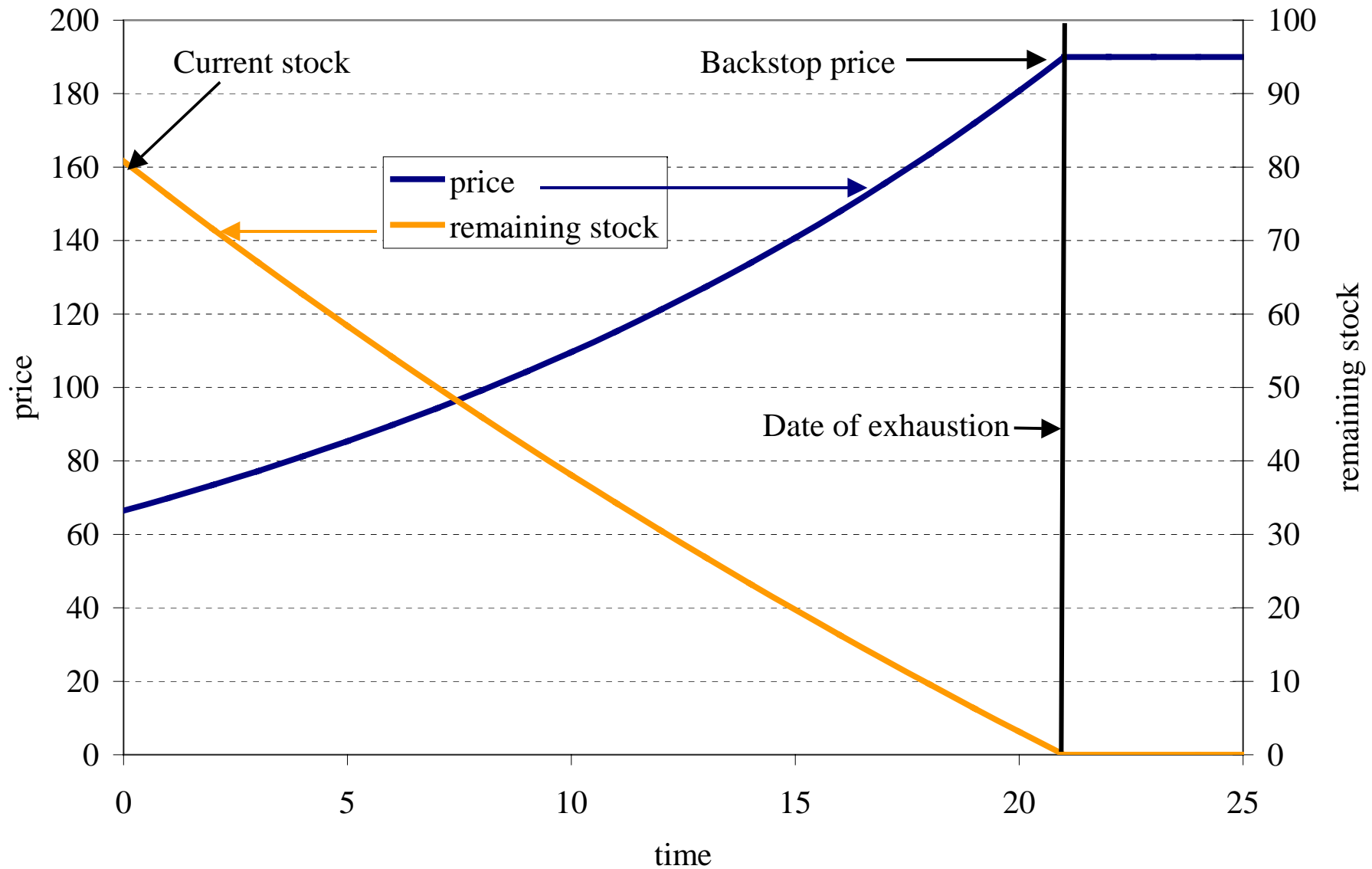
- current price depends on **expectations** about future
- price p_t less marginal extraction cost = **rent**
- rent rises at discount rate r during extraction
- backstop price p^* set by substitutes or exhaustion
- p_0 depends on stock, cost profile, future R&D, p^* , r
- Shocks affecting current price
 - new **discoveries**, **technical progress**, backstop p^* ,
changes in ownership affecting r , **supply constraints**

Simplest Hotelling case

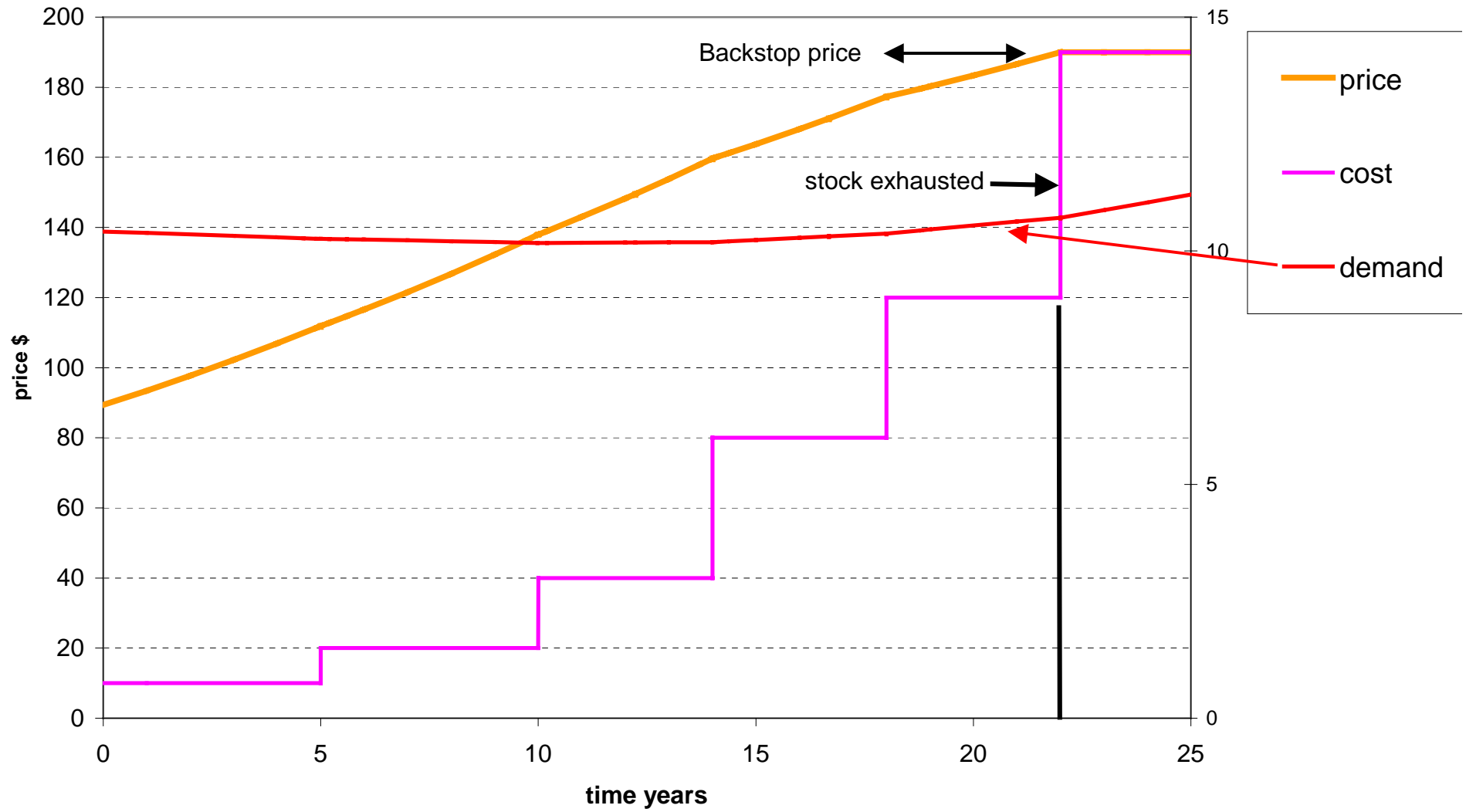
- Oil - very low variable cost, elastic supply
- competition \Rightarrow price rises at rate of interest
- future price fixed by backstop
- work back to find demand at each price
- cumulative demand exhausts at backstop

*current price found from future price
and current stock*

Hotelling theory - zero extraction cost



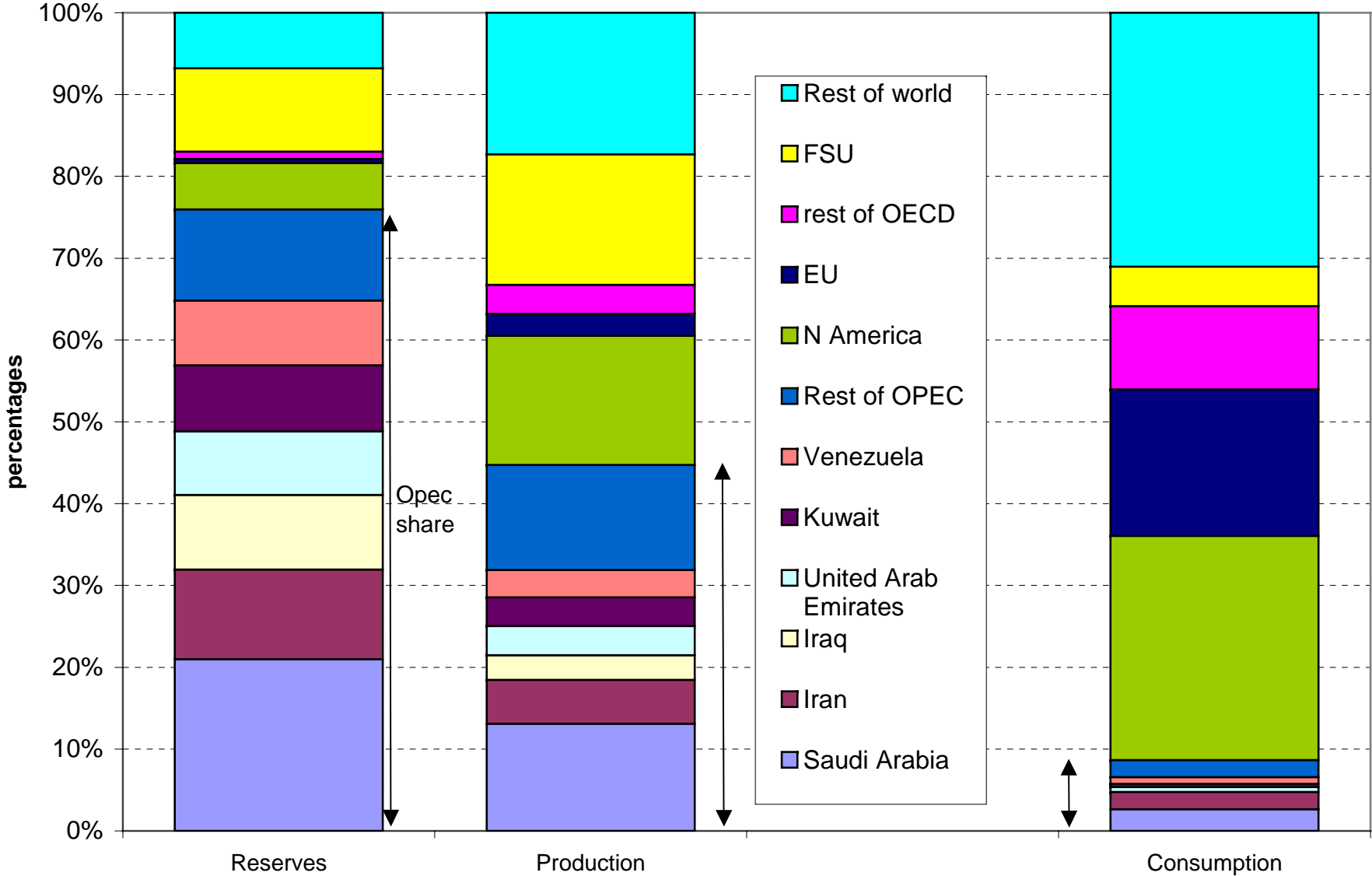
Price, cost and demand for an exhaustible resource



Market failures

- Oligopoly => prices higher than otherwise
- Imperfect property rights => overexploitation
- Import cartels - e.g. fuel import tariffs
 - raise domestic price => reduce demand => lower world price (*but how much?*)
 - not credible? hard to distinguish from road taxes?
- Externalities in use - GHG emissions
=> restrict use, lower demand and world price

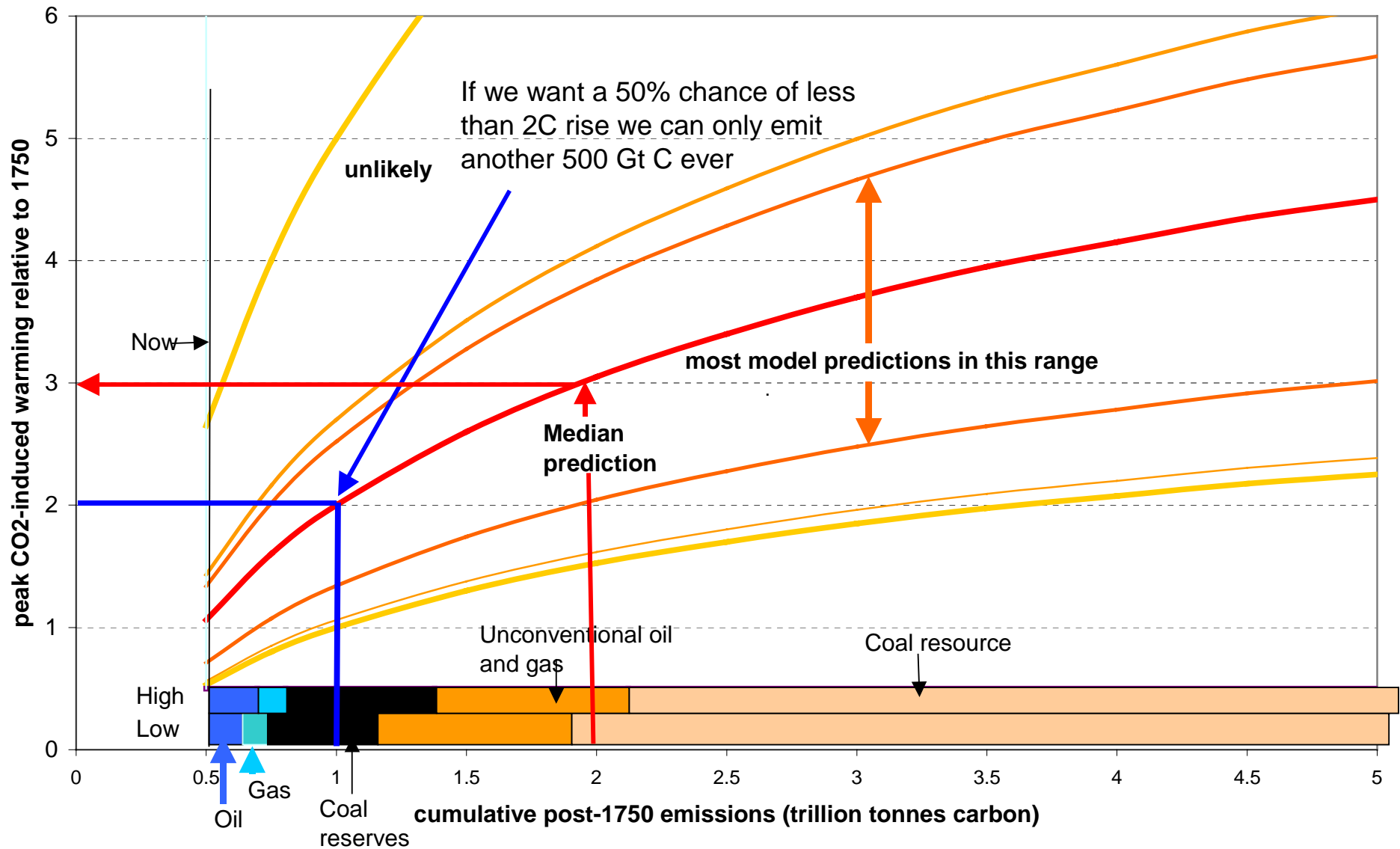
Reserves, Production and Consumption shares 2008



Policies for mitigating climate change

- GHG emissions are a **global stock public bad**
 - uncertain distant damage with uneven impacts
 - => **very hard to agree coordinated policies**
 - damage regardless of emissions location, persistent
 - => **damage moderately independent of date of emission**
 - much irreversible over historical time scales
- Solution: uniform charge for GHG emissions,
 - charge rises at discount rate
 - reset in light of new information

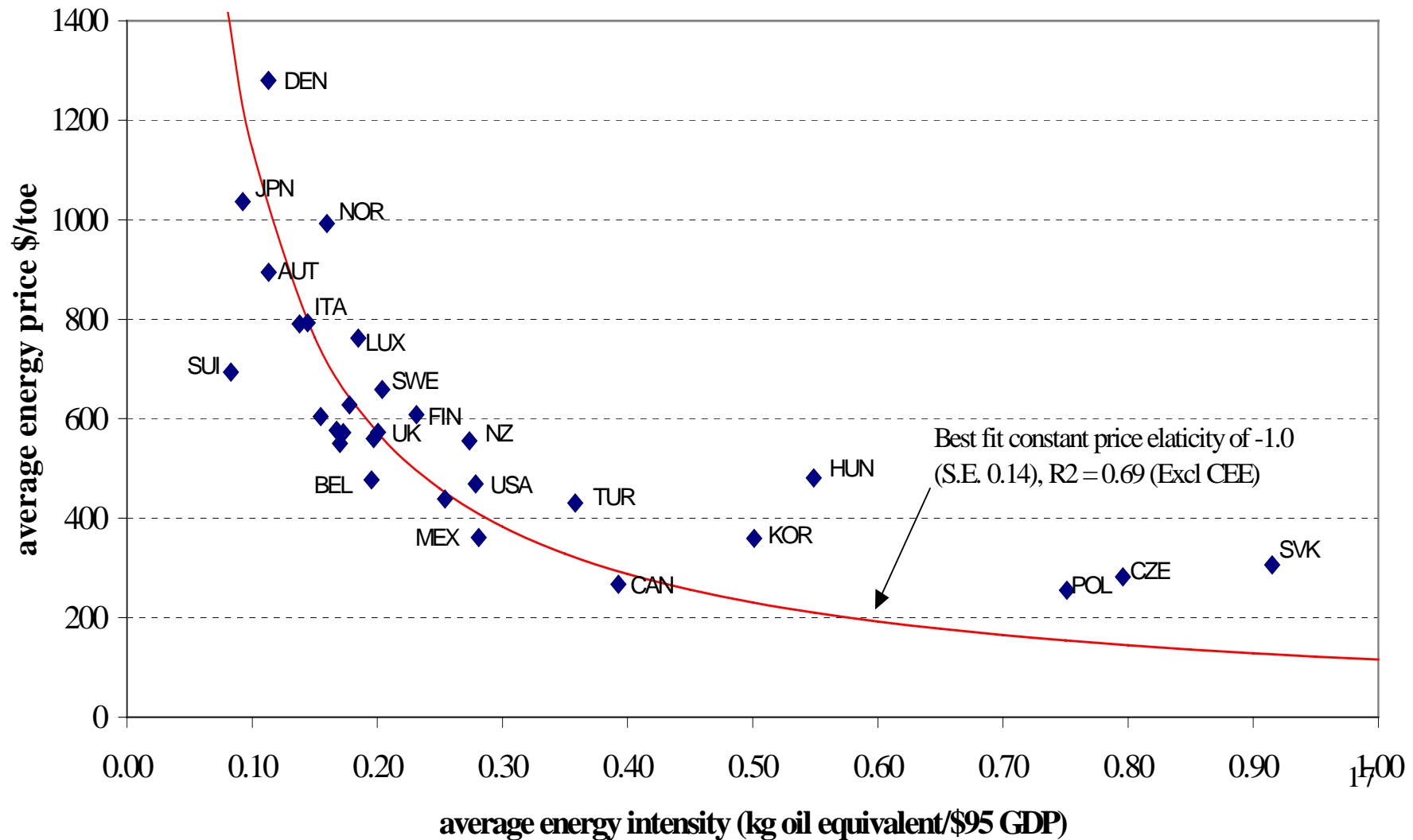
Peak CO₂-warming vs cumulative emissions 1750–2500



After MR Allen *et al.* *Nature* **458**, 1163-1166 (2009) doi:10.1038/nature08019

Prices matter for energy use!

Cross-section relation between average energy intensity and average energy price
1993-99

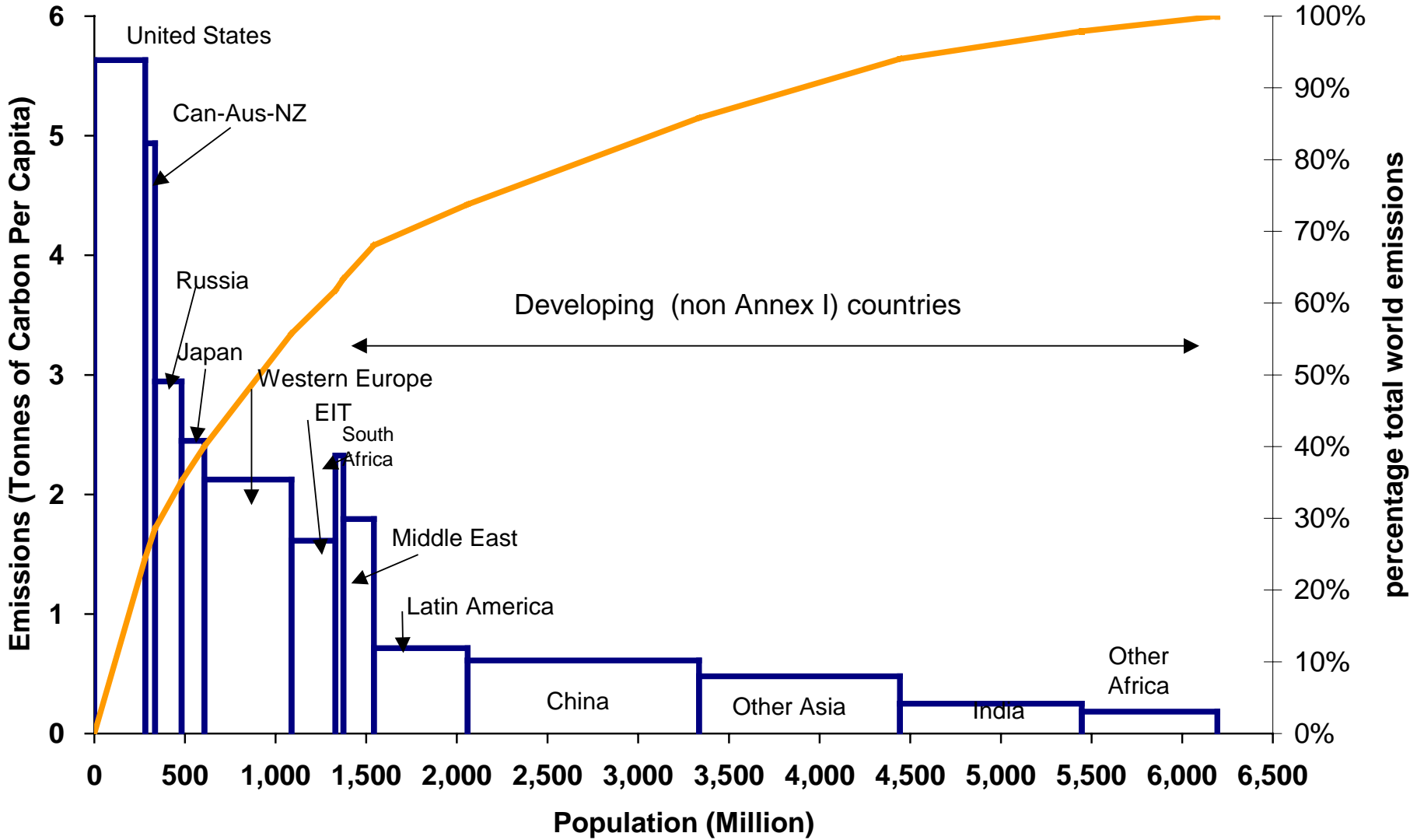


Controlling GHG emissions

- Kyoto to agree targets for reduction by 2012
 - Annex 1 countries, CDM/JI to encourage others
 - But Copenhagen failed to extend adequately
- European Emission Trading System
 - Allocate allowances to member states
 - National Allocation Plans overstated for national gain
- Fixes total quantities: cap and trade in EUAs

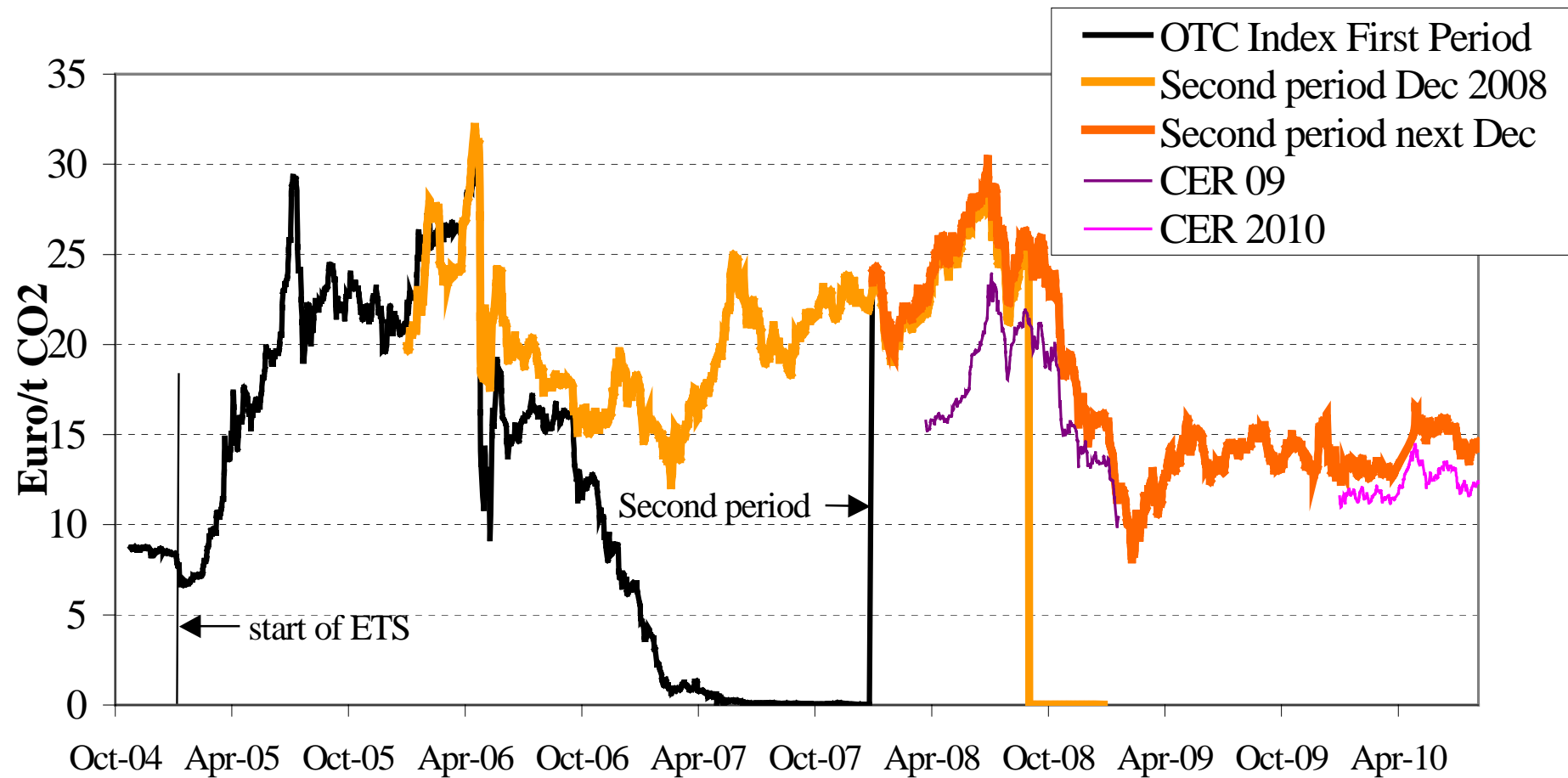
But EUA prices volatile, collapse in 2009

CO₂ emissions/hd (areas = total emissions)

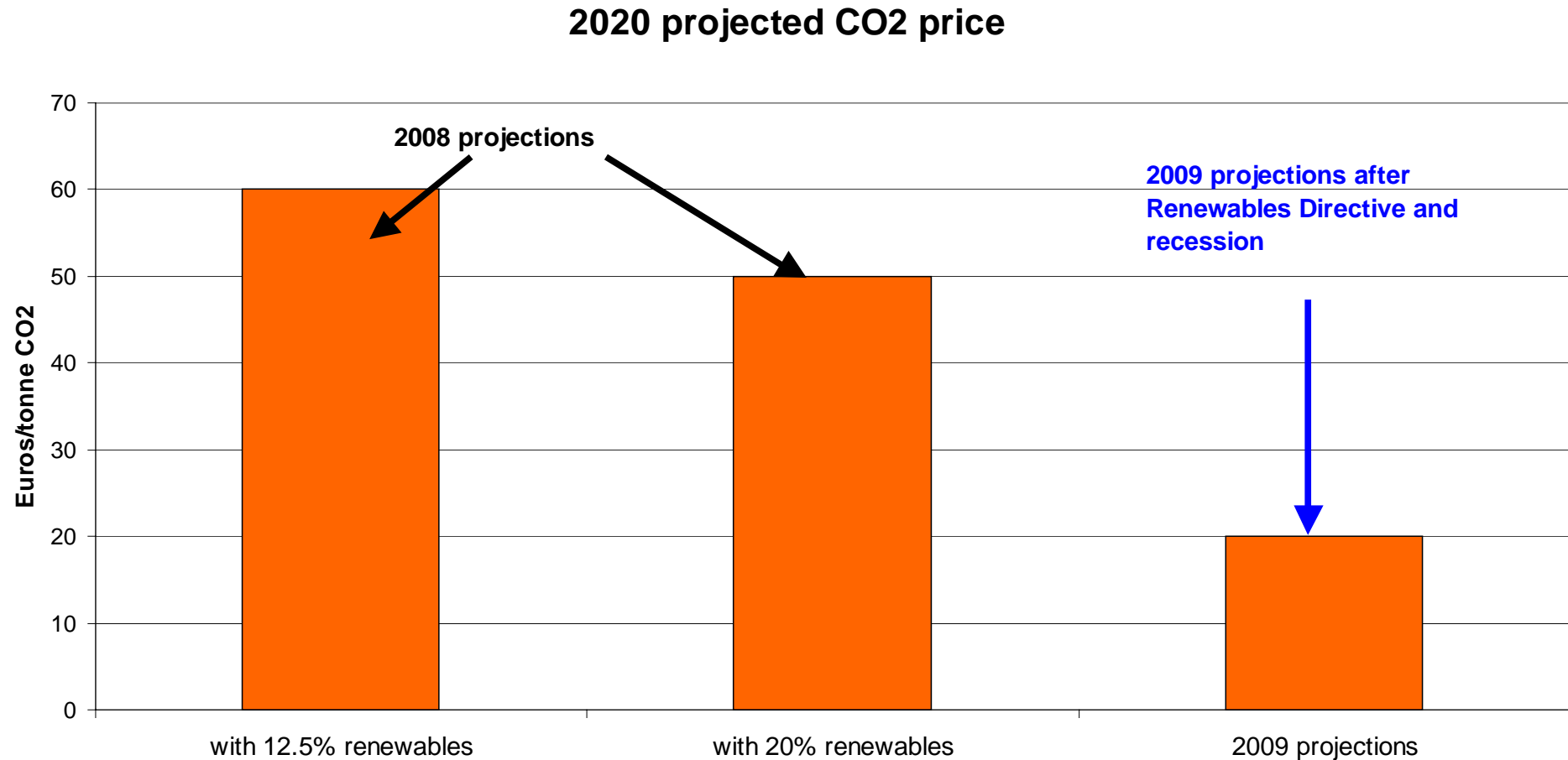


CO₂ prices are volatile and now too low

EUA price October 2004-December 2010



Current forecasts too low for low-C generation



Source: Committee on Climate Change, 2008 and 2009

Permits vs Taxes

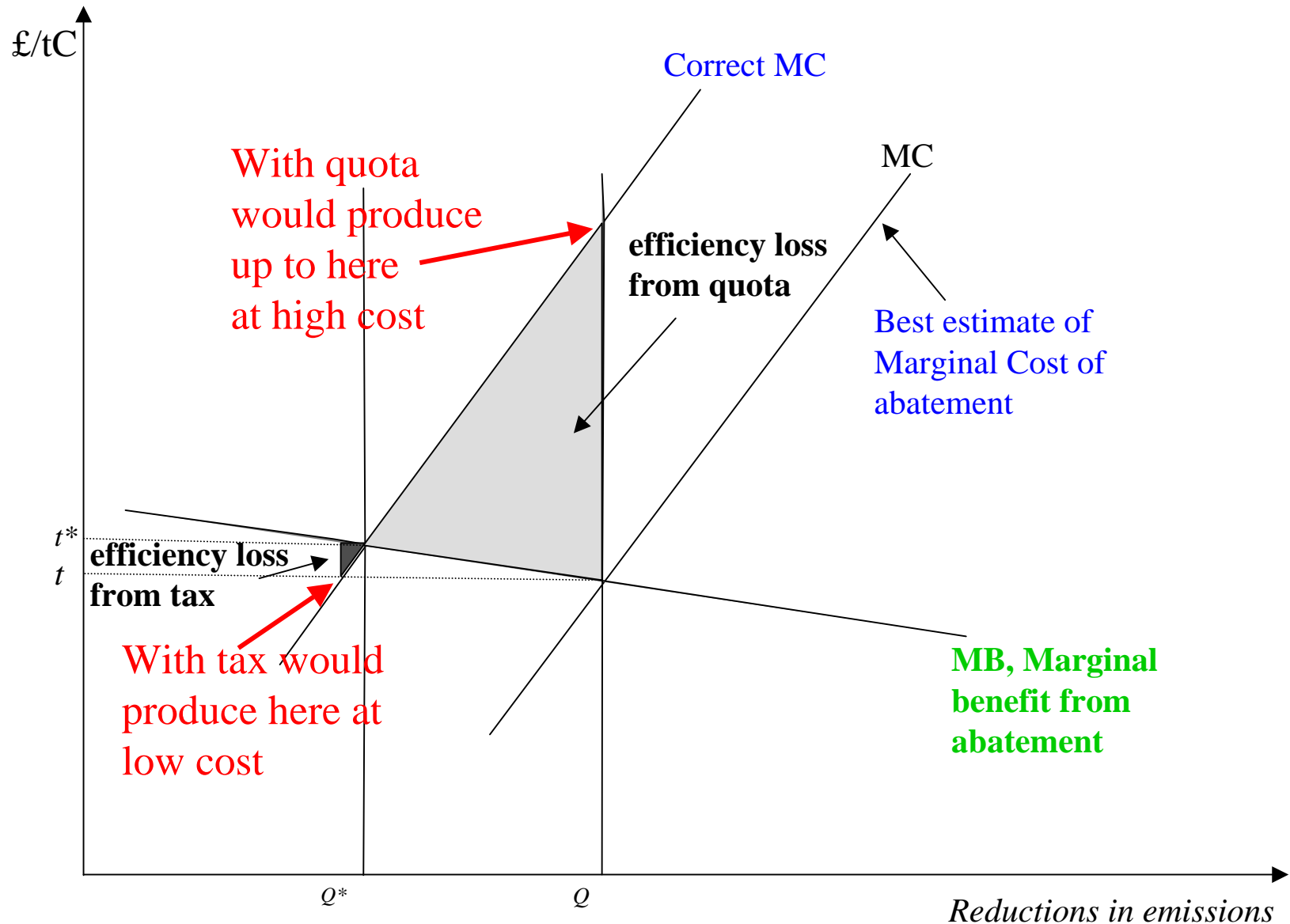
Weitzman: Taxes superior to permits unless MB of abatement **steeper** than MC

CO₂ is a *global persistent stock pollutant*

- CO₂ 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
but permits easier to introduce***

Costs of errors setting prices or quantities



Prisoner's dilemma

- Players: UK (or Annex 1) and rest of world (ROW)
 - UK: 2% of GHG; EU: 15%; OECD: 47%; Annex 1: 57%
- Actions: abate (A) or not abate (N)
 - Tax/price GHG or not; countries keep C-tax revenue
- Pay-offs (e.g. India, 5%, ROW 95% total):
 - (N,N) => no costs now but damaging climate change
 - (A,A) => costs now, future CC damage averted
 - (N,A) => India: **no costs, cheaper fossil fuel, AND most CC damage averted**

Incentive not to co-operate

Prisoners' Dilemma

Player 2

		Player 2	
		A	N
Player 1	A	10, 10	-50, 110
	N	110, -50	5, 5

If P1 plays A, P2 plays N, P1 gets -50

If P1 plays N, P2 plays N, P1 gets 5

***(N,N) is a dominant strategy and Nash Equilibrium
in one-shot game***

Repeated game

- If the players repeatedly play they can sustain co-operation and enjoy (10,10) instead of (5,5)
 - temptation to deviate and gain 110 can be punished by refusing to co-operate ever again
- => gain 100 for one period, lose 5 for ever
- => worth co-operating if discount future at 5% or less

Co-operation in PD requires penalties on deviants

Game theory and climate agreements

- Climate damage is not a static repeated game
 - Gradual increase, significant after 50-100 yrs
 - Once damage apparent it may be too late to act
- Strong mitigation now lowers energy prices
 - Increases incentive to cheat
- Unequal impacts around world
- Not two parties but large number
 - Coalitions like EU help, but China, India both large

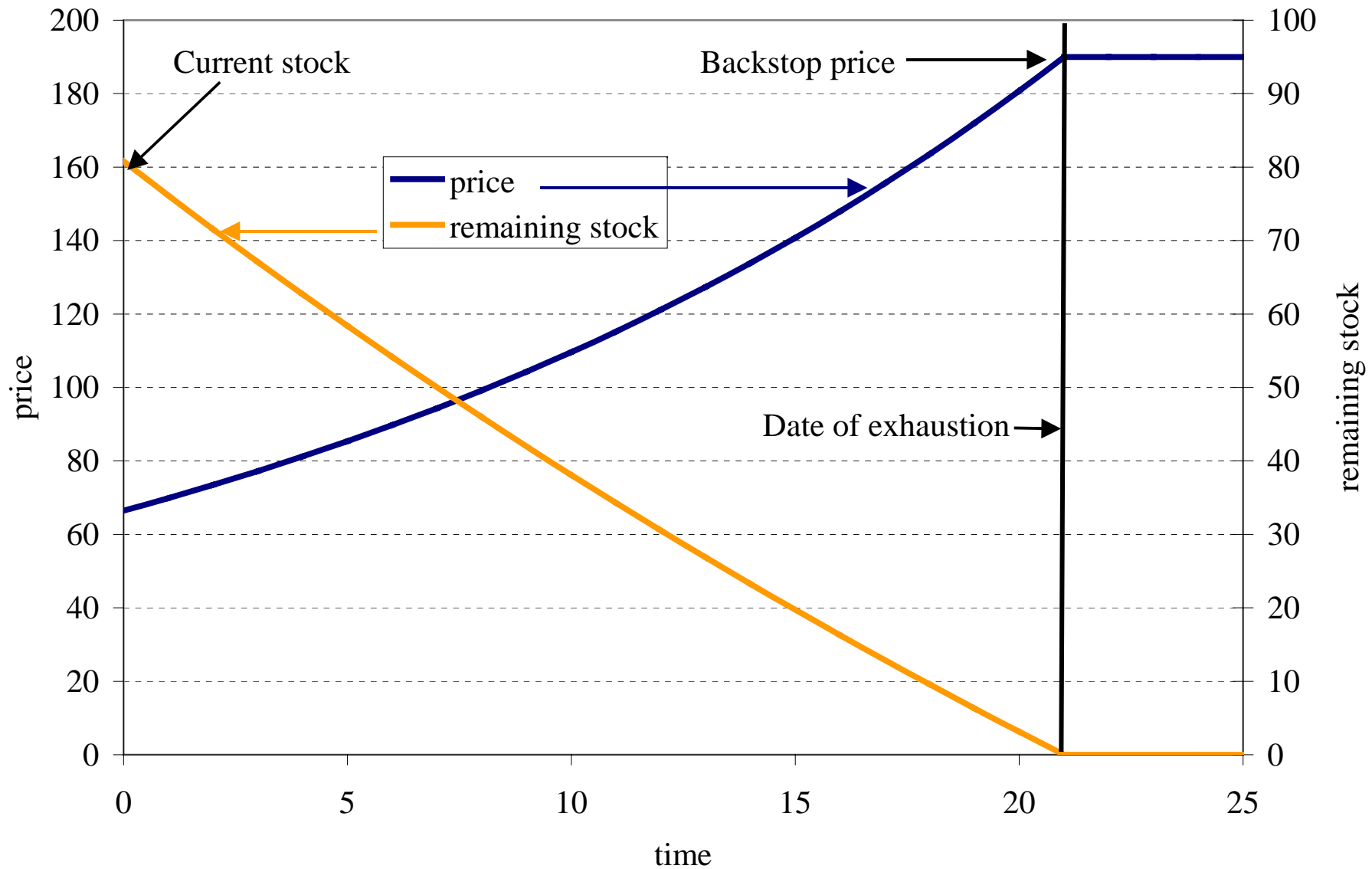
=> Increase benefits of cooperation, costs of deviation

Efficient global carbon tax

- Rises at rate of interest
 - solution where CO₂ has very long residence time
- emission allowances are financial assets
 - their price would rise at rate of interest

As an oil tax rise at rate of interest

Hotelling theory - zero extraction cost



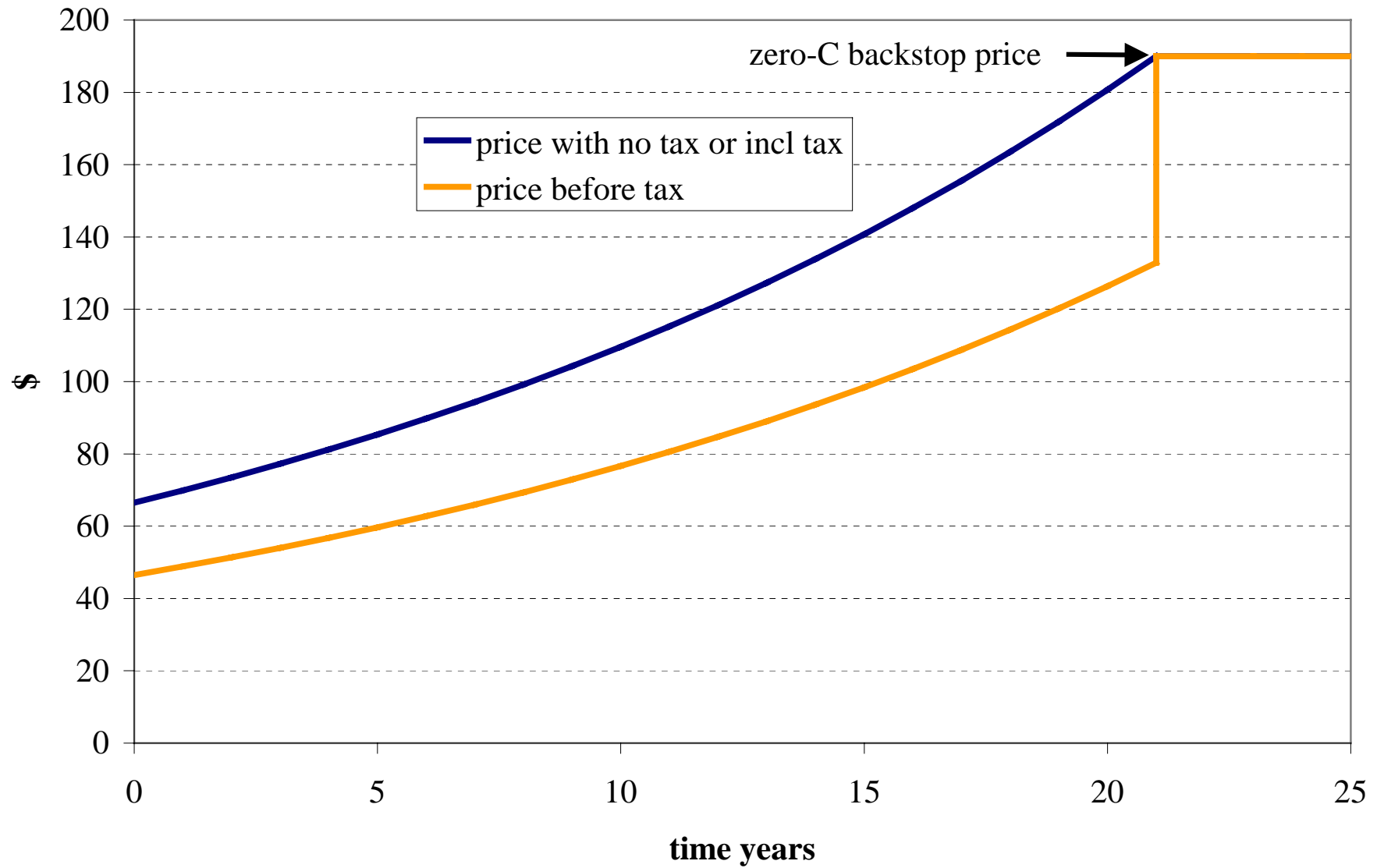
Green paradox

- Oil - very low variable cost, elastic supply (?)
- competition \Rightarrow price rises at rate of interest
- future price fixed by backstop
- efficient global tax rises at rate of interest
 - no distortion in intertemporal use
- No tax on backstop \Rightarrow post tax price = pre-tax price; all tax borne by oil suppliers

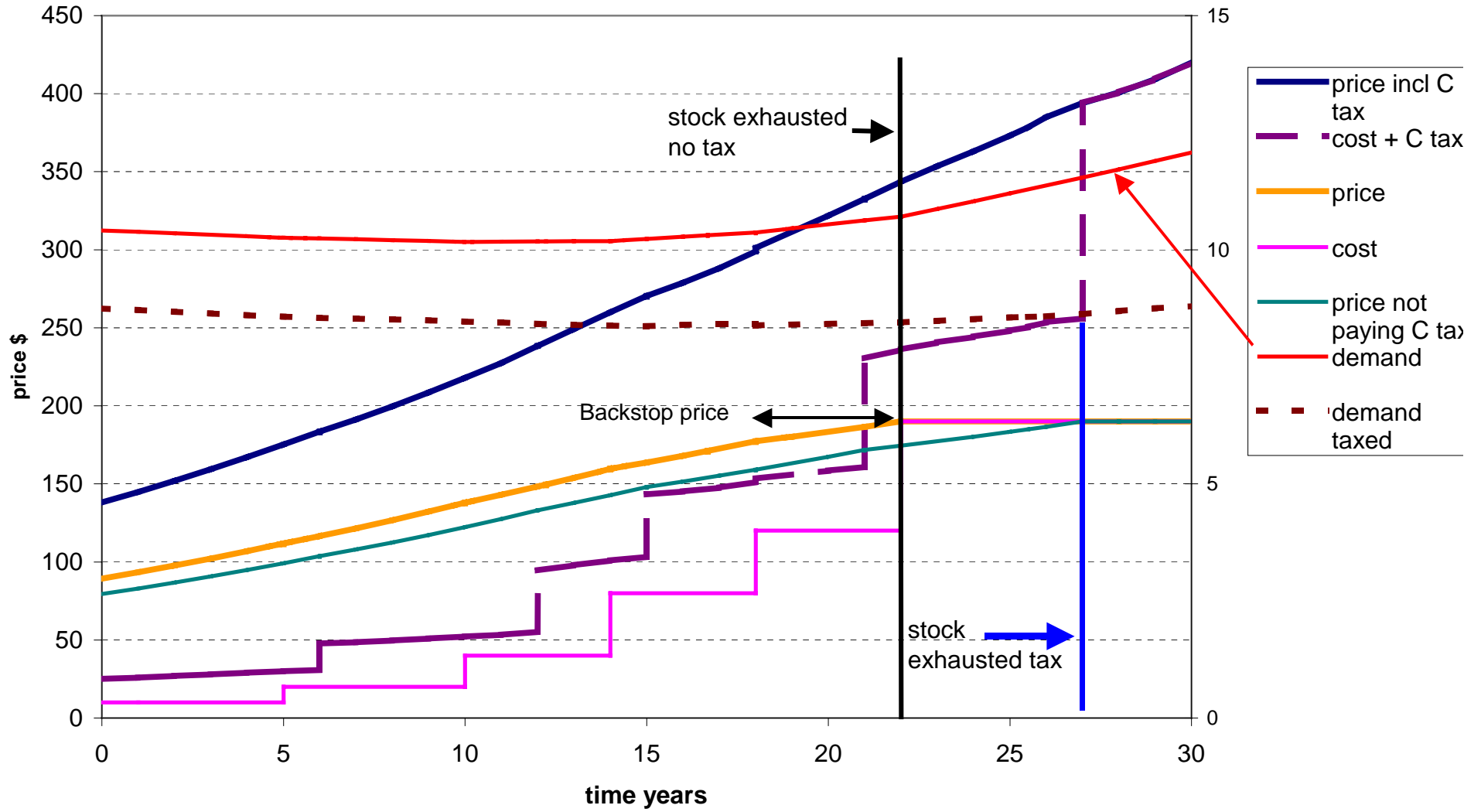
No impact on carbon emissions

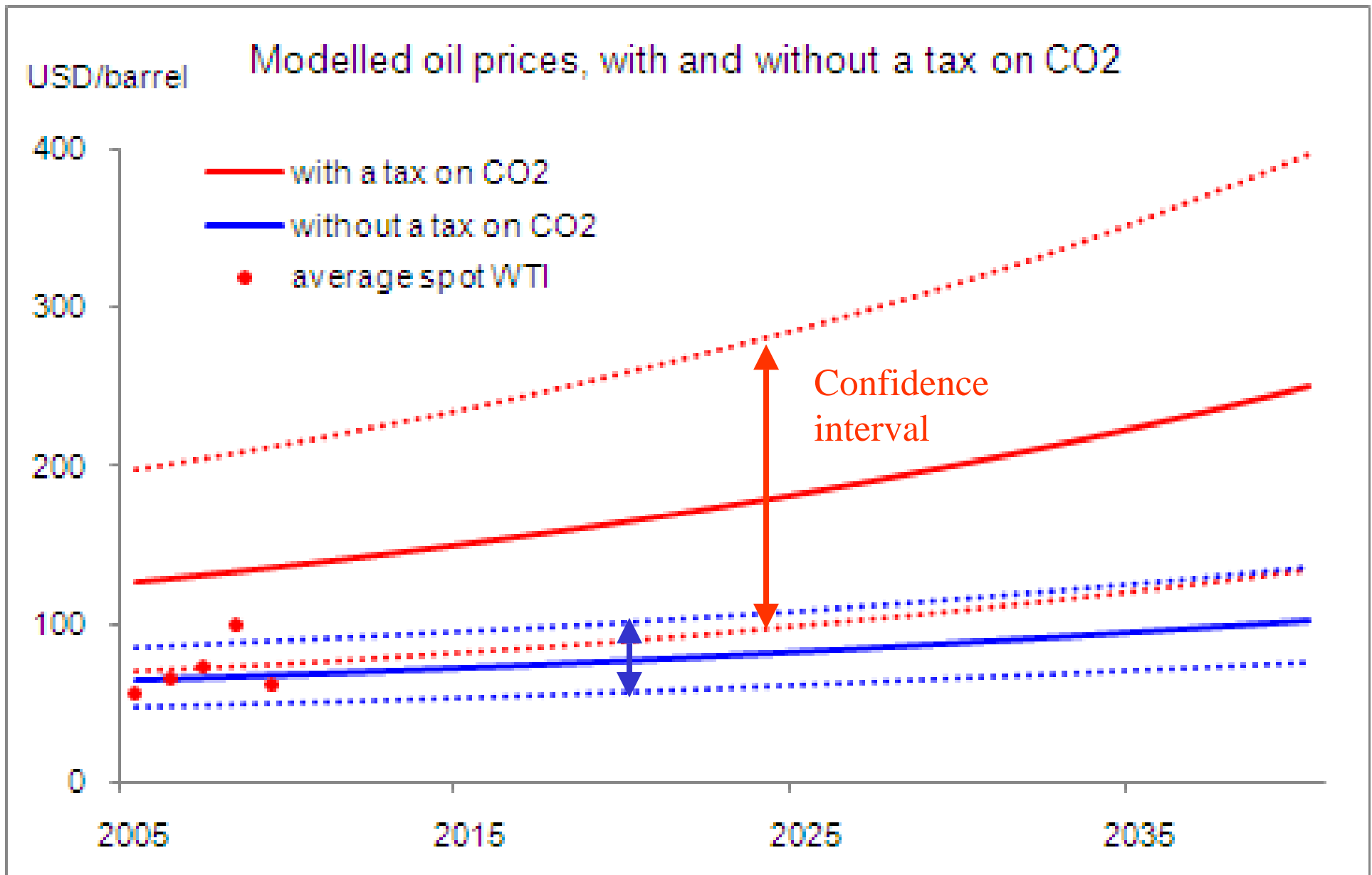
pre-tax price falls \Rightarrow cheat \Rightarrow more CO_2

Green paradox



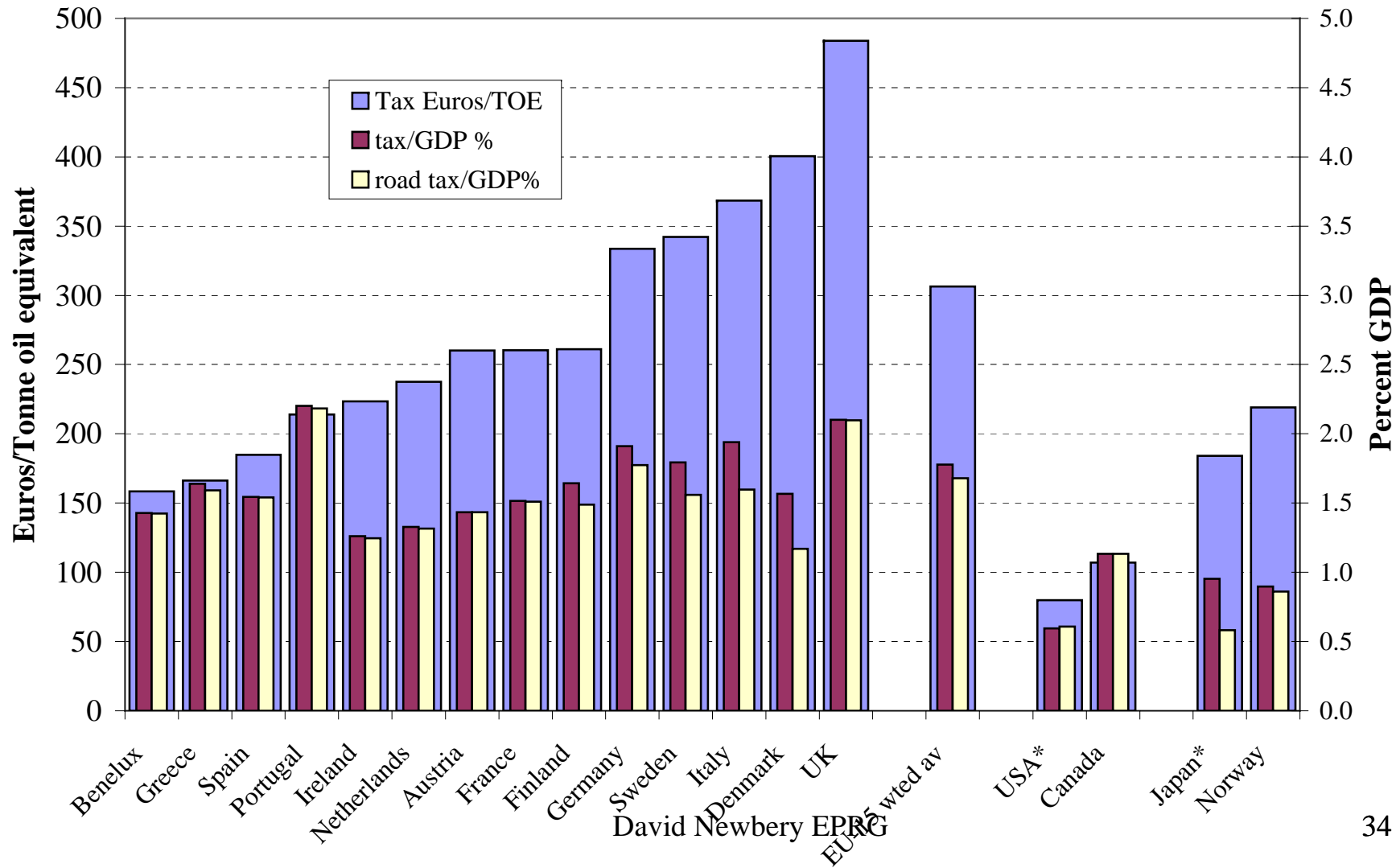
Price, cost and demand for an exhaustible resource





Source: Mejean and Hope 2010 David Newbery EPRG

Taxes on oil and products 2002



Encouraging mitigation

- Charge GHG emissions everywhere to correct failure to properly price GHG
 - => C-tax on fossil fuel (rebates for ETS)
 - => countries replace other taxes with C-taxes
- Encourage compliance with border taxes
 - VAT on imputed carbon content
 - corrects for subsidy in non-taxing countries

Conclusions

Economic theory helps think about fossil fuels
and climate change

- Hotelling exhaustible resource theory

- externalities and public goods

=> corrective taxes/prices

- but Prisoners' dilemma requires incentives

=> penalties for non-compliance

=> border tax adjustments

***But equity and efficiency in conflict
damage distant and uncertain***

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