Obstacles and the need for radical climate policies

ECB WORKSHOP
'FISCAL POLICY AND CLIMATE CHANGE'
FRANKFURT, 20 SEPTEMBER 2022

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OUTLINE

- Golden policy: carbon pricing (etc.)
- Very little has been achieved
- Obstacles to climate policies
- Need for radical climate policies

GOLDEN POLICY: CARBON PRICING

- Curbs demand for fossil fuel.
- Encourages to leave more fossil fuel in crust of earth.
- Induces substitution from carbon-intensive (tar sands?, coal, crude oil) to less carbon-intensive fossil fuel (gas).
- Induces substitution away from fossil fuel to renewables and brings forward the carbon-free era.
- Boosts CCS and limits slash and burn of forests.
- Boosts R&D into clean fuel alternatives and into energy-saving technology.
- Encourages households, firms and government to spend more on CO2 mitigation and CO2 adaptation e.g. dykes).

Peak Global Warming and Safe Carbon Budget

- Temperature cap acts as political focal point
- Cumulative emissions drive peak global warming
- Safe carbon budget is about 122 GtC to stay below 1.5 degrees Celsius: about 14 years at current use of fossil fuel use left

- Clock is ticking fast

- Carbon price necessary to stay within 1.5 degrees Celsius cap must rise at a rate equal to the interest rate (Hotelling)

- Alternative: Pigouvian approach (social cost of carbon)

VERY LITTLE HAS BEEN ACHIEVED

- What have we learned according to Nordhaus:
  - Very little carbon pricing
  - With very little coverage: muddled, fragmented & low
  - Collapse of Kyoto agreements: international climate policy is at a dead end
  - Not enough investment in green technology: double externality (global warming and learning by doing)
  - Huge fossil fuel subsidies, especially coal

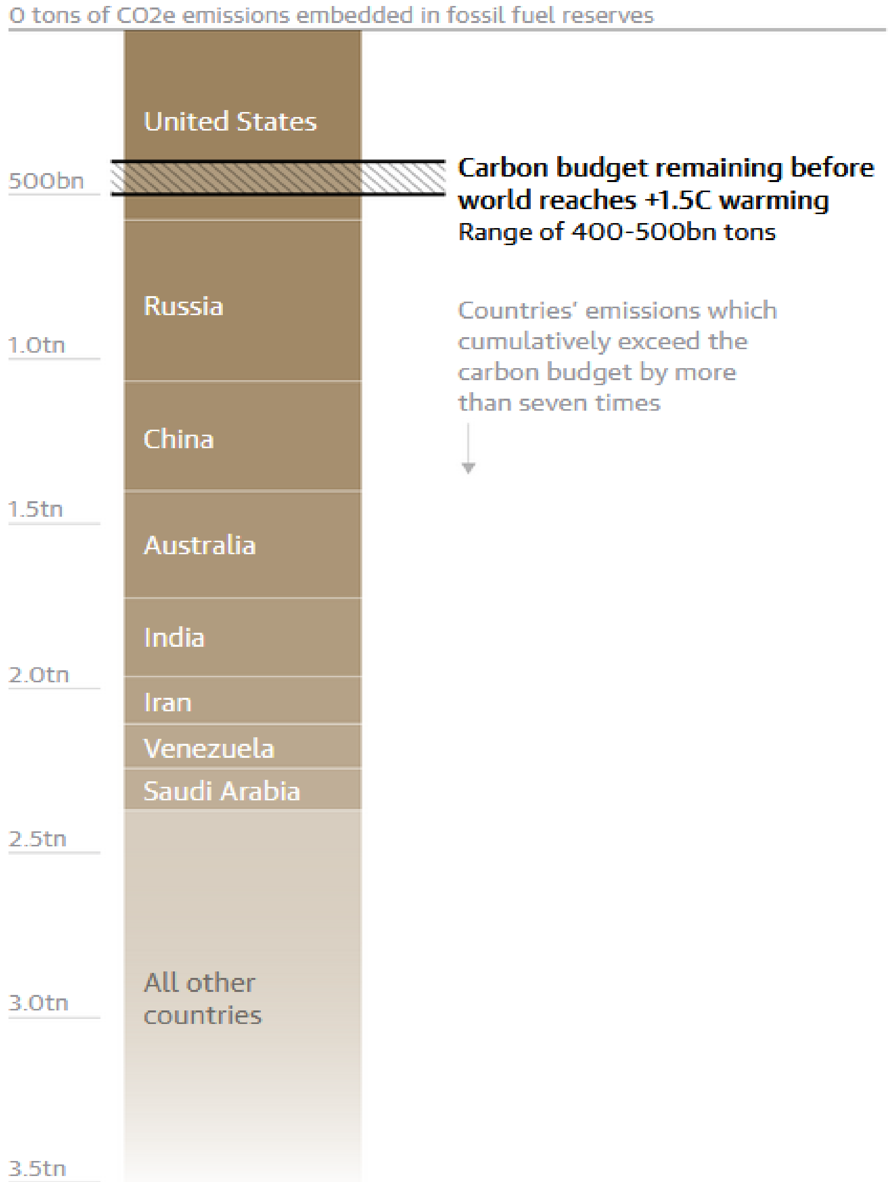
- So there are obstacles (to be discussed now) and need for big flywheel effects (to be discussed later)

Obstacle 1: risk of stranded assets

- To keep global warming below 1.5 degrees the world can only burn 400-500 $GtCO_2$ or 109-136 GtC
- Reserves of big oil and gas companies are much bigger and that is not counting reserves of the state companies
- If climate policy is uncertain, risk of stranded fossil fuel assets once climate policy kicks in
- Russia, Nigeria, Algeria: race to burn last ton of carbon?
- Ongoing explosion of carbon discoveries and reserves cannot go on if planetary warming must stay below 1.5 degrees Celsius. Need carbon pricing and climate club

Burning world's fossil fuel reserves is disaster

- Can emit 3.5 trillion tons of CO_2 if identified reserves of oil, gas and coal are permitted to be burnt
- Carbon budget of 400 to 500 billion tons of CO_2 to say below 1.5 degrees Celsius would be exceeded by factor 7 $\Rightarrow$ temperature can rise 1.5 degrees above target
- See Carbon Tracker's new *Global Registry of Fossil Fuels* launched yesterday!
- Guardian identified nearly 200 'carbon bomb' projects, helmed by companies such as Exxon, BP and Shell, that would each result in at least a billion tons of CO_2 over their lifetimes. Private equity firms, too, continue to pour billions of dollars into the sector



Guardian graphic. Source: The Global Registry of Fossil Fuels. Note: Carbon budget to reach +1.5C warming from pre-industrial levels based on IPCC 50% probability scenario.

Peak demand is the new *peak oil*, even more with covid-19

"[Investors'] biggest fear is that oil demand growth is no longer a given in perpetuity, with some predicting that by the end of the next decade the industry could be facing a peak in consumption, as government policies try to curb the use of fossil fuels."

"After all, no chief executive wants to be left holding multibillion-dollar oilfields the world no longer wants or needs."

A Shakespearean moment

The Big Read Oil + Add to myFT

Oil producers face their 'life or death' question

Fear of an imminent peak in demand means companies are less likely to invest. So does that make shortages and a price rise inevitable?

Is risk of stranded assets priced in? Yes, since 2015

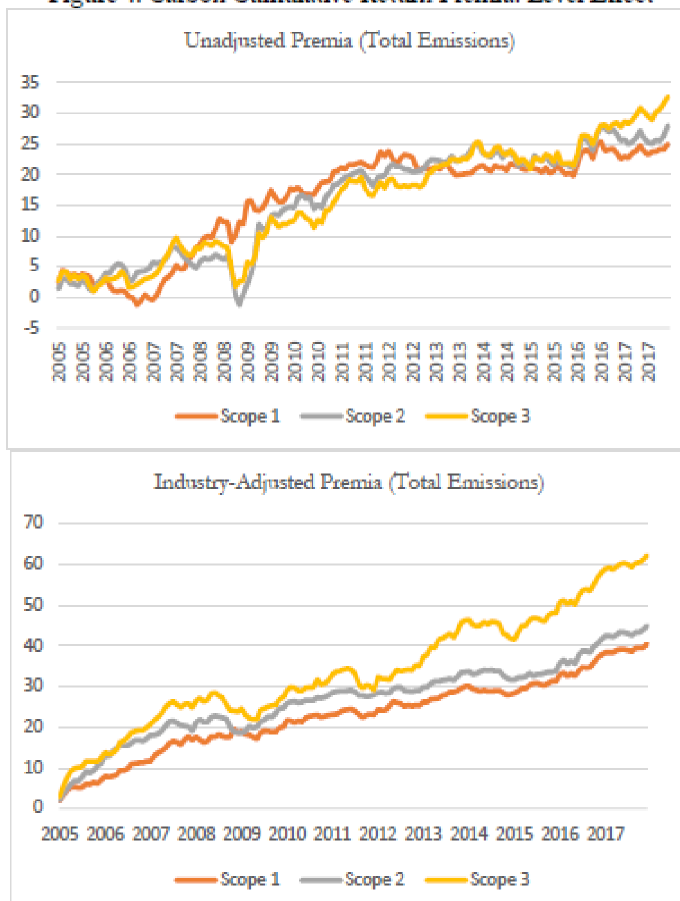
- Bolton and Kacperczyk (2021, 2022) find a substantial carbon premium in US and worldwide stock market returns even after controlling for the Fama-French factors

- Hsu, Li and Tsou (2022): find a pollution premium of 4.5% which appears to be related to litigation penalties

- Delis et al. (2019): find that commercial banks charge fossil-intensive firms higher interest rate for their loans:
  - 1 standard deviation increase in Climate Policy Exposure implies a higher AISD by 16 basis points
  - 1% increase in fossil fuel reserves implies an increase of 6.9 basis points in AISD
  - Green banks charge carbon-intensive firms even more

Bolton and Kacperczyk (2022): cumulative carbon risk premia

Figure 4. Carbon Cumulative Return Premia: Level Effect



Note: Figures plot cumulative carbon premia with and without industry fixed effects.

Oversight and regulatory authorities

- Governors of central banks have warned for carbon bubbles and financial and fiduciary risks of holding large investments in fossil fuel; e.g., Carney (2015)
- Insurance companies and especially pension funds should be concerned too
- Need 1.5 & 2°C stress tests for investment portfolios!
- Not clear which capital market regulators are held responsible for carbon-related systematic risks and who is responsible for ensuring that full corporate disclosure of carbon risks takes place

Obstacle 2: time scale and hedging climate risk

- Climate risks are very, very far in the future
- So need very low discount rates for discounting benefits 100 years (Weitzman, Gollier) from now but politicians do not use these
- A climate hedge is an investment project that yields a really big return in 100 or 200 years if global warming then turns out to be much hotter than expected
- What are these projects apart from dikes, water defences, etc?

Intergenerational hurdles

- Current generations must make sacrifices to curb global warming for future, perhaps much richer, generations $\rightarrow$ run up debt to give transfers and get intergenerational win-win outcome
- Kotlikoff et al. (2021): Intergenerational win-win (shows it in an impressive OLG setup)
- Remarkably, also *international* win-win!

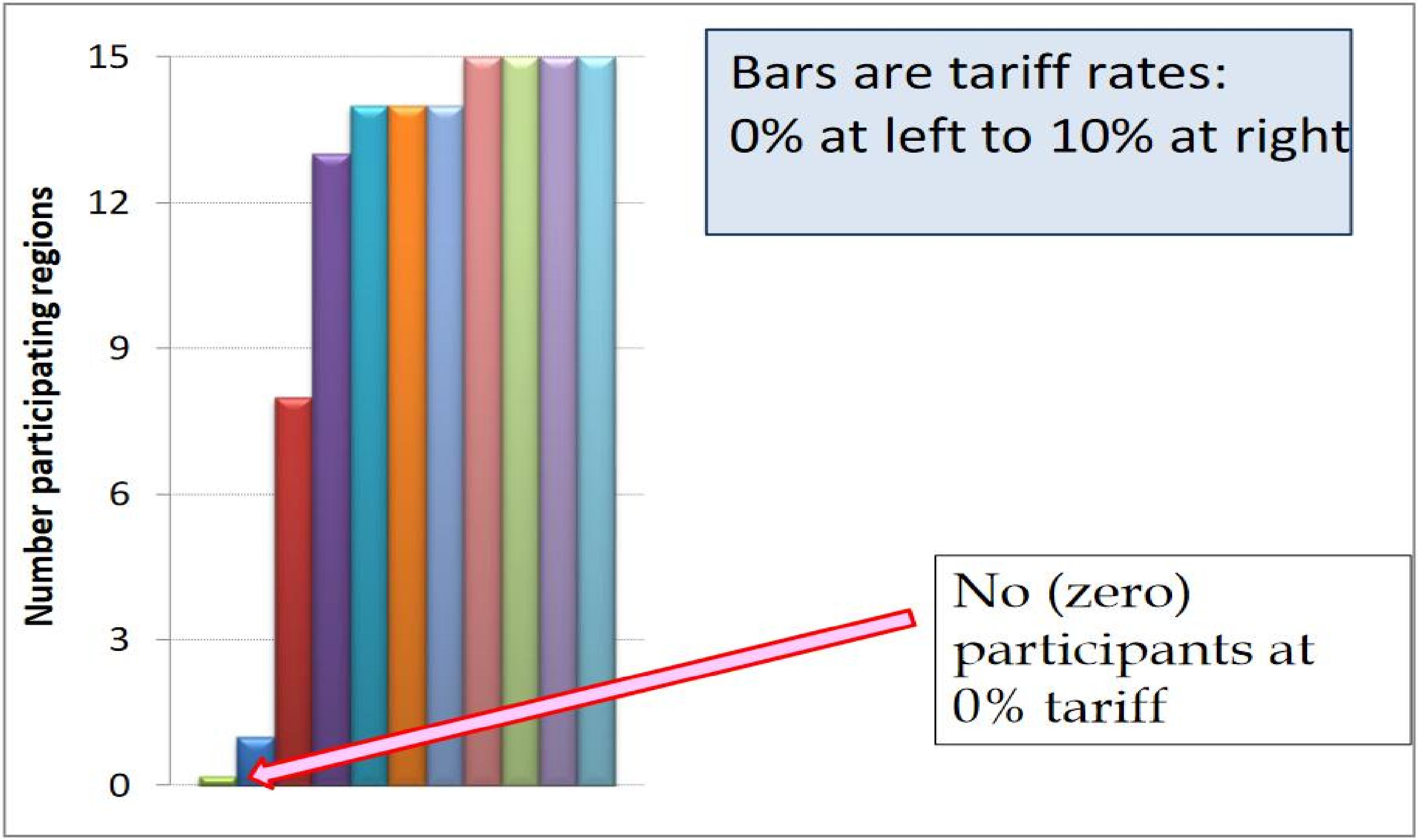
Obstacle 3: leakage and green paradox effects

- If Kyoto countries price CO_2 emissions, some of it is shifted to producers especially if fuel demand is elastic and supply inelastic
- World price of oil falls - gift to non-Kyoto countries!
- Renders CO_2 policy less effective unless it truly is a global deal including at least China and India
- BTAs: if not possible, output-based rebates for industries that suffer most from dirty competition from abroad.
- Coase: bribe … buy up forest

International challenges

- **Climate club**: Nordhaus (2015) suggests "climate clubs" – the more people join, the more attractive it is to join
- Cf. the Paris club to deal with hold-out problem in debt restructuring: fight free riding, need critical mass, and leverage up the club
- **Global refunding scheme**: pay a fee into a global fund which is invested in long-run assets and only earns a return if agreed emissions cuts have indeed been realised (Gernsbach et al.)
- **Technology and self-enforcing climate treaties:** commit future goverments (Harstad, et al., 2021)

Example of Climate Compact Participation



Example for $50/ton minimum carbon price.

Source: Nordhaus (2021, Markus Academy Webinar) and (2015, *AER*)

Green paradox

- Politicians: procrastinate and prefer carrot to stick
  - Europe has focused on renewable subsidies, not carbon pricing

- Anticipation of green policies: sheiks pump oil faster to avoid capital losses, which accelerates global warming

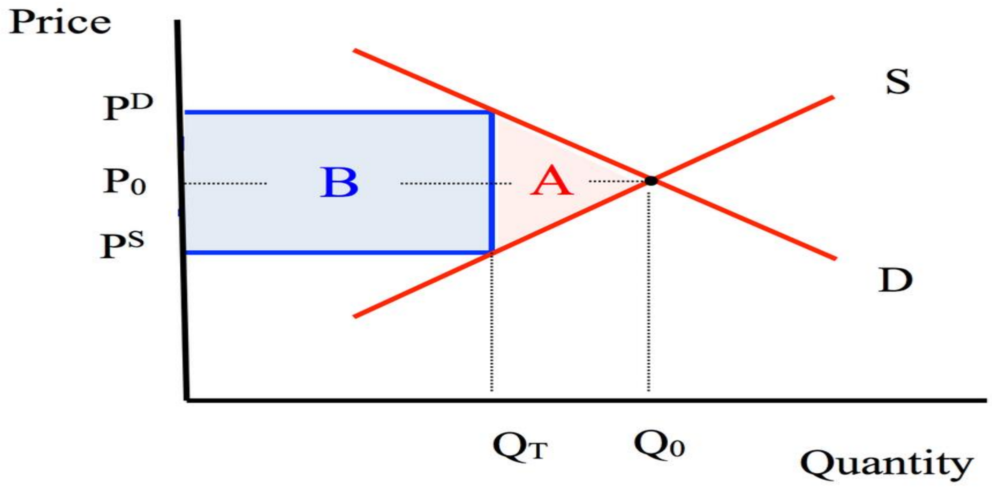
- Welfare goes up if price elasticity of demand is low, that of supply is high, and ecological discount rate is high

Obstacle 4: policy failure and capture

- Lobbies for exceptions: ETS – grandfathering; if coal is excluded from tax or even subsidised; etc.
- Government picks winners & faces lobbies
- Subsidies tend to become addictive
- Bio-fuel mandate puts up land price $\Rightarrow$ food poverty
- Non-price controls are susceptible to capture: energy efficiency standards, mandatory sequestration, renewable mandates, etc.

Deadweight cost of carbon tax is A (proportional to square of the tax), but only if tax revenue B is not wasted (e.g. if it is fully rebated)

Subsidies and rent seeking are wasteful: cost may be A + B



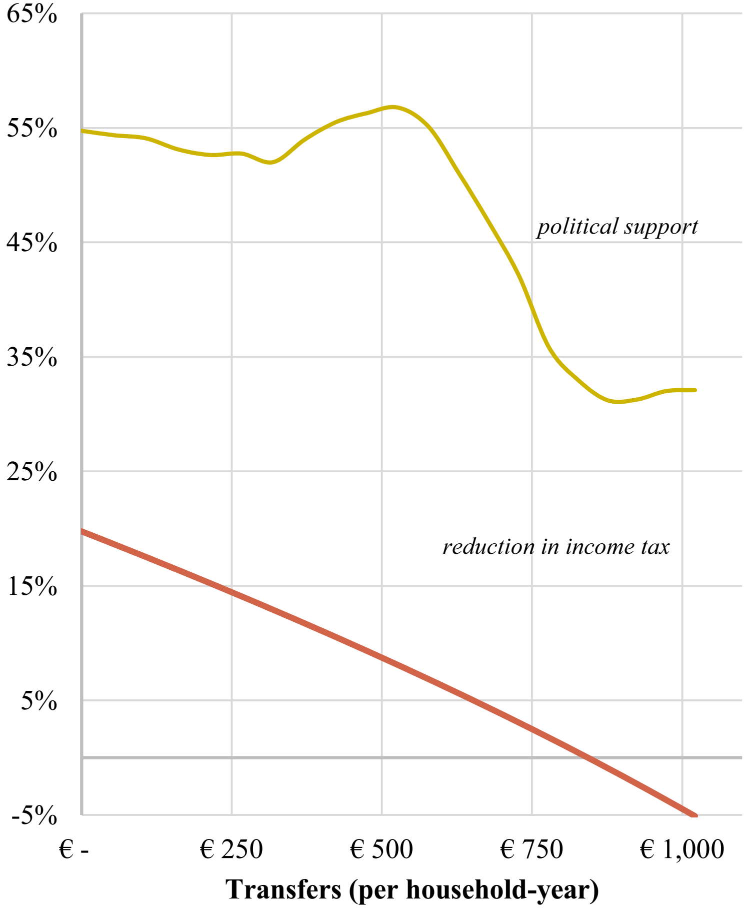
Obstacle 5: adverse effects on income distribution

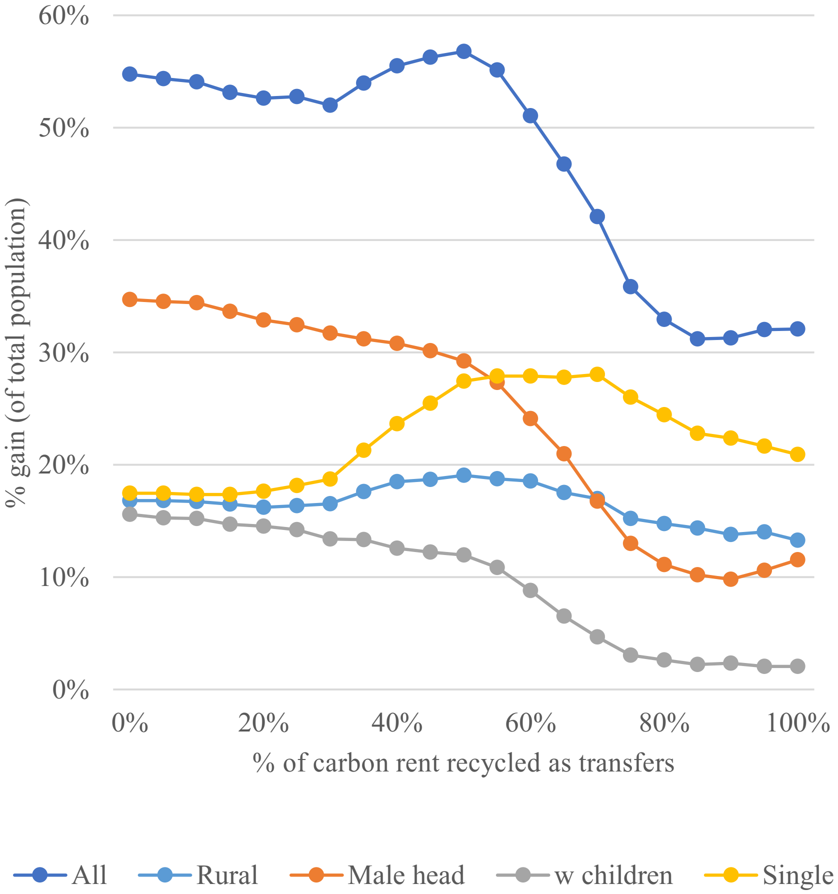
- Fossil fuel subsidies are staggering $5.3 trillion a year (6.5% of world GDP) versus renewable subsidies of only $120 billion/year (FAD, IMF)

- No brainer: scrap these subsidies asap, but dirty coal is consumed relatively more by the poor

- Replace subsidies with general tax deductions for the poor: more efficient way to redistribute
- Avoid "yellow vests": use revenues from carbon tax to lower income tax and hand out carbon dividends to get it across the line in most efficient manner
- Majority support if half of revenue is used to lower income taxes and boost economic activity and the tax base

Political arithmetic of carbon pricing





Source: van der Ploeg, Rezai and Tovar (2021)

How to recycle carbon dividends?

- Carbon pricing is regressive
- So ensure political acceptability with an upfront, visible and uniform "carbon dividend" or even a directed transfer to the lowest incomes
- France: insulation subsidies for low incomes
- Or subsidies for electrical cars, tax credits for energy-efficient buildings
- Firms that are most at risk of leakage get rebates proportional to production (second-best to BTA)

Fiscal costs of climate policy

- **Barrage (2020):** big welfare gains from carbon taxation (33%) even taking account of fiscal impacts; second-best carbon pricing lower; high adaptation spending and high MCPF if no mitigation
- **Fried (2022):** OLG with Heathcote et al. tax function
  - Ramsey approach to optimal fiscal policy
  - Most efficient form of rebating carbon taxes is via increasing progressivity of income taxes, not lump sums
- **Douenne, Hummel and Pedroni (2022):** heterogenous agents with climate
  - Second-best carbon tax path is lower

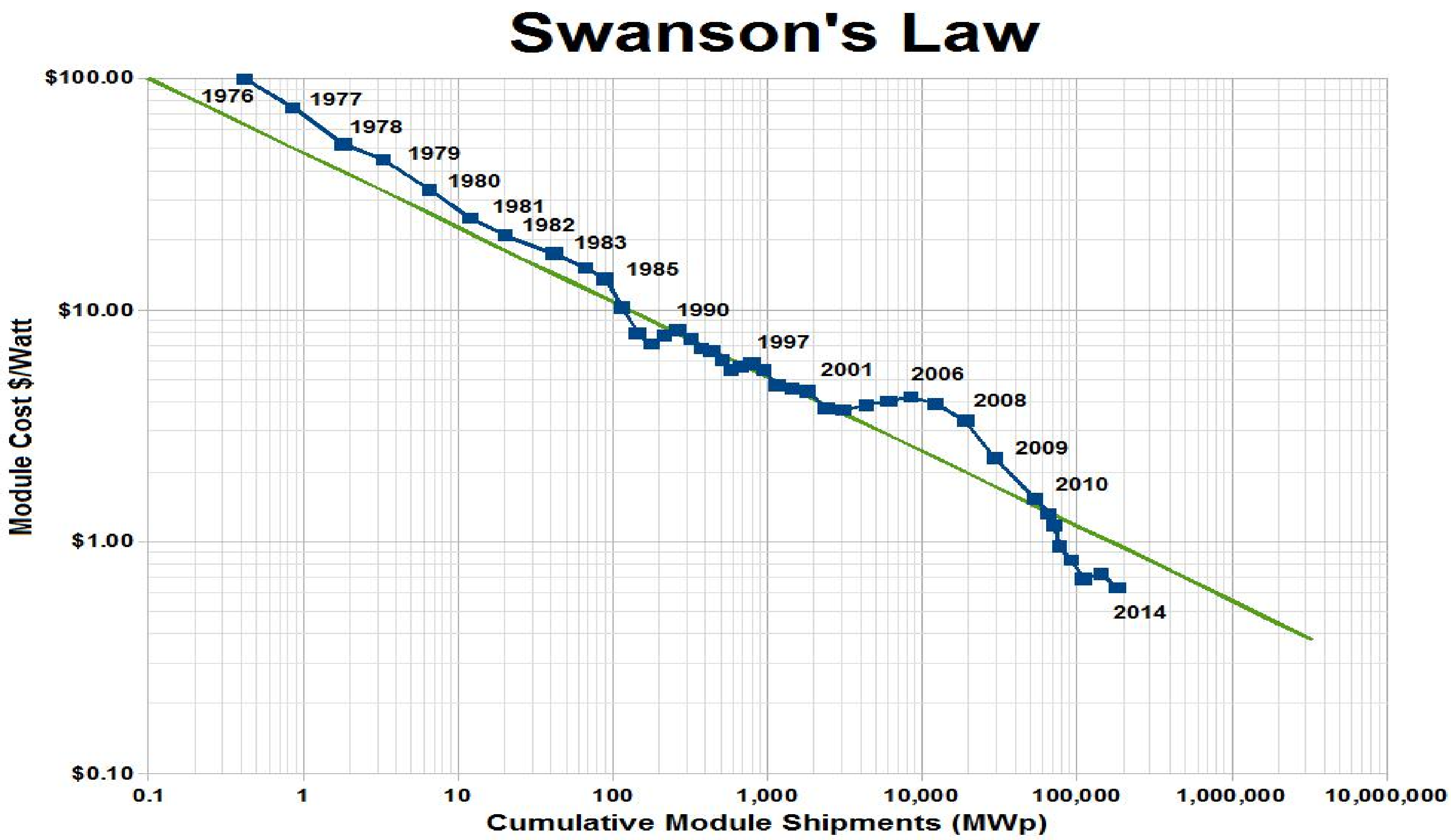
Other obstacles

- **Spatial needs:** need space for windmills, solar panels, hydrogen factories and CCS in the landscape, in the soil and on sea – huge challenge (NIMBY politics)
- **Climate scepticism:** cf. Pascal's wage about better to believe in God if you are an agnost; cost of carbon pricing when sceptics are right are small, but cost of inaction if IPCC is right are huge $\Rightarrow$ max-min or min-max regret policies indicate ambitious carbon pricing
- **Behavioural distortions:** e.g., salience (Farhi and Gabaix, 2022) $\Rightarrow$ carbon tax < SCC and $s_R \uparrow$

RADICAL CLIMATE POLICIES
(van der Ploeg and Venables, 2022, World Bank)

- Scientists warn about 9 irreversible climate tipping points getting more imminent with global warming
  - melting Greenland and Antarctic Ice Sheet, loss of Arctic Sea ice, thawing permafrost, Gulf Stream, etc.
- What society and policy makers need to exploit are:
  - Social tipping points (peer effects, Extinction Rebellion and other grass root movements)
  - Technological tipping points (based on exploitation of learning by doing embodied in Wright's and Swanson's law; alternatively via directed technical change)
  - Political tipping points (e.g., Nordhaus' climate clubs)
- Relies on positive feedback effects or – what economists call – strategic complementarities

Cost solar panels drops 20% for every doubling of cumulative shipped volume



Outline of analytical model

- 'Neo-classical' world:
  - Efficient: set carbon price to expected present discounted value of MDs from emitting one ton of carbon today (SCC or Pigouvian tax)
- Cumulative causation, complementarities and socio-economic tipping points:
  - Technical: increasing returns to scale not internalised by producers
  - Social preferences: peer effects, imitation and herding
  - Network effects and chicken & egg externalities: e.g., EV charge points
- Complementarities and socio-economic tipping points:
  - Climate policy – to be efficient, or just effective – may require stronger policies than the 'optimal' carbon tax (or SCC) $\Rightarrow$ global optimum?

Diminishing versus increasing returns

Individuals choose clean x (EV) or dirty (ICE) where q_x is proportion of population choosing green *x* & $q_y = 1 - q_x$ is proportion choosing *y*

Blue line = utility of choosing *x*; red line, utility of *y*

Fig. 1a: Utility *falls* as more people choose (price gets bid up) $\Rightarrow$ unique stable equilibrium: small change in attractiveness (e.g., tax) causes small movement of equilibrium

Fig. 1b: Utility *rises* as more people choose (price falls, network effects) $\Rightarrow$ one unstable equilibrium and two stable equilibria:

- How do we switch between them?
- Big-push policies?

Figure 1a: Diminishing utility

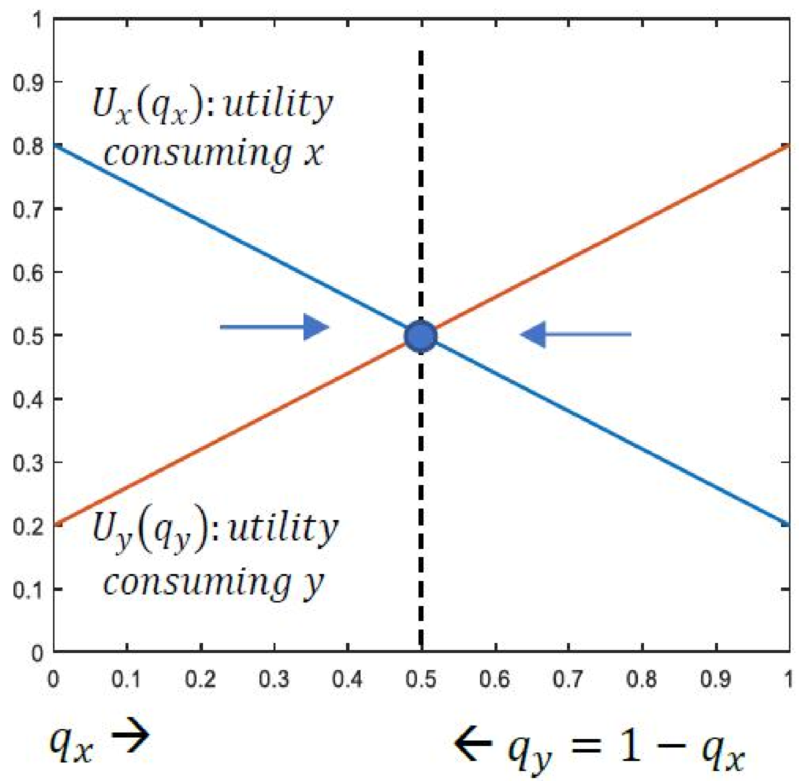
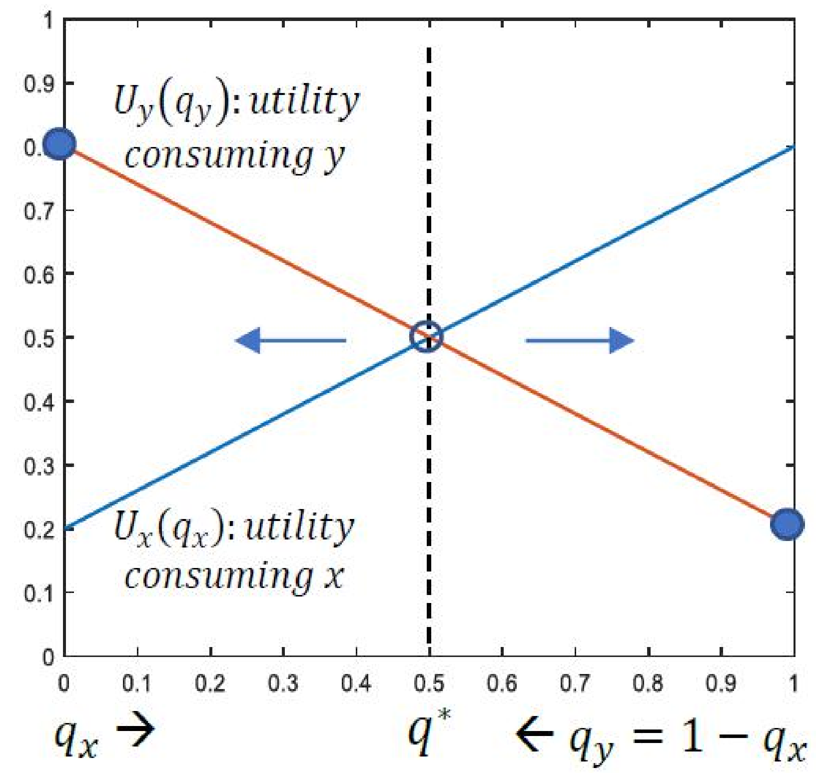


Figure 1b: increasing utility



Diminishing utility implies a unique equilibrium, but increasing utility gives two equilibria that are stable, and one that is unstable.

Micro-founded model

Activity (e.g., motoring with green choice x or dirty choice y)

Demand for $x,\ y$: $x = a_x p_x^{-\sigma} P^{\sigma-\epsilon}$ and $y = a_y p_y^{-\sigma} P^{\sigma-\epsilon}$.

Prices of each type and price index of motoring $P = \left(a_x p_x^{1-\sigma} + a_y p_y^{1-\sigma}\right)^{1/(1-\sigma)}$.

Production: price = unit cost times tax factor: $p_x = t_x c_x$ and $p_y = t_y c_y$.

Three types of externalities:

- ***Social preferences***: Preference parameters depend on the aggregate quantities sold

  $a_x[X,Y]$ $a_Y[X,Y]$

- ***Increasing returns***: Costs depend on the aggregate quantities produced (= sold)

  $c_x[X]$ and $c_y[Y]$

- ***Climate damage functions***: Utility loss from output of each good (or just good y).

  $K_X[X]$ and $K_Y[Y]$

Supply and demand with social preferences

Fig. 1a: simple S-shape for social preference for good x (left-figure)

Fig. 2b: supply and demand: price on vertical, share of population green on horizontal

- Blue line is willingness to pay (inverse demand curve)
- Red line is supply curve (= unit cost)
- Unique equilibrium with low x (and ∴ high y)

Taxing dirty good y (or subsidising clean good x) shifts up the willingness to pay for x

- One equilibrium …. then 3 (yellow line)…. jump to high x (low y equilibrium): green transition.

Figure 2a: Preferences with peer effects

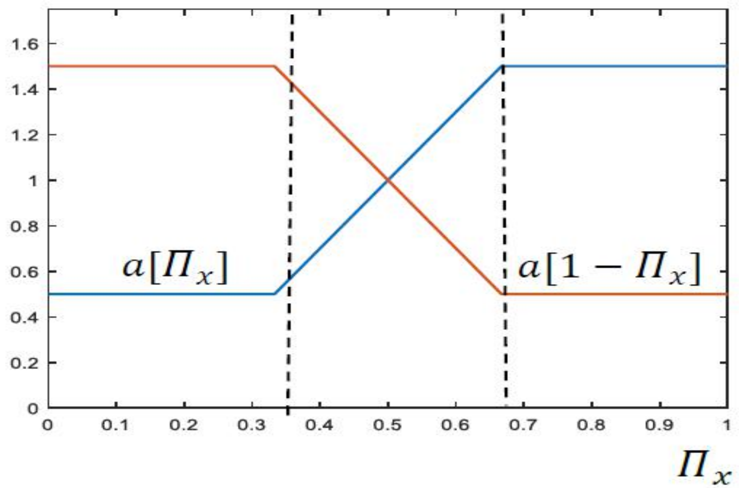
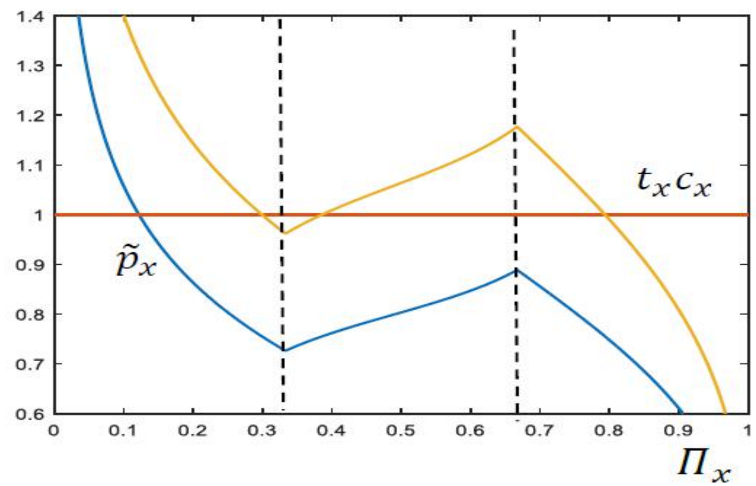


Figure 2b: Unit cost and demand curves, $\tilde{p}_x$



Peer effects in preferences can cause the demand curve to slope upwards, creating the possibility of multiple equilibria.

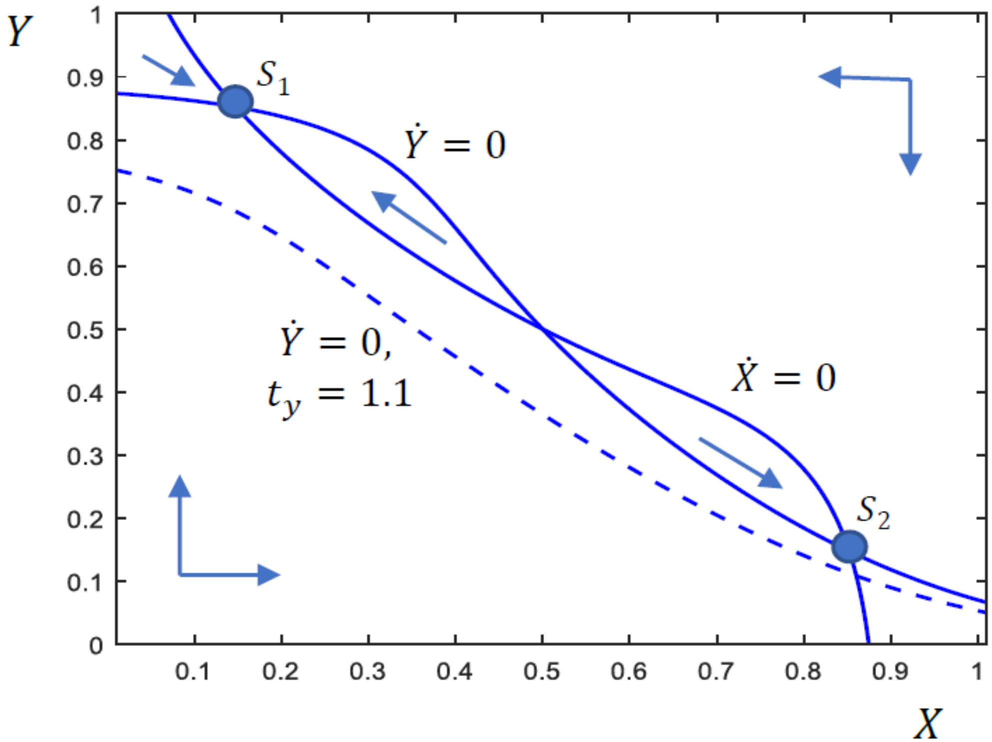
Intermezzo: dynamics and stalled transition

Suppose that X, Y now denote the ***stock*** of output of each type

- Peer effects now depend on the stock of X – as do global warming effects
- Stock is driven by differential equations;
  Output (= demand, blue line) minus depreciation (loss of memory, red line)

$$\dot{X} = a_x[X](t_x c_x)^{-\sigma} P^{\sigma-\epsilon} - \delta_x X, \qquad \dot{Y} = a_y(t_y c_y)^{-\sigma} P^{\sigma-\epsilon} - \delta_y Y,$$

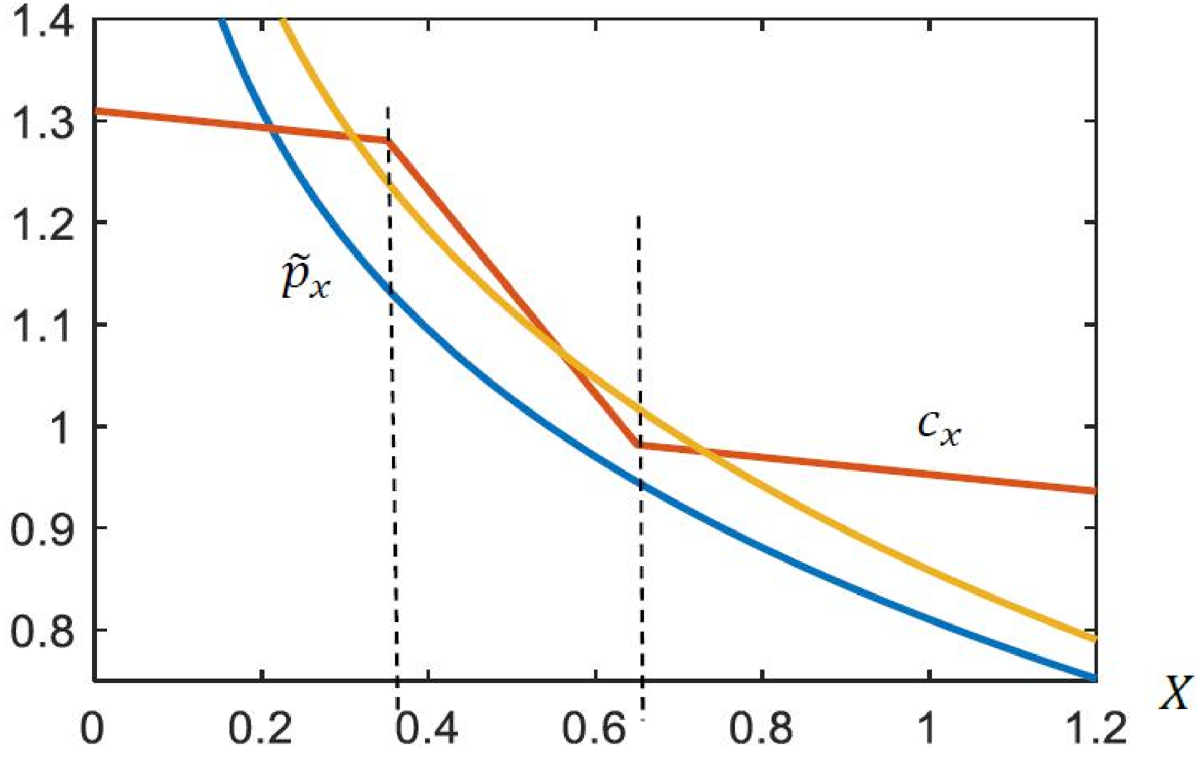
- As drawn, three stationary points: S_1, S_2, and unstable one in middle
- Starting from low X, transition stalls at S_1 where production of x is no greater than depreciation of existing stock
- Need to:
  - lower depreciation rate
  - Subsidise x or tax y to shift blue line up)



Policy to avoid stalled transition

- If there is a single equilibrium, optimal control techniques give optimal path from any starting point to the green equilibrium at $S2$, trading off the cost of distorting current consumer prices away from MC against benefit of faster transition thus cutting global warming damages
- If stalling is an issue, policy must prevent economy stalling at the bad equilibrium $S1$with high emissions
- The challenge is to ensure that economy moves from dirty low-X equilibrium to clean high-X equilibrium with a high share of green products in the mix

External economies in production



External economies of scale in production of good x cause the unit cost curve to slope down, creating the possibility of multiple equilibria.

Policy with technological spill-over effects

- At unique equilibrium, subsidy to green or tax on dirty raises inverse demand from blue to yellow line, so green x increases due to direct subsidy effect and to amplification caused by downward slope of cost curve
- If policy is intensified, yellow line shifts up more until good high X equilibrium is reached
- Price-taking firms expand production of green fast: unit cost < price until high-x equilibrium is reached
- Radical policy: shifts equilibrium from bad to good one $\Rightarrow$ emissions ↓↓↓
- Note: Dynamic version can also lead to risk of stalling
- Note: cost reduction & development of new products is like increase in a_x, as more product varieties induce consumers to switch expenditure to green

Locally optimal policies

- Locally optimal policies set green subsidy to internalise production externalities, $t_x - 1 = \gamma_x < 0$, and set carbon tax to the SCC, $t_y - 1 = \frac{K_y'}{c_y} > 0$
- Amplification due to peer effects or increasing returns to scale require smaller policy instruments to hit a particular target level of output and emissions
- Locally optimal first-best tax or subsidy is unchanged by peer effects, if these are purely expenditure switching
- A unit change in a policy towards first-best Pigouvian value brings greater utility benefit with peer and technological externalities
- If carbon tax is ruled out, $t_x - 1 = \gamma_x + \frac{K_y'}{c_x}\frac{dY}{dX} < \gamma_x < 0$

Tipping with radical policies

- Left panels of figures 5 and 6 show green output and right panel show utility level for the 3 equilibria versus price of dirty and price of green, resp.
- To switch from bad to good equilibrium, need either carbon tax on y bigger than the SCC (figure 5) or a large renewable subsidy on x if the carbon tax is set to the SCC (figure 6)
- Having a radical policy leads to large welfare gain
- Once equilibrium has shifted, it is a Nash equilibrium and the economy is stuck in it so can lower the policy again

Figure 5a: Y-sector tax & X-sector output.

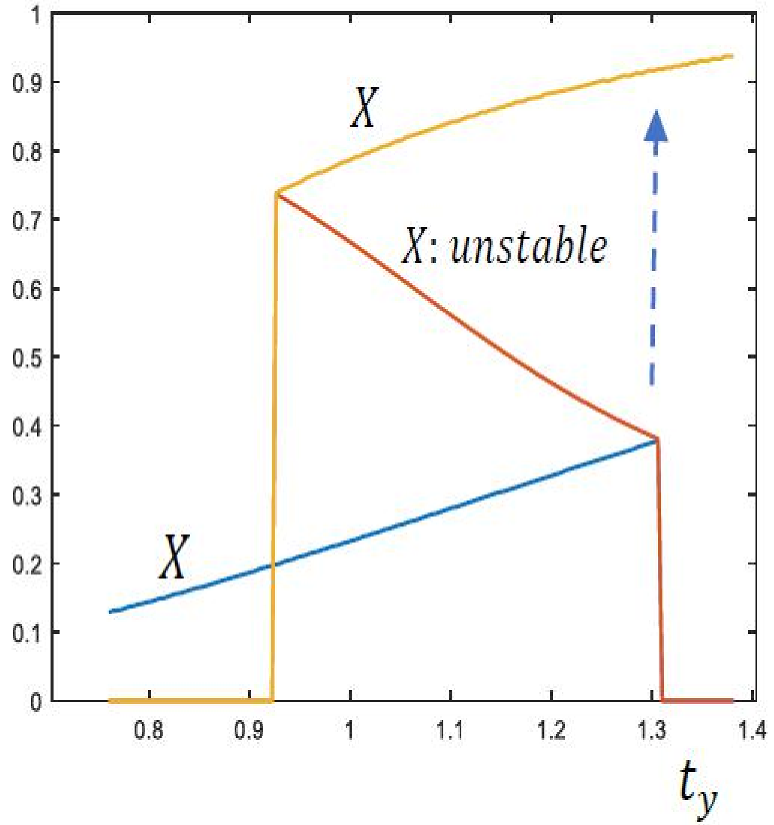
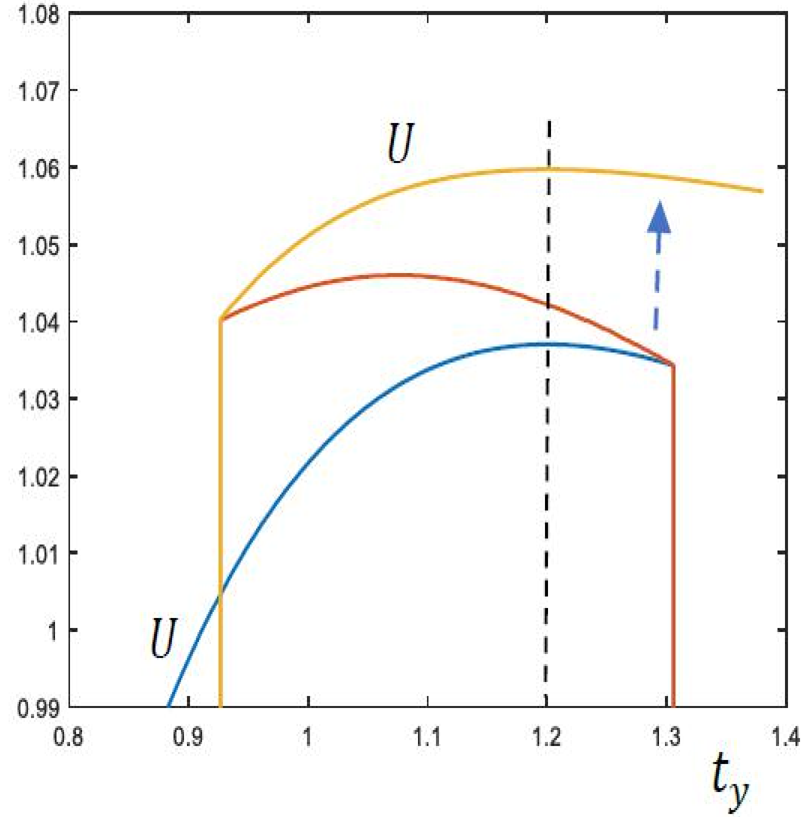
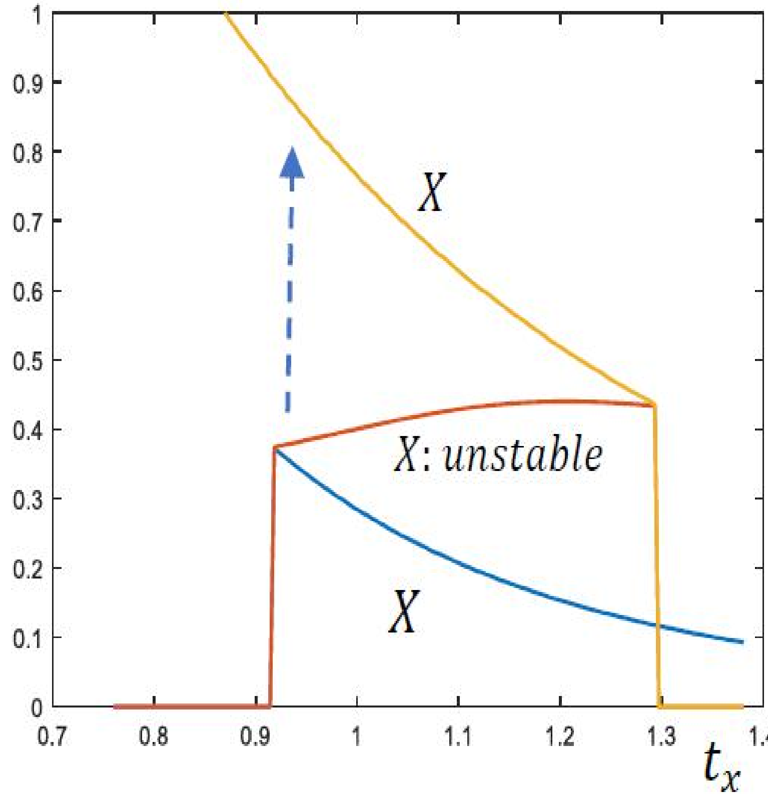


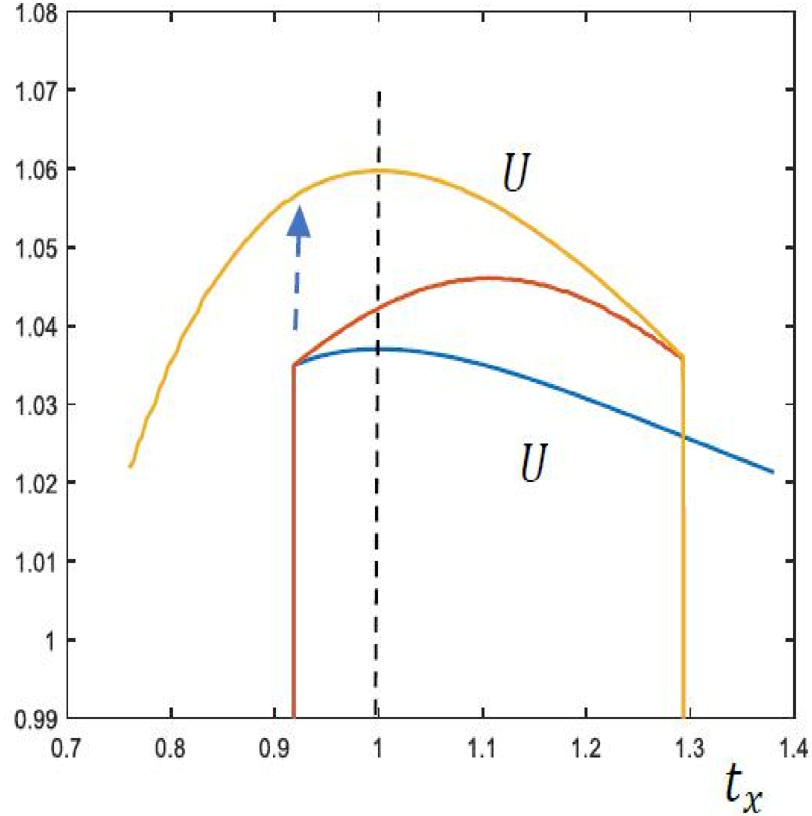
Figure 5b: Y-sector tax & utility.



Utility maximisation requires a tax high enough to flip from the dirty equilibrium (blue line) to the clean equilibrium (yellow). In this example the tax exceeds the Pigouvian rate.

Figure 6a: *X*-sector tax & *X*-sector output. **Figure 6b: *X*-sector tax & utility.**





Dirty output is subject to the Pigouvian tax, but it takes a subsidy to the clean good to flip the economy from the dirty equilibrium to the clean equilibrium.

Recap: applies to demand, supply, politics

- Complementarities $\Rightarrow$ amplification effects of carbon taxes and green subsidies (cf. Mattauch et al., 2018; Konc et al., 2021)
- If complementarities are positive and strong enough, 2 stable equilibria with, respectively, low and high emissions and a third unstable equilibrium in middle
- Policy must bring about switch between equilibria – or prevent stalling – so may need higher tax rate (or more activist policy) than usual guide for carbon price
- While these uncertainties are enormous – with substantial complementarities – optimal policy is likely to go well beyond the Pigouvian policies so often advocated
- **Questions:** How large must complementarities be to give multiple equilibria? How can policy makers know when to try to bring about a tipping point or prevent a technological transition from stalling?

Political economy of climate trap
(Besley and Persson, 2021)

- Political economy framework to understand commitment problems
- Demand for green technology (batteries, electrical vehicles, heat pumps, etc.) depends on low-cost products being available
- But supply of cheap products only becomes available if there is enough demand
- **Socialisation of preferences**: as more and more people are environmentalist, more materialists turn green too
- Political system cannot commit to future policies
- $\Rightarrow$ **Strategic complementarities** leading to a climate trap
- Need grand coalition of visionary politicians, business leaders and people in society to shift from bad to good equilibrium

Transformative climate policies: broader view

- Political, social, and technological tipping points
  - How to set in motion a quick and sudden transition to a net-zero economy
  - Low tariff of 2-5% of climate club can set it off (Nordhaus)
- Social norms
  - Punctuated equilibria and evolutionary games
  - Self-enforcing social norms (Young, Weibull)
- Amplification via networks
  - Direct policy at key players in network (Ballister et al.)

Transformative climate policies: broader view

- Expectations and carbon lock-in
  - Initial conditions, history and market size matter
  - They can lead via expectations lead different outcomes (vd Meijden and Smulders, Smulders and Zhou, Acemoglu et al.)
  - With time-inconsistent preferences invest in green technologies that are strategic complements to future investments that are further up the supply chain or have longer maturity: tie hands of successors (Harstad)
- Sensitive intervention points
    - Seek interventions that kick of shift the system so that initial change is amplified by feedback effects that deliver an outsized effect (Farmer et al.)
- Sustainability science approaches