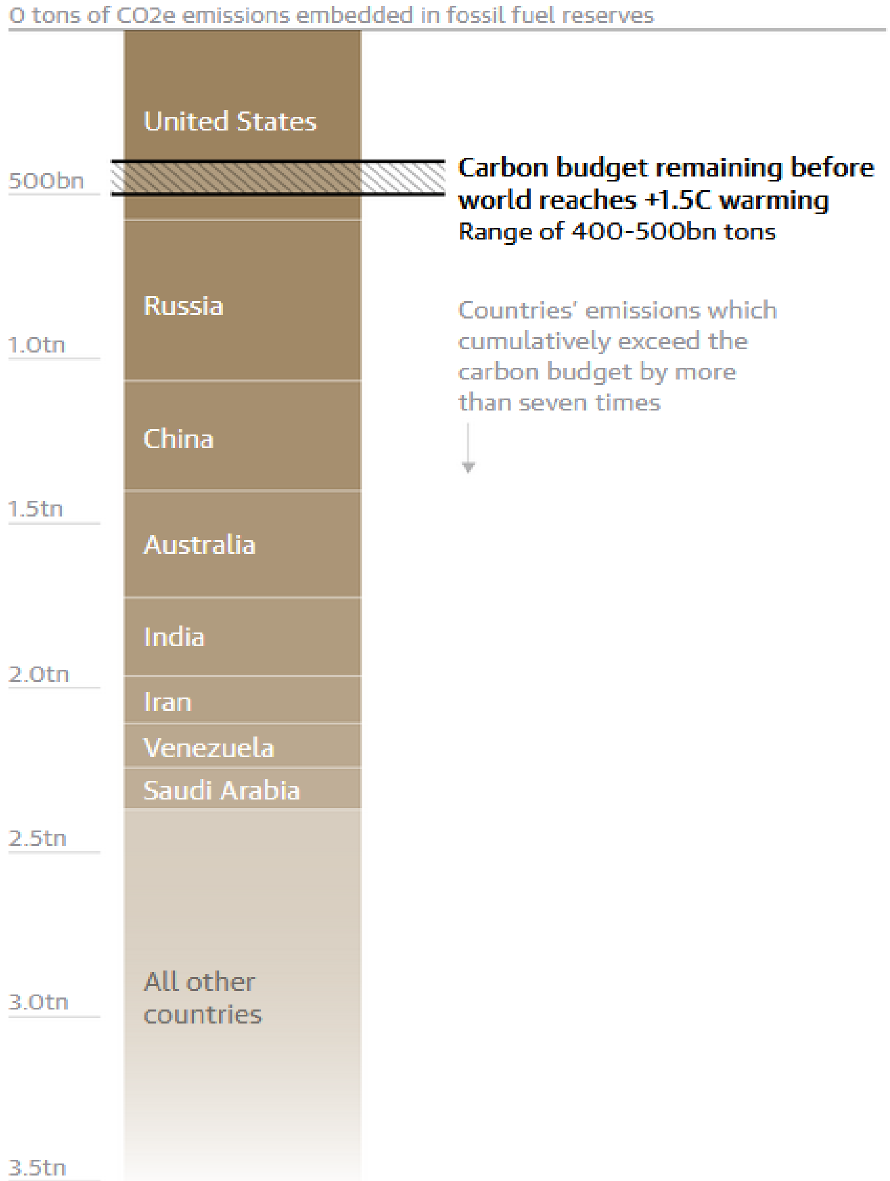
PART I

Why Climate Policy is a Mess

Rick van der Ploeg, Oxford

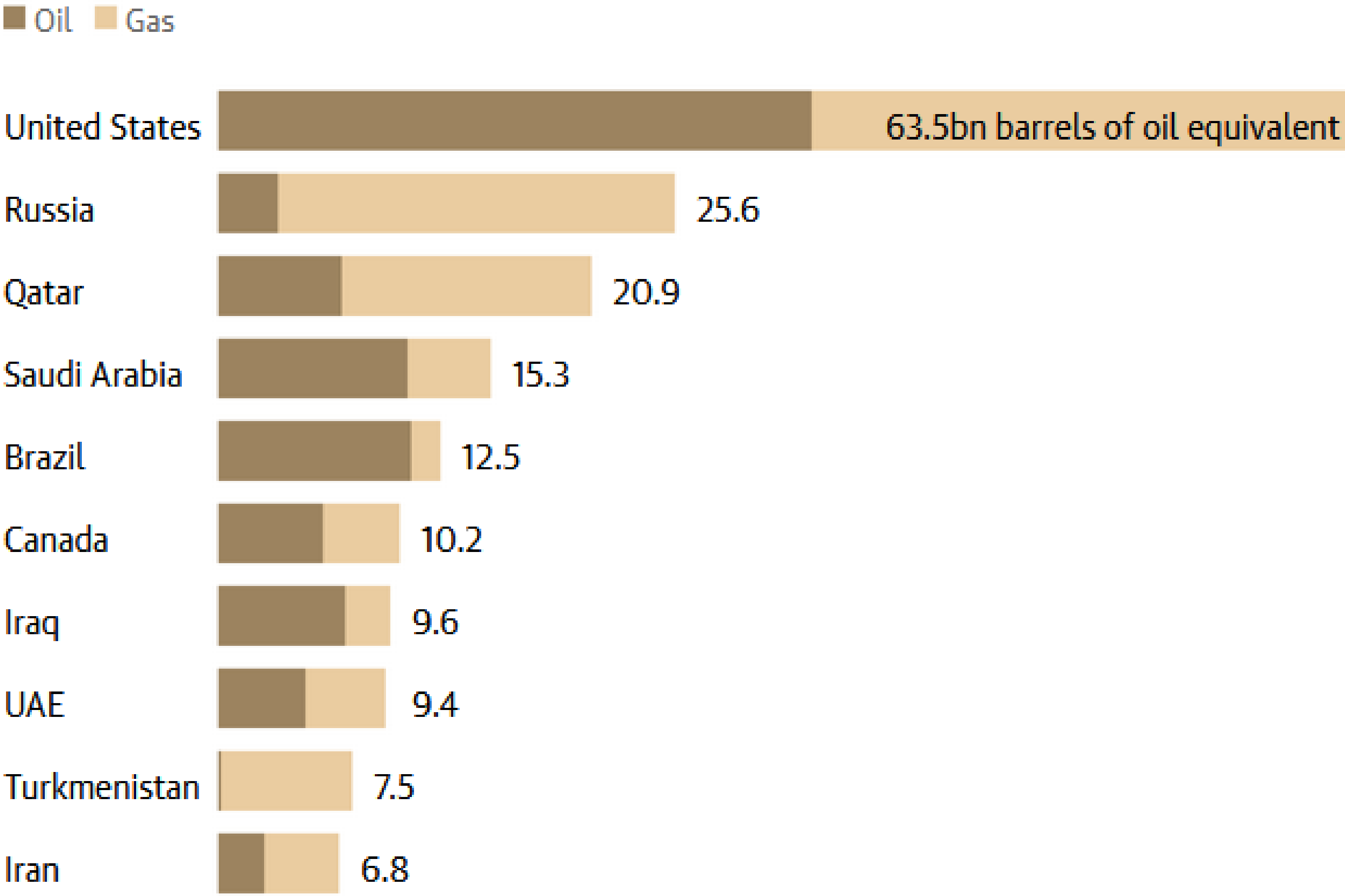
Burning world's fossil fuel reserves is disaster

- Emit 3.5 trillion tons of CO2 if identified reserves of oil, gas and coal are burnt
- Carbon budget of 400 to 500 billion tons of CO2 to say below 1.5 degrees Celsius would be exceeded by factor 7 $\Rightarrow$ temperature can rise easily 1.5 degrees **above** target
- See Carbon Tracker's new *Global Registry of Fossil Fuels* launched earlier this year!
- Guardian identified 200 'carbon bomb' projects, helmed by companies such as Exxon, BP and Shell, that would each result in at least a billion tons of CO2 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.

Countries with the most fossil fuel reserves in development



Guardian graphic. Source: The Global Registry of Fossil Fuels.

40-47 bln Euro fossil subsidies in NL

- Until now Dutch government thought amount was mere 4.5 billion Euro
- Steel, domestic shipping, greenhouse agriculture, coal power stations, refineries, airline (2 billion exception for tax on kerosine) …
- Amount will fall due to behavioural responses during green transition
- Dutch government started reducing these subsidies by 6 billion:
  - Less regressive energy tax for natural gas (0.3 billion) and electricity (5 billion!)
  - Scrap lower energy tax (0.17) and limit input allowance in energy tax (0.159) for greenhouse agriculture
  - Cut special exceptions in vehicle tax (0.2)
  - Get rid of indirect cost compensation ETS (0.082)
- Point is that so little is done still and so many subsidies are still around
- Danger that cutting gas subsidies will bring in coal again

Worldwide fossil fuel subsidies are huge

- 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
- Like having “heating and air condition on at the same time”
- But dirty coal is consumed relatively more by the poor so need compensation for the poor (more difficult in countries with poorly developed tax systems)

Energy Charter Treaty (ECT)

- Fossil fuel investors have used ECT to sue states in investment arbitration, challenge climate measures, and claim tremendous amounts of compensation
- Will rise significantly in coming years as governments tackle the climate crisis
- Tienhaara et al. (2022, Science): ECT is greatest contributor to potential ISDS claims over forced stranding of oil and gas assets that do not fit 1.5°C carbon budget (ECT applies to 19% of all treaty-protected oil/gas assets that would be excluded from the IEA Net-Zero by 2050 energy transition pathway)
- Not in line with Paris agreement to phase out fossil fuel rapidly: *totally outdated treaty*
- 2022 agreement: still an additional 10 years of investment protection and indefinite for non-contracting parties

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 400-500 GtCO2 to stay below 1.5 degrees Celsius: about 12 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 rule)
- Nordhaus alternative: Pigouvian approach (social cost of carbon)

Carbon pricing helps in many ways

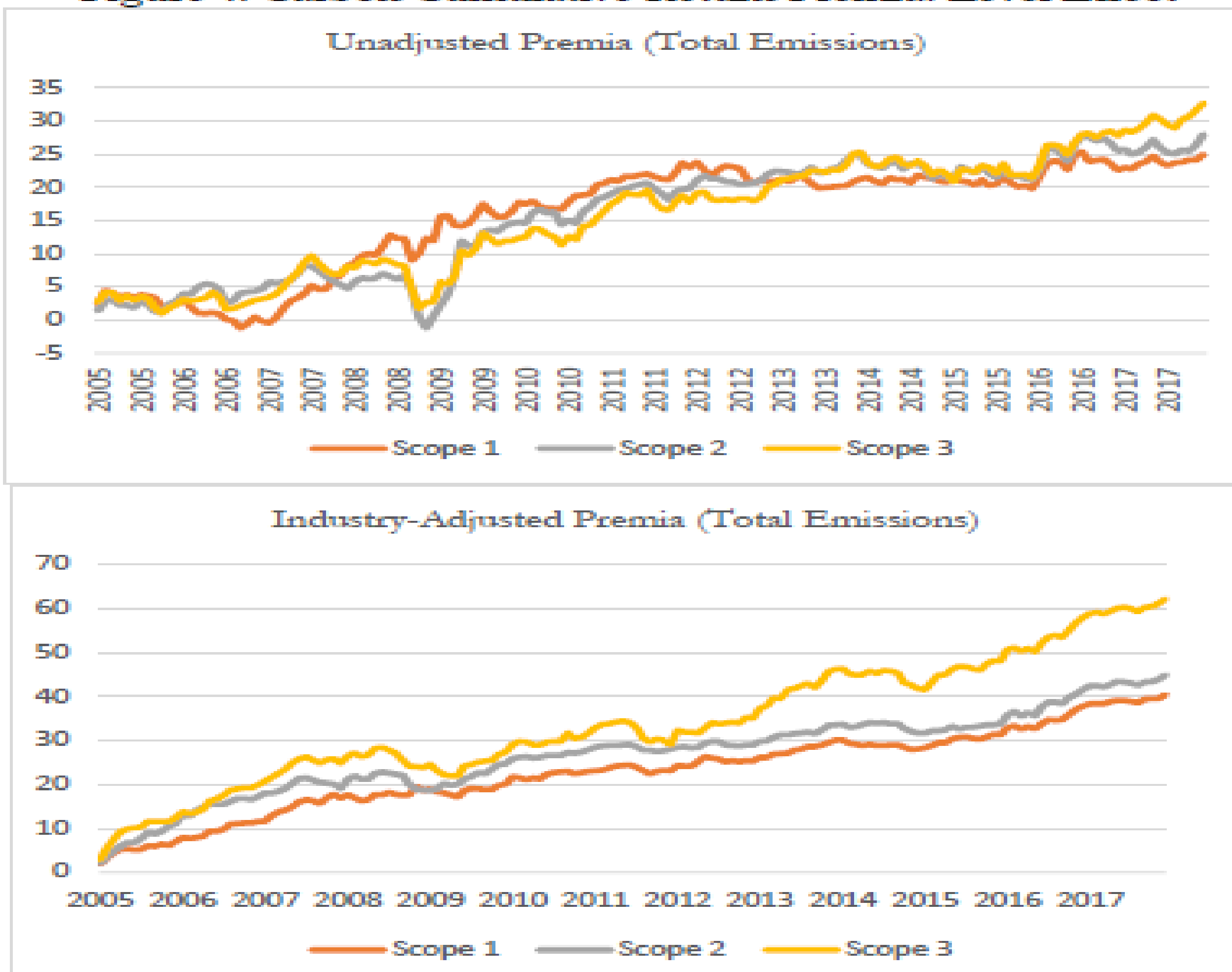
- Curbs demand for fossil fuel.
- Encourages to leave more fossil fuel in crust of earth.
- Induces substitution from carbon-intensive (tar sands?, coal, crude oil) to less carbon-intensive fossil fuel (gas).
- Induces substitution away from fossil fuel to renewables and brings forward the carbon-free 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. sea walls, stills, and dykes).

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

- Bolton and Kacperczyk (2023, 2x) find 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

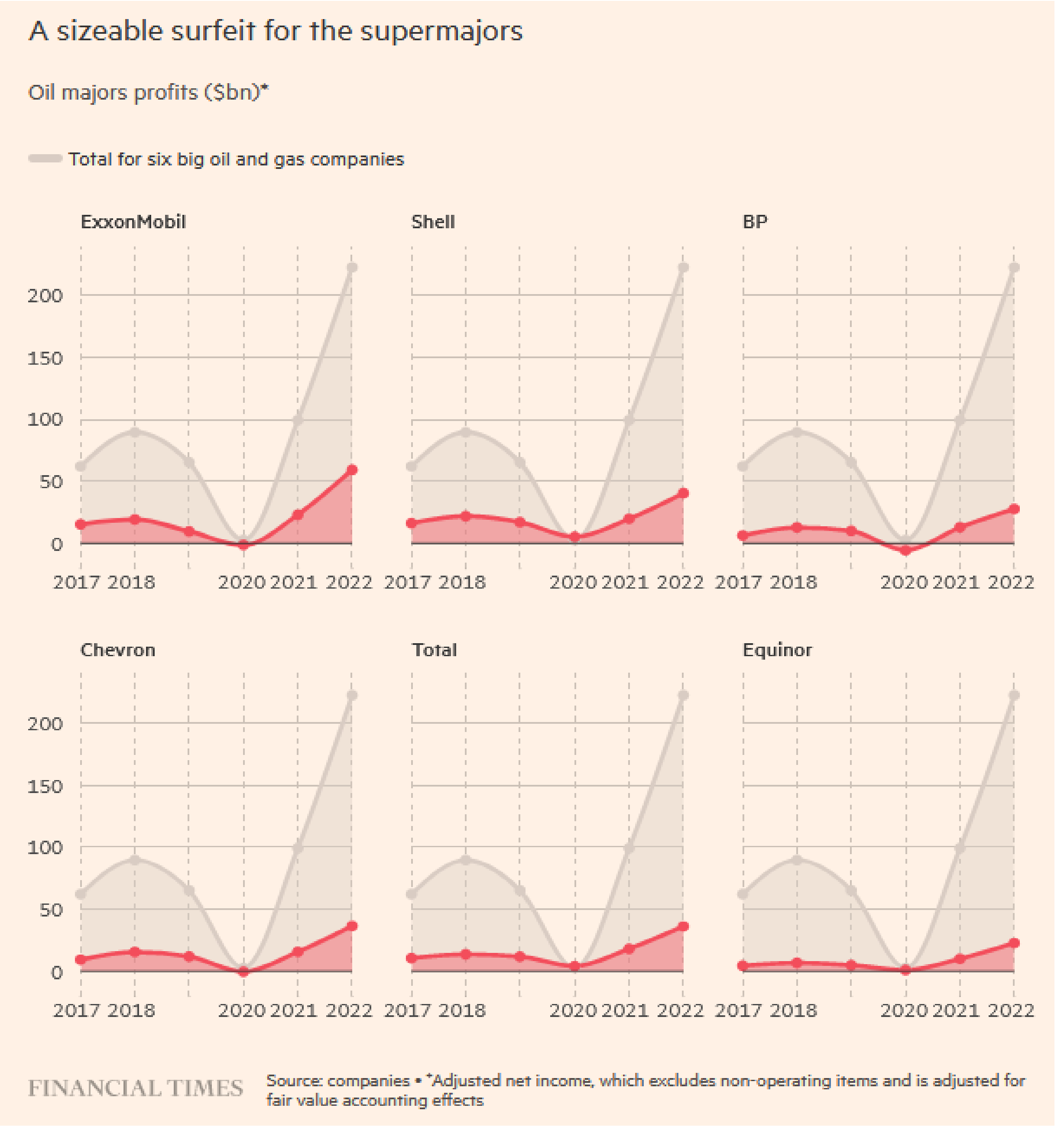
Bolton and Kacperczyk (2022): cumulative carbon risk premia

Figure 4. Carbon Cumulative Return Premia: Level Effect



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

But oil majors made huge windfall profits due to war and recent spike in energy prices



Procrastination is very costly

- Politicians tend to procrastinate and prefer excessive subsidies over carbon pricing (in US with 2022 Inflation Reduction Act and Europe especially Germany but also the Timmermans Plan)
- Increases the risk of stranded financial assets
- Cost of litigation and compensation (ETC)
- Cost of inefficient green transition by doing too little upfront and having to do more upfront
- Induces Green Paradox (faster pumping to avoid capital losses), especially if supply of reserves does not react much to price of fossil fuel)

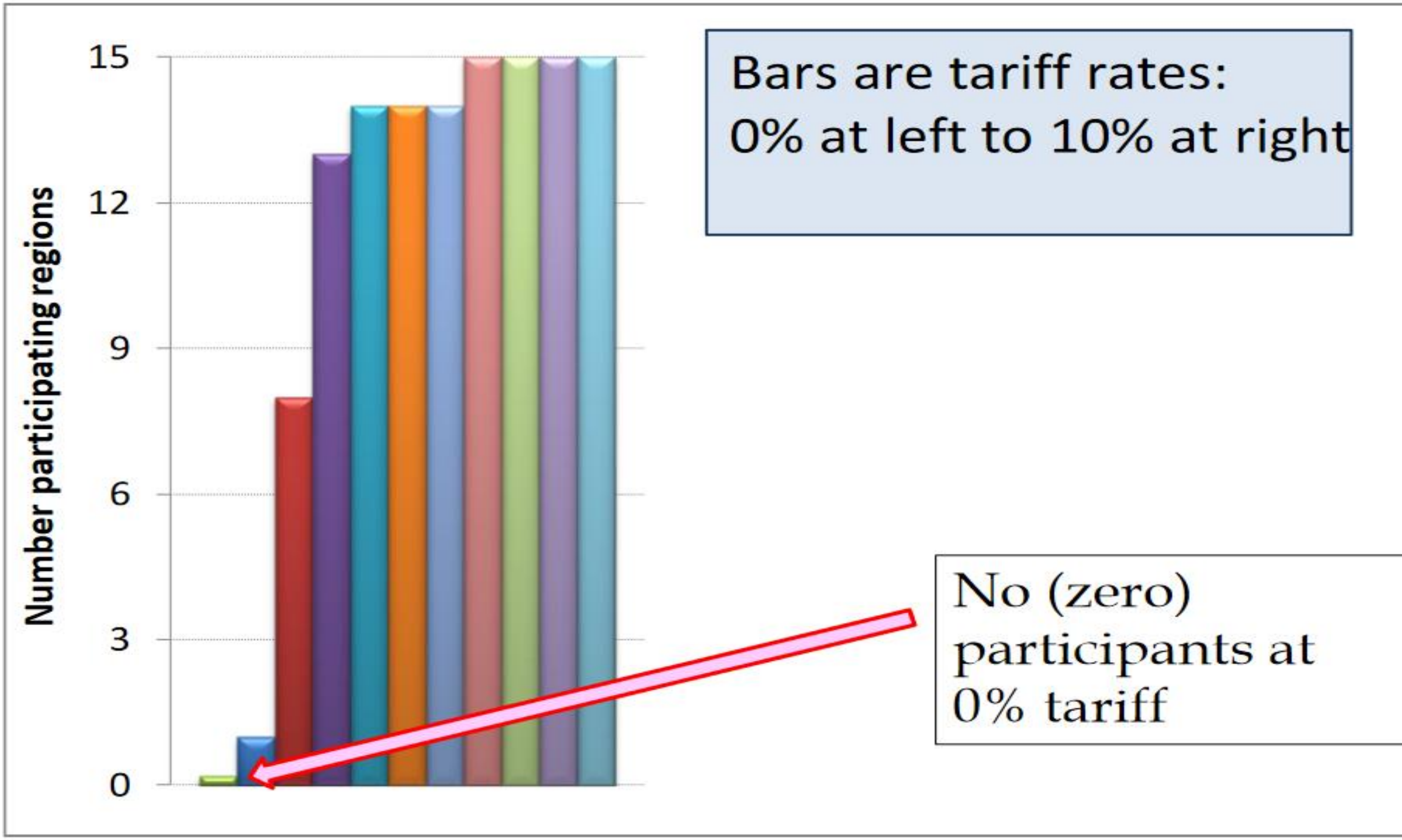
Intergenerational hurdles

- 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
- Give transfers to countries with lots of fossil reserves and to poor countries to ensure a uniform global carbon price
- Surprise: one can design a Pareto-improving green tax reform: an *intergenerational* and an *international* win-win!
- Kotlikoff et al. (2023) but need much more work with say HANK models

International (and intertemporal) hurdles

- Leakage: if only some countries price CO2 emissions, other countries benefit from lower world price of oil
- Emissions fall less: leakage due to tax shifting
- Need global carbon pricing deal including China and India
- Need "climate wall" around Europe (BTAs)
- "Climate clubs" may help too: due to increasing gains from trade, the more countries join, the more attractive it is for other countries to join (Nordhaus, 2015)
- Intertemporal hurdle: technology and self-enforcing climate treaties, so lock in green technologies to commit future governments (Harstad, 2021)

Example of Climate Compact Participation



Example for \$50/ton minimum carbon price.

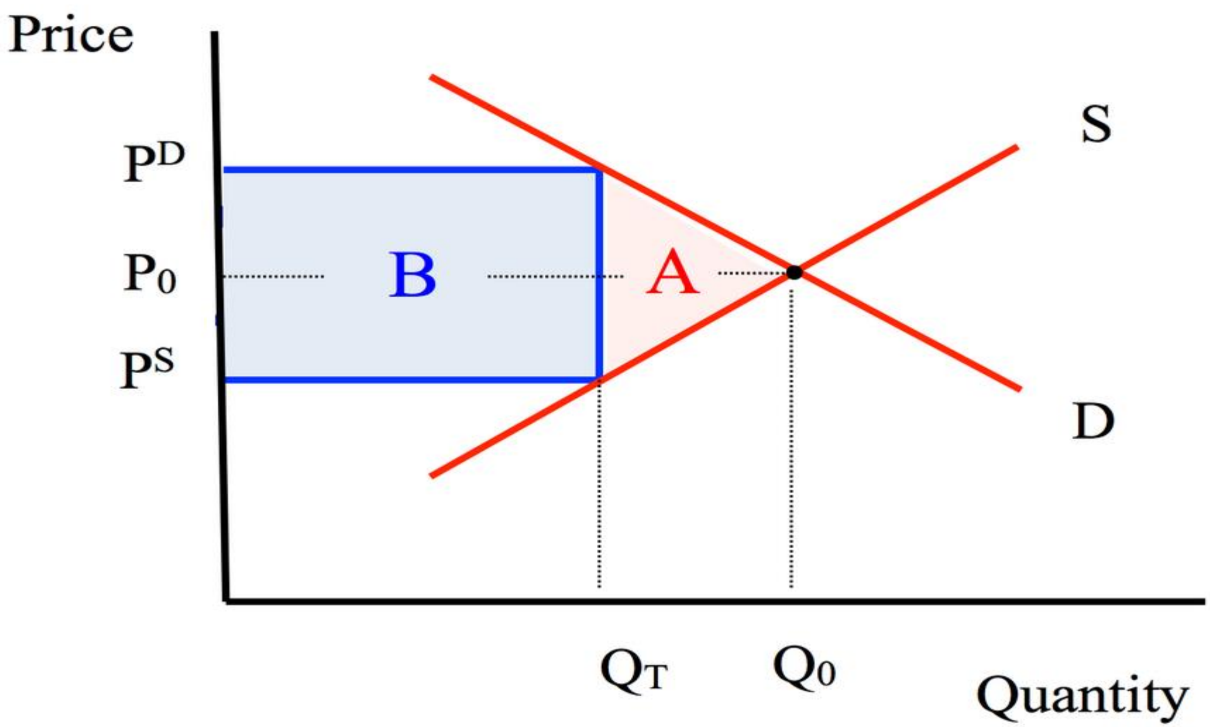
Source: Nordhaus (2021, Markus Academy Webinar) and (2015, *AER*)

Hurdles due to 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 revenue is fully rebated)

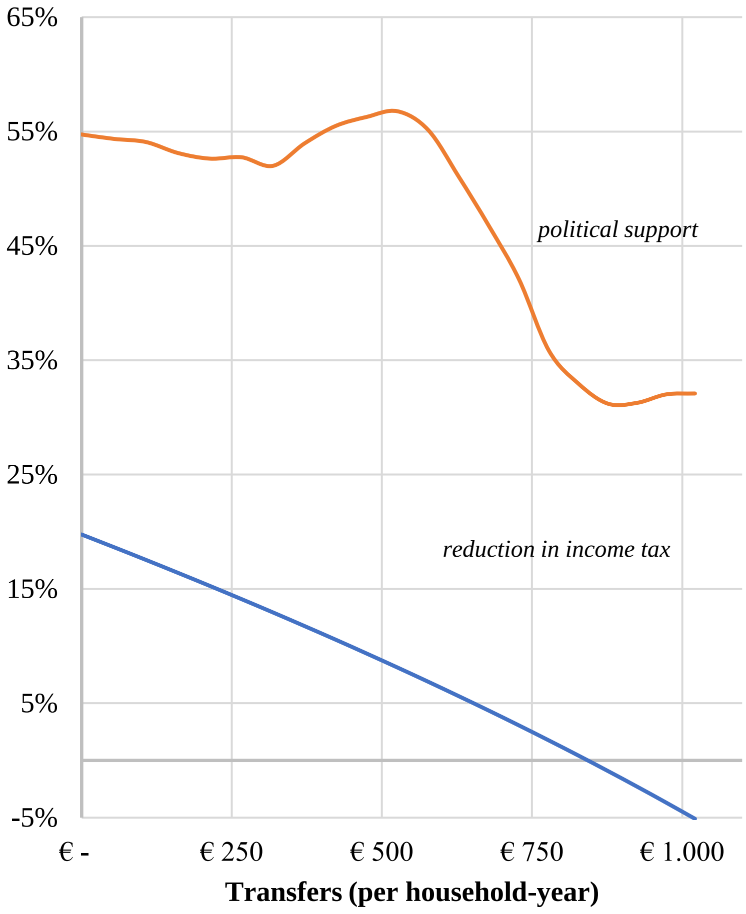
Subsidies and rent seeking are wasteful: cost may be A + B

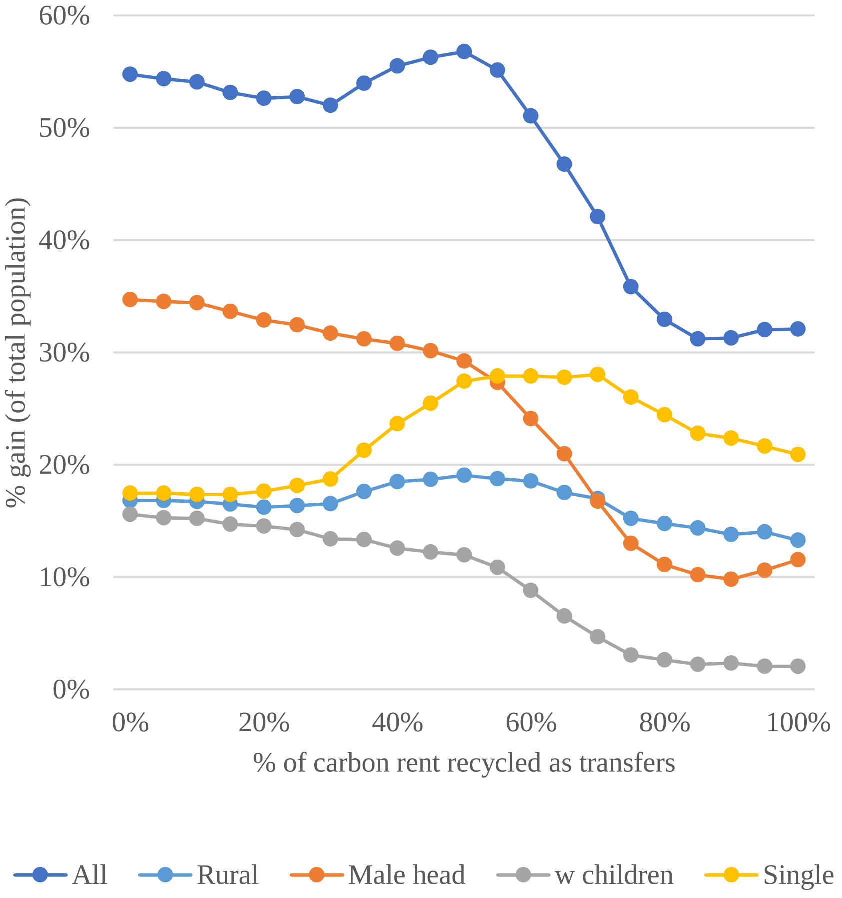


Hurdle: adverse effects on income distribution

- Replace fossil fuel (e.g., electricity) subsidies with general tax deductions for the poor: more efficient way to redistribute incomes
- When pricing carbon, gain popular support
- Avoid “Yellow Vests”: use revenues from carbon tax to lower income tax and hand out *carbon dividends* to get it politically across the line *in the most efficient manner*
- Majority support if half of revenue is used to lower income taxes and boost economic activity and the tax base and other half of revenue is handed out as carbon dividends

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 hurdles to be overcome

- *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 wager about better to believe in God; costs of carbon pricing if sceptics are right are small, but costs of inaction if IPCC is right are huge $\Rightarrow$ max-min or min-max regret policies require ambitious carbon pricing

- *Behavioural distortions:* e.g., salience (Farhi and Gabaix, 2022) $\Rightarrow$ distorted carbon tax < SCC and distorted renewable subsidies higher

PART II

Need for Radical Climate Policies

(based on work with A.J. Venables)

Rick van der Ploeg, Oxford

Learning from climatic tipping points

- 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; or via Acemoglu’s directed technical change)
  - Political tipping points (e.g., Nordhaus’ climate clubs)
  - Network effects
- Relies on positive feedback effects or – what economists call – strategic complementarities

Are IAMs fit for purpose?

IAMs rarely account of:

- behavioural changes of actors surrounding them (‘peer effects’)
- that the efficiency of new techniques may change as the scale of output will change (‘returns to scale’)
- that as people and companies gain experience with new technology, they will apply that technology more and more efficiently and productively (‘learning by doing’)
- that the policy to be implemented can also bring about a positive change in the way companies, governments and individuals interact (‘networks’)

Carbon pricing not enough

- Traditional climate policy focuses mainly on carbon pricing via a carbon tax or cap-and-trade system
- However, little progress has been made
- Need for more radical, transformative policies (e.g., renewable energy subsidies) which can be done sector by sector
- Furthermore, social and technological interventions can encourage a tilt in the desired direction.
- A policy that triggers social, technological and political tipping points and leverages networks might radically accelerate the green transition

Need a “new” type of economics

- From ‘neo-classical’ world of IAMs:
  - Efficient: set carbon price to expected present discounted value of MDs from emitting one ton of carbon today (SCC or Pigouvian tax)
- To models that have 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?

Resilience

Micro-founded, discrete-choice 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 peer effects

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

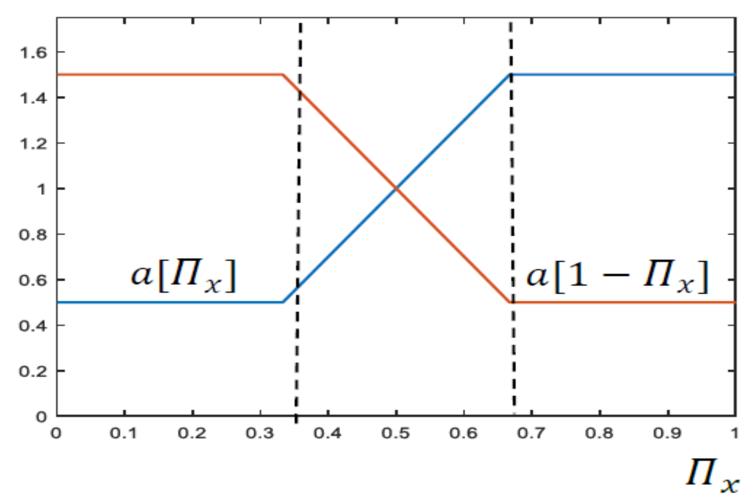
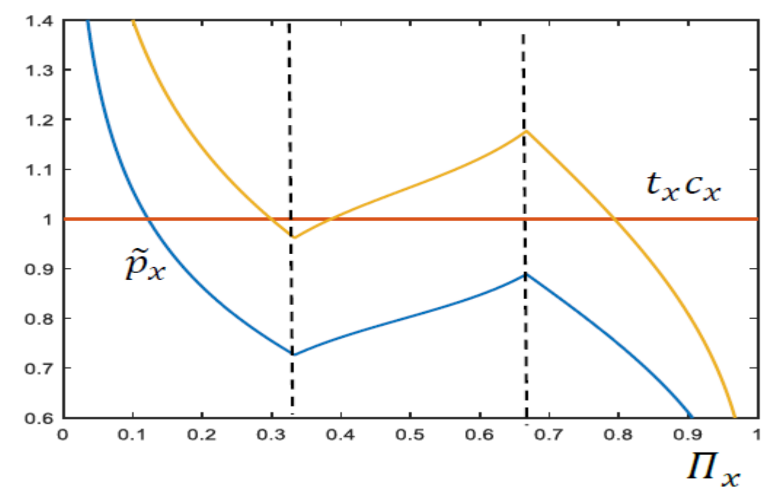


Figure 2b: Unit cost and demand curves, $\tilde{p}_x$

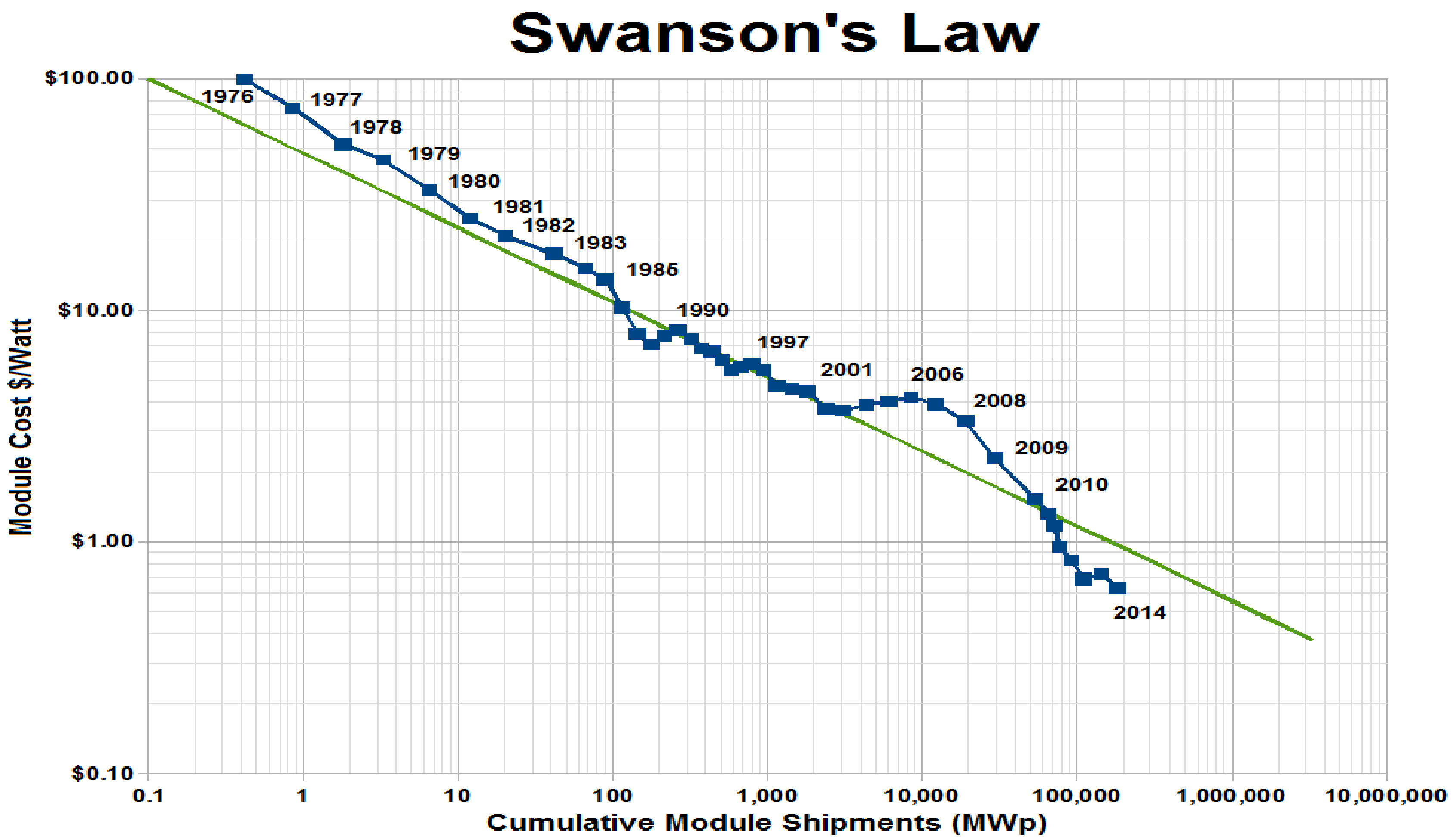


Peer effects in preferences can cause the demand curve to slope upwards, creating the possibility of multiple equilibria.

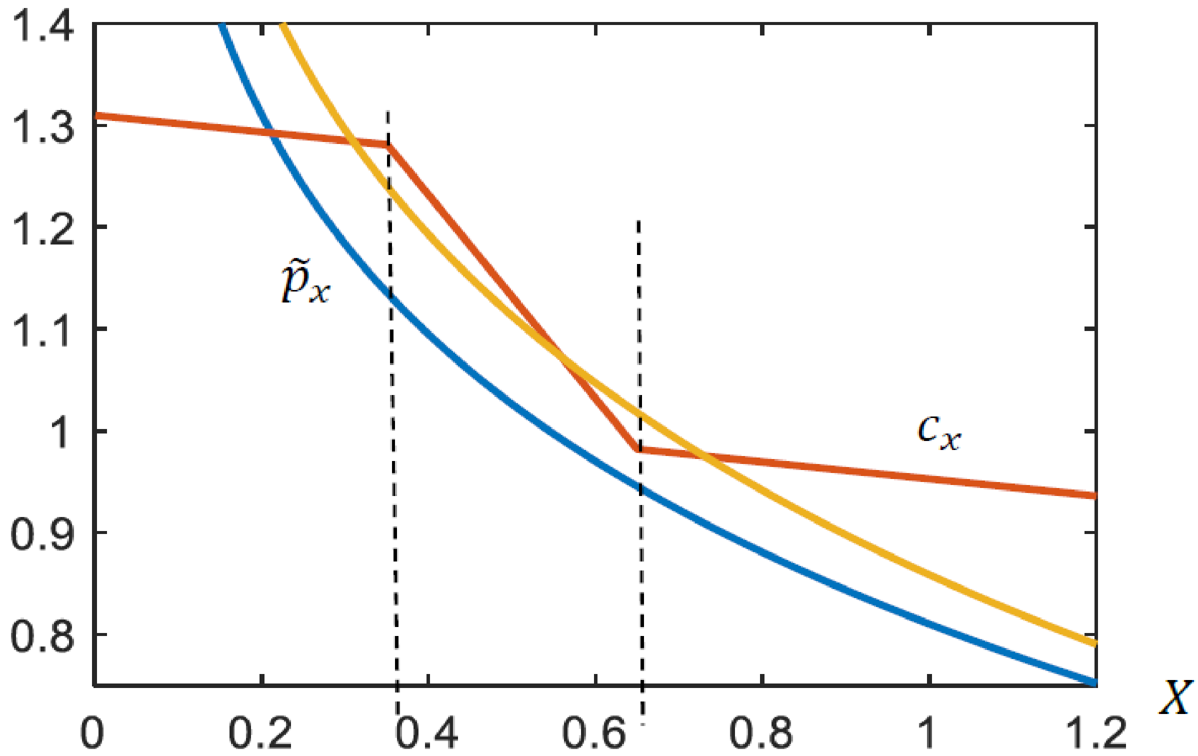
Policy with technological spill-over effects

- 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
- Cost reduction & development of new products is like rising a_x, as more product varieties induce consumers to switch to green

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



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.

Tipping with radical policies

- Left panels of figures 5 and 6 (next slide) 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 6a: *X*-sector tax & *X*-sector output.

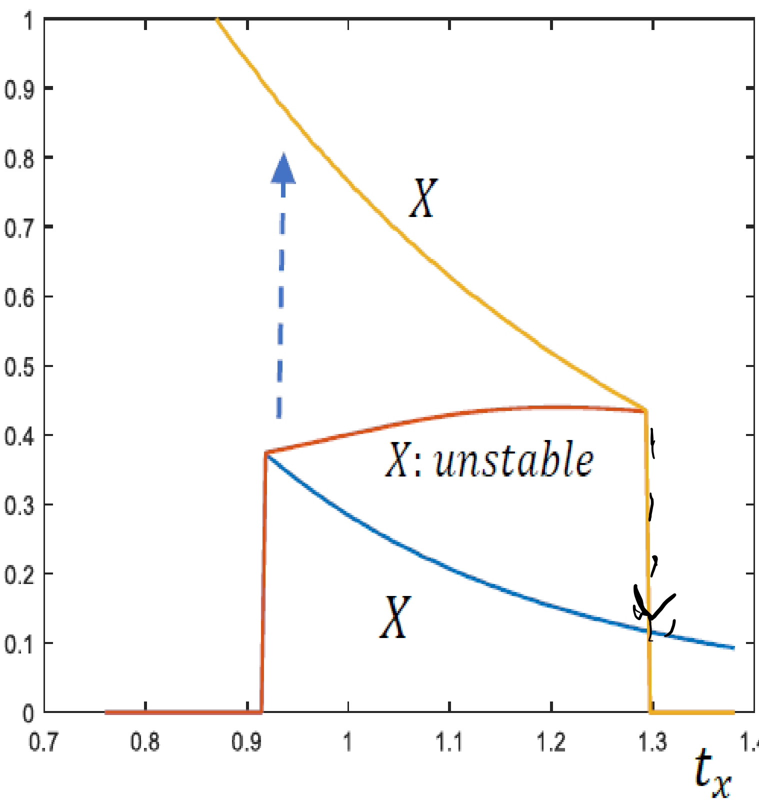
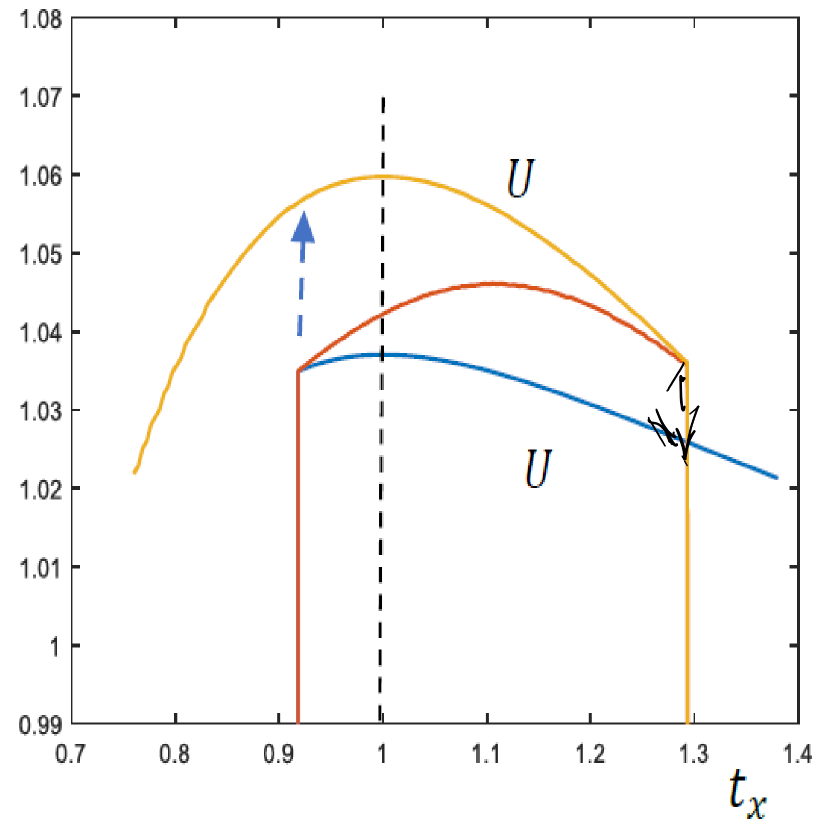


Figure 6b: *X*-sector tax & utility.



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.

Recapitulation

- Complementarities $\Rightarrow$ amplification effects of carbon taxes and green subsidies $\Rightarrow$ need ***lower*** carbon tax or ***lower*** subsidies (cf. Mattauch et al., 2018; Konc et al., 2021)
- But if complementarities are positive and strong enough, two stable equilibria with, respectively, low and high emissions (and a third unstable equilibrium in middle)
- Policy must bring about switch between equilibria, so need ***higher*** carbon tax than SCC or ***higher*** renewable subsidies
- Despite uncertainties about substantial complementarities, optimal policy needs 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?

History vs expectations: 3 possibilities

- **Weak peer effects**: saddle-point dynamics, so relative value of green technology *V* jumps while share of green renewables *X* is predetermined. Only an interior solution
- **Intermediate peer effects**: unstable & eigenvalues have zero imaginary parts, so for all X_0 less than a critical value there is a unique monotonic adjustment path to the brown boundary steady state and else there is a unique monotonic adjustment path to the green boundary steady state
- **Strong peer effects**: unstable with complex eigenvalues, so either cyclical adjustment to brown boundary state if X_0 less than a low critical value, or cyclical adjustment to green boundary state if X_0 more than a high critical value, or two cyclical adjustment paths originating from the same X_0, one towards the brown and one towards the green steady state (the "overlap", cf. Krugman, 1991)

Related studies

- Van der Meijden and Smulders (2022): “Factor-eliminating technical change in the energy transition” also has 3 equilibria
  - Technological breakthroughs needed in hard-to-abate sectors to increase substitution possibilities
  - So, weight of fossil fuel in production function becomes endogenous
  - Temporary carbon tax can shift economy from low to high decarbonisation equilibrium; permanent carbon tax affects share of decarbonised sectors in clean equilibrium
  - FETCH and clean DTC are complements
- Smulders and Zhou (2022): “Self-fulfilling prophecies in the transition to clean technology” also has 3 equilibria in DTC model where clean and dirty goods are good substitutes
  - multiple transition paths
  - Need a coordination device in addition to Pigouvian carbon tax

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 environmentalists, 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

Credibility, politics and climate trap

- Electoral competition: two political parties try to attract swing voters who might switch allegiance
- Directed technical change
- Dynamics of technologies, values and political decisions
- With evolutionary forces policies and expectations of these policies lead to a *materialist* or *environmentalist* outcome: multiple equilibria
- Need not converge to outcomes with highest welfare
- This is due to inability to commit to future policies
- May be easier to commit to future institutions (e.g., an independent central bank for emission permits)

Transformative climate policies

- 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.)
- Sensitive intervention points
  - Interventions that kick the system so initial change is amplified by feedback effects that give an outsized effect (Farmer et al.)

Summing up

- Despite decades of economic advice, little progress on climate policy
- Obstacles to successful implementation range from risk of stranded assets, carbon leakage, green paradox effects, adverse distributional effects, lobbying pressures, and psychological barriers to climate scepticism
- Marginal policies wholly inadequate to engineer a green transition
- Need for radical climate policies to shift economy from bad, high-emissions equilibrium to good, low-emissions equilibrium
- Careful attention must be paid to key players in various socio-economic and ecological networks and policies should leverage them
- Sensitive intervention points help in search for effective and transformative climate policies