Strategic green industrial policy

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Green industrial policy

- The use of government interventions to support domestic industries that have environmental benefits.
- Some rationales for GIP (Rodrik 2014)
  - Foster new clean technologies to overcome "infant" industry issues, including network, scale and innovation externalities
  - Create jobs and exports
  - Countervail emissions that are underpriced
    - Subsidies to fossil fuels
- Popularity
  - In the great recession, 16% of global stimulus funding was for green projects, of which 9% involved renewable energy

Popularity of Renewable Energy Incentives

Countries with national or provincial renewable energy policies or targets in place, as of early 2015 (Source: REN21 2015)

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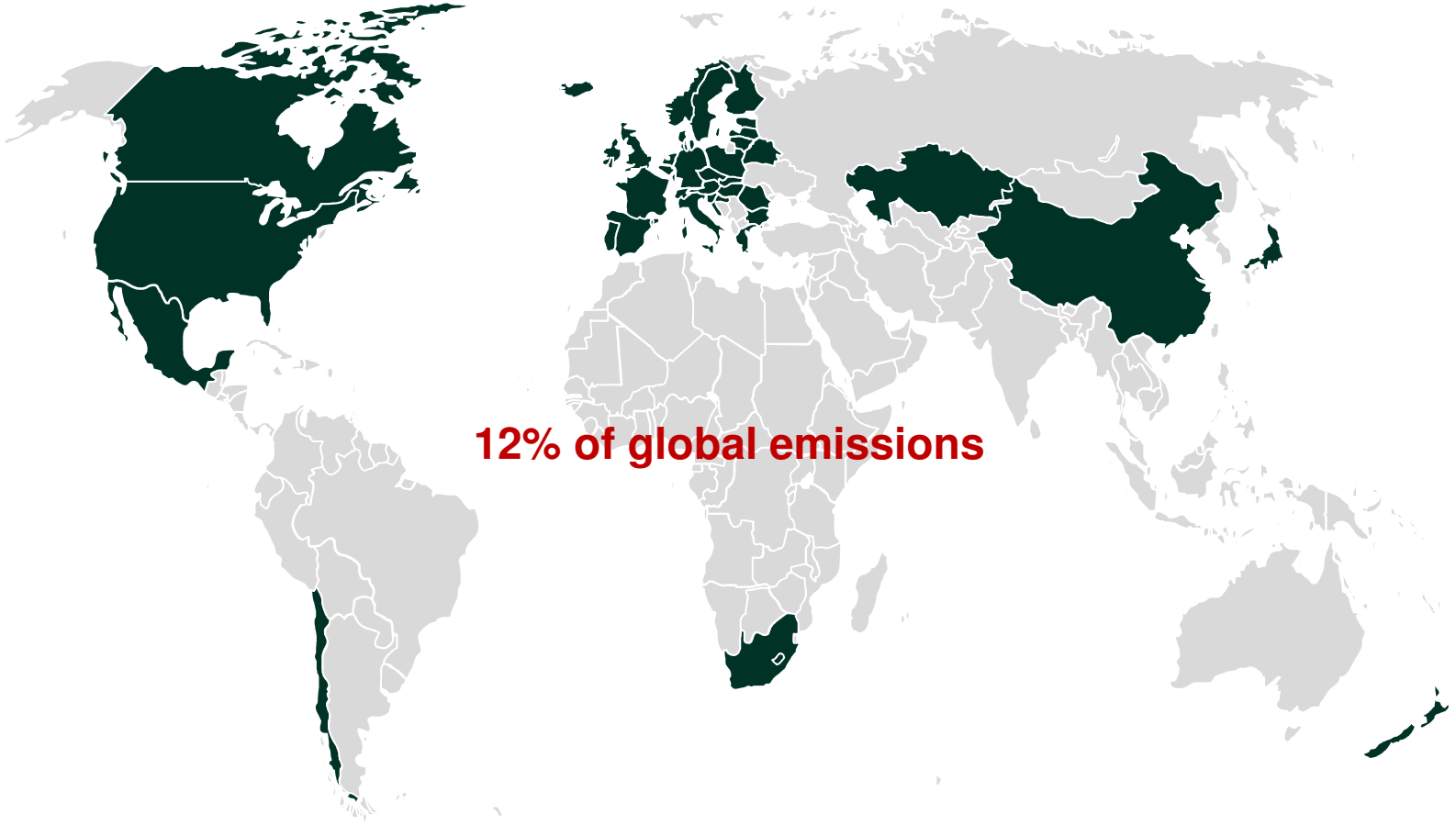
Popularity of Carbon Pricing



Countries with a national or provincial ETS or carbon tax implemented or scheduled, as of early 2015 (Source: World Bank 2015)

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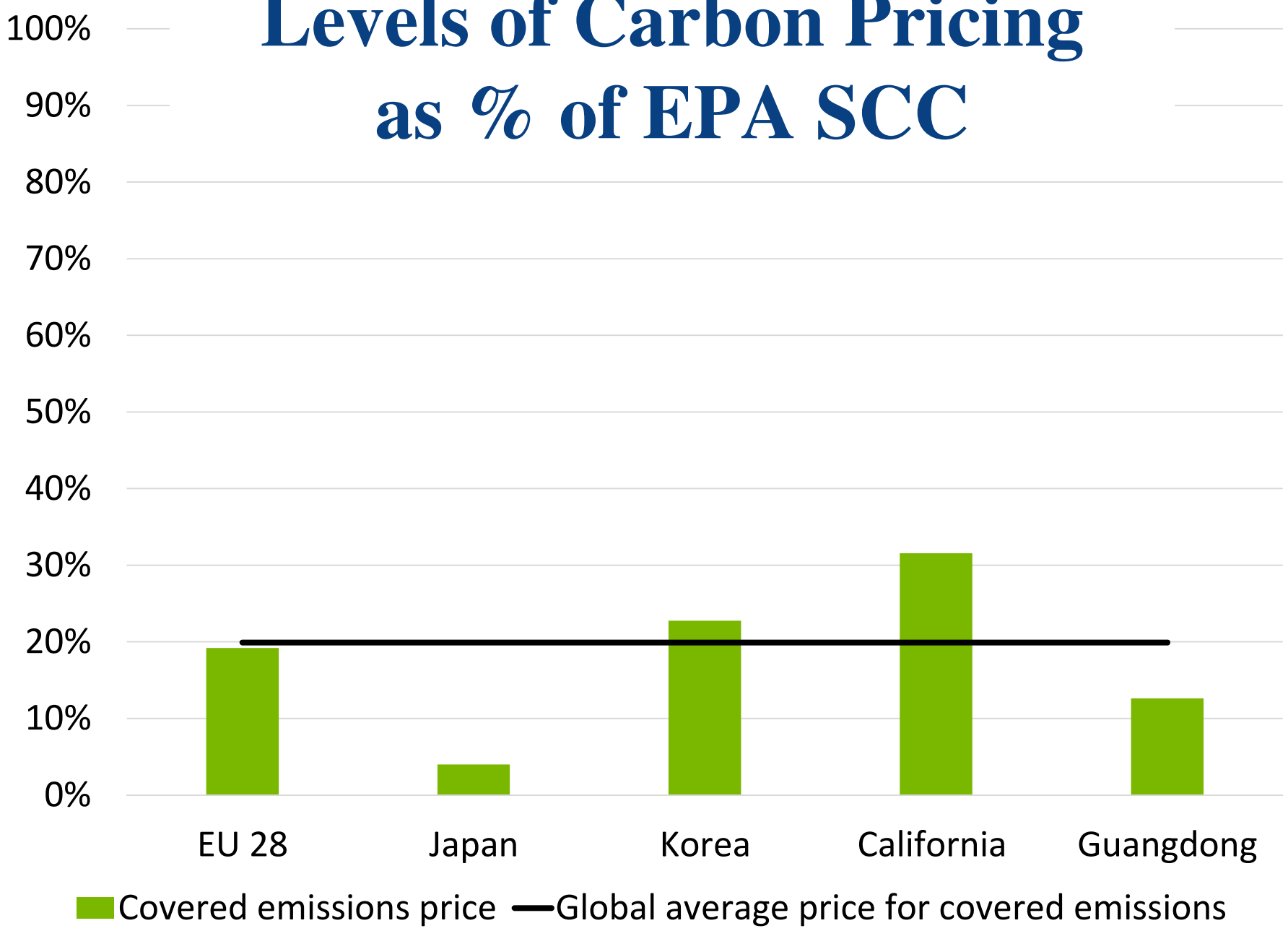
Levels of Carbon Pricing as % of EPA SCC



Industrial policy and the WTO

- Trade lawyers and economists have long been skeptical of industrial policy
  - beggar-thy-neighbor protectionism, opportunities for rent seeking, and
    difficulty in picking winners
- WTO Agreement on Subsidies and Countervailing Measures
  - Disciplines use of discriminatory subsidies: upstream production and export subsidies, local content requirements
  - Lacks environmental exceptions (unlike GATT)

Recent WTO renewable energy disputes

- European Union — Certain Measures on the Importation and Marketing of Biodiesel and Measures Supporting the Biodiesel Industry (Complainant: Argentina, 2013)
- India — Certain Measures Relating to Solar Cells and Solar Modules (Complainant: United States, 2013)
- European Union and Certain Member States — Certain Measures Affecting the Renewable Energy Generation Sector (Complainant: China, 2012)
- Canada — Measures Relating to the Feed-in Tariff Program (Complainant: European Union, 2011)
- Canada — Certain Measures Affecting the Renewable Energy Generation Sector(Complainant: Japan, 2010)
- China — Measures concerning wind power equipment (Complainant: United States, 2010)

Trade literature on subsidies

- Spencer and Brander (1983), Brander and Spencer (1985) (and followers)
  - 2 Cournot producer countries with 3rd party export market
  - Focus on export / production subsidies, not in tandem with consumption subsidies
- Find that joint profits would be maximized with *lower* upstream subsidies than a Nash equilibrium obtains
  - Thus recommend negotiating restrictions on subsidies
- Ignores that global welfare is maximized with *higher* subsidies…
  - Strategic countries do not internalize the upstream market failure for other countries (Fischer 2016)

Protection for sale

- Grossman and Helpman (1994 and 1995) explain excess protectionism with a model of industry group lobbying, distorting the government's objective function away from pure welfare.
- Political distortion does mean that limiting subsidies can improve global welfare

- Neither of these literatures consider environmental externalities or other market failures

This paper

- Combine elements of strategic trade and subsidies, protection for sale, and environmental externalities
- Application to renewable energy and climate change
- Consider the effects of restricting the use of upstream subsidies and the value of an alternative policy: climate finance

Model setup

- 2 regions produce and consume a green technology and export to a 3rd region
  - E.g., technology leaders and follower / developing region
- Global planner wants to maximize welfare, including environmental benefit of v_G:

$$W_G = \Pi_1 + \Pi_2 + TR_1 + TR_2 + CS_1 + CS_2 + CS_3 + v_G E_G$$

- Governments of individual regions maximize welfare, with their own environmental valuation v, plus a weight on production:

$$W_i = \Pi_i + CS_i + TR_i + v_i E_G + \omega y_i$$

Downstream consumption of the green good

- Linear demand function
  - Market share weight of *m* to explore demand heterogeneity

$$x_i = m_i\left(a-(P-\eta_i)\right)/b; \quad \sum_i m_i = 1$$

- Leads to linear inverse demand function for upstream producers of

$$P = A - BX = a + \bar{\eta} - bX$$

- External benefits related to consumption
  - Region-specific avoided emissions factors

$$E_G = \mu_1 x_1 + \mu_2 x_2 + \mu_3 x_3$$

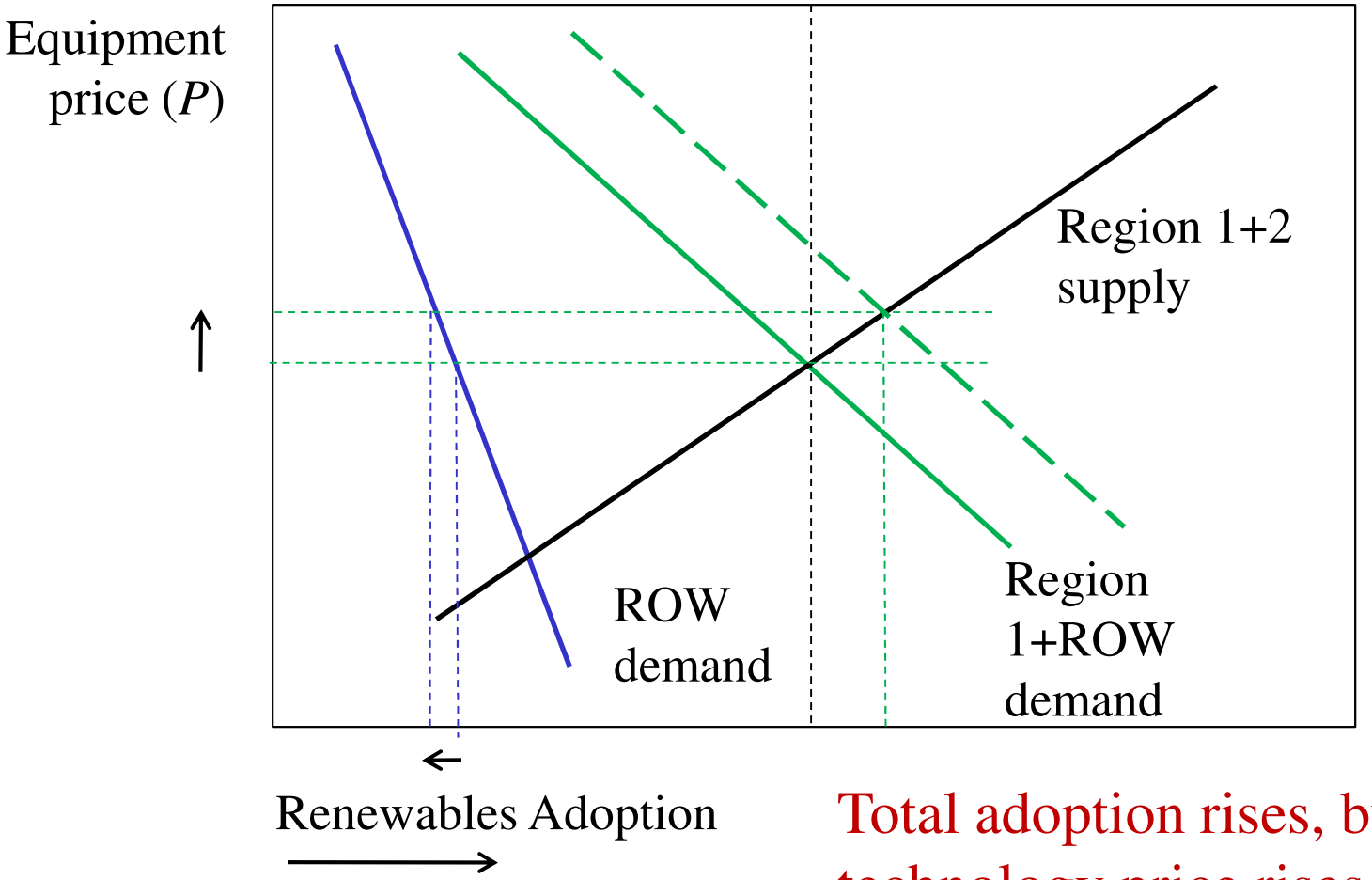
Upstream market

- Representative technology industry of price-taking firms, leading to upward-sloping linear supply curves
  - E.g., production lines of heterogeneous producers with limited capacities (as in Laffont and Tirole 1996)
- Profits $\pi_d = \left(P + \gamma_d - (c + h y_d)\right) y_d$
- Output $y_d = \dfrac{(A - c + \gamma_d) + \dfrac{B}{h}\dfrac{(\gamma_d - \gamma_f)}{2}}{2(B+h)}; \quad Y = \dfrac{A - c + \overline{\gamma}}{B+h}$
- Equilibrium price $P = (c - \overline{\gamma})\dfrac{b}{b+h} + (a + \overline{\eta})\dfrac{h}{b+h}$

Policies

- Upstream subsidy to manufacturing γ_i
  - Tax incentives, preferential finance, land, Local content requirements, R&D support
- Downstream subsidy to deployment η_i
  - Production subsidies, feed-in tariffs, renewable portfolio standards, Investment incentives
- Contributions to deployment in ROW, f_i
  - Climate finance

Renewable Technology market: Downstream subsidy



Total adoption rises, but technology price rises too and foreign adoption falls

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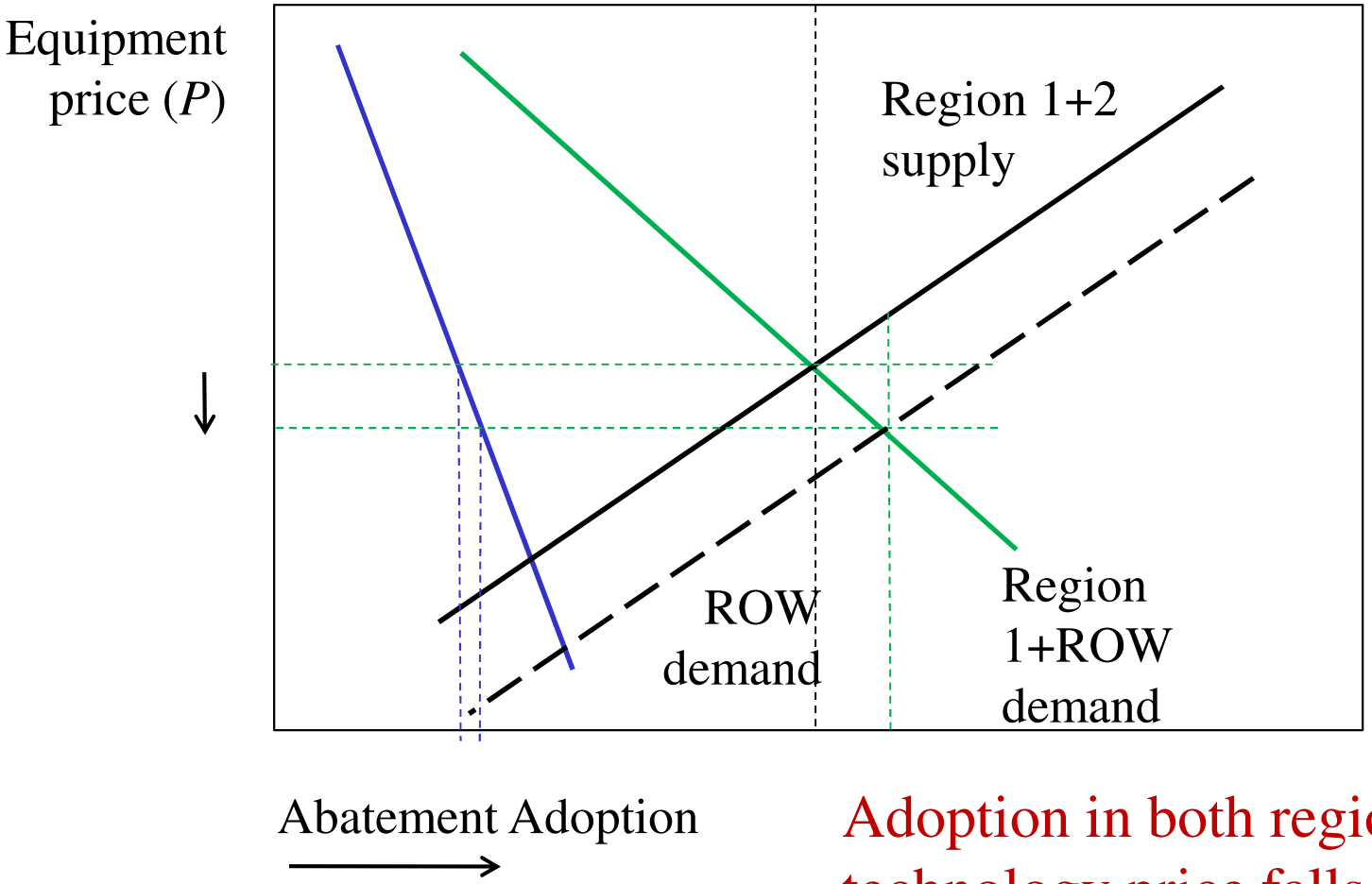
Renewable technology market: Upstream subsidy



Adoption in both regions rises, technology price falls

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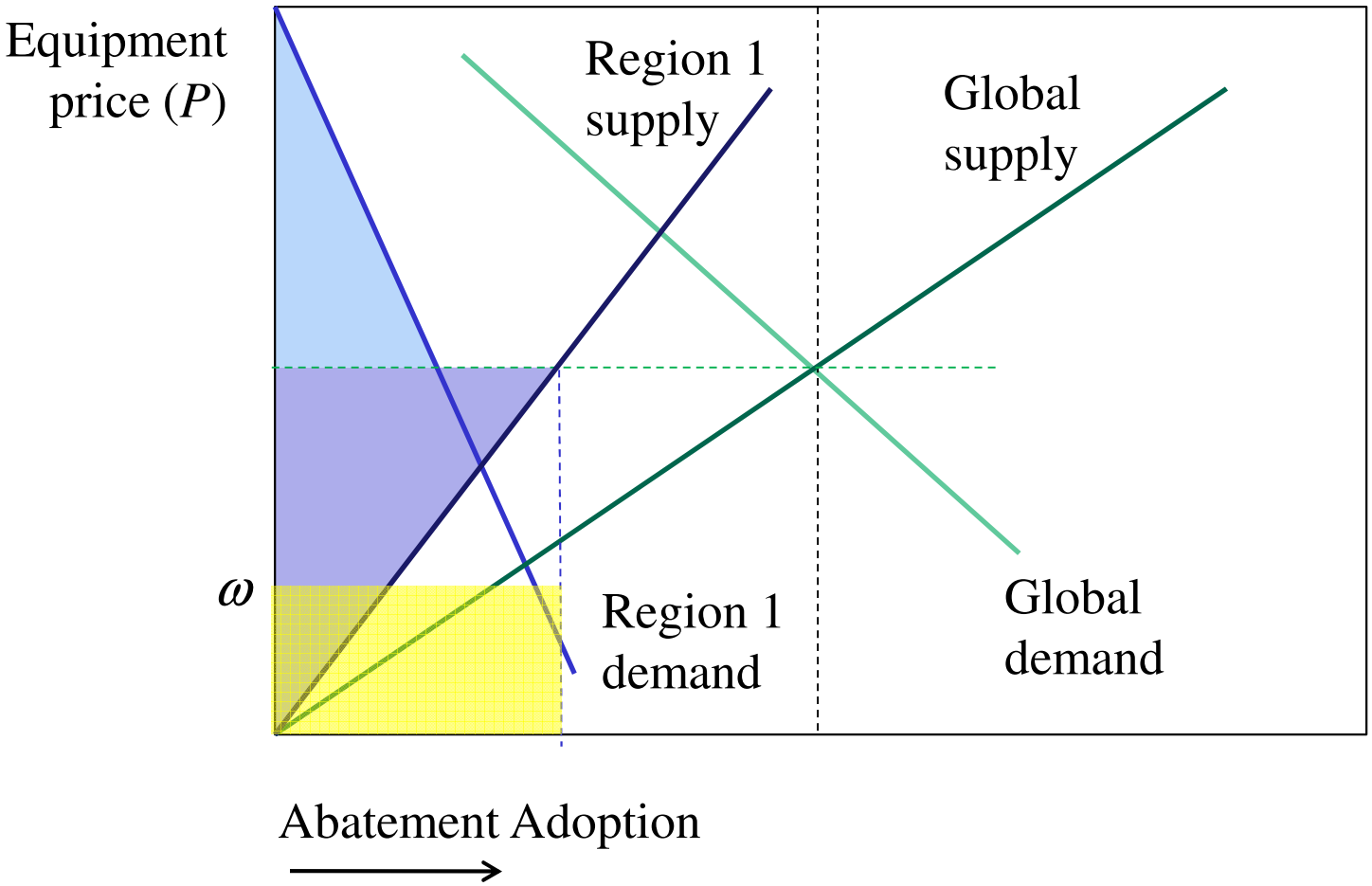
Planner and Nash equilibria

- Planner maximizes global welfare w.r.t. upstream / downstream subsidies in each producing region
  - Upstream subsidies symmetric
- Nash game: each producer country maximizes its own objective function, taking other's subsidies as given, knowing its effects on the international market
- (Also some scenarios with policy constraints)

Region 1 surplus



Results without external benefits

- Optimal policy is to have no subsidies $(\gamma_i^* = \eta_i^* = 0)$
- $\omega = 0$: Nash equilibrium has producer countries *taxing* upstream and subsidizing downstream by an equivalent amount, to the extent that they are net exporters
  - Both behaviors raise export prices
- $\omega > 0$: Sum of the Nash subsidies equals ω
- In a symmetric-country duopoly, $\gamma_i^N = \omega, \eta_i^N = 0$

Results with external benefits

- Global planner sets subsidies so the sum = MEB in all regions $\left\{\gamma_i^* = v_G\mu_3;\ \eta_i^* = v_G(\mu_i - \mu_3)\right\}, i = \{1,2\}$
- *Sum* of the Nash subsidies equals the MEB as valued by that country, plus weight on production

$$\gamma_i^N + \eta_i^N = v_i\mu_i + \omega,\ \ i = \{1,2\}$$

- Without 3rd market ($m_3 = 0$), Nash duopoly replicates the social optimum if v_i = SCC and $\omega = 0$
- With 3rd market, insufficient upstream subsidies and lower environmental gains—unless counterbalanced by overweighting of production

Results with climate finance contributions

- Global planner is indifferent between subsidizing upstream or via contributions to ROW
- If upstream subsidies are not allowed, and $\omega = 0$, strategic countries in the Nash equilibrium would tax downstream consumption at home to the extent that the ROW has market share, and would also like to tax ROW consumption.
- Strategic countries will subsidize both downstream consumption at home and in ROW only if the overweighting of production is sufficiently large.

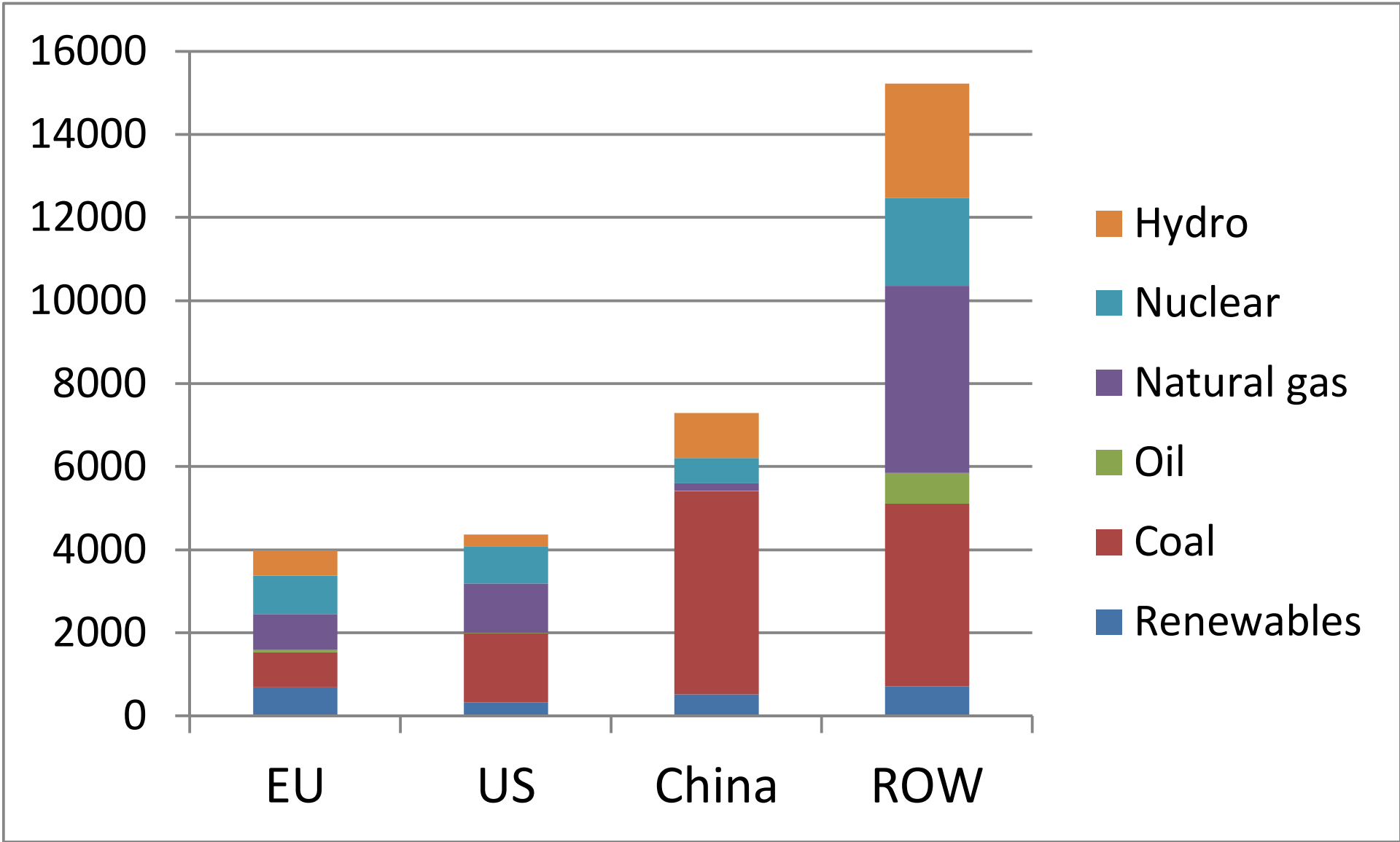
Summary of theory

- For brown goods, restrictions on upstream subsidies are either useful (if $\omega > 0$) or ineffectual (if $\gamma^N < 0$)
- For green goods, allowing upstream subsidies may be useful, *especially* if $\omega > 0$
- Climate finance will only be a good substitute if $\omega > 0$

Numerical simulations: an application to renewable energy

- EU, US, China + ROW
- Downstream electricity markets with linear supply curves for fossil and renewable energy
  - 2020 projections from International Energy Outlook
  - Market equilibrium derives renewables as function of the policy variables
- Parameterized based on other exercises
  - Fischer, Newell and Preonas (2013) for US
  - Fischer, Huebler and Schenker (2014) for EU
  - No dynamics here; 2015-2020 stage
  - China and ROW assumed to have same supply elasticities at the baseline point

Generation in 2020 by source (IEA 2014)

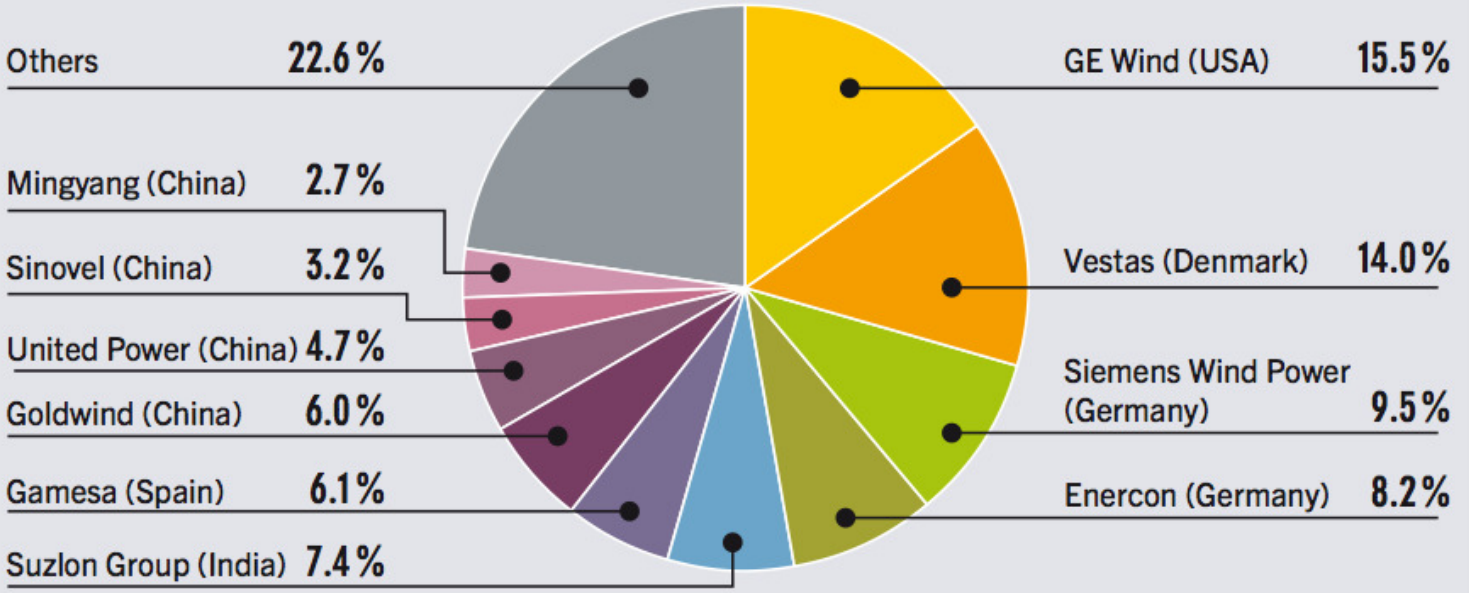


Upstream market stylized on wind

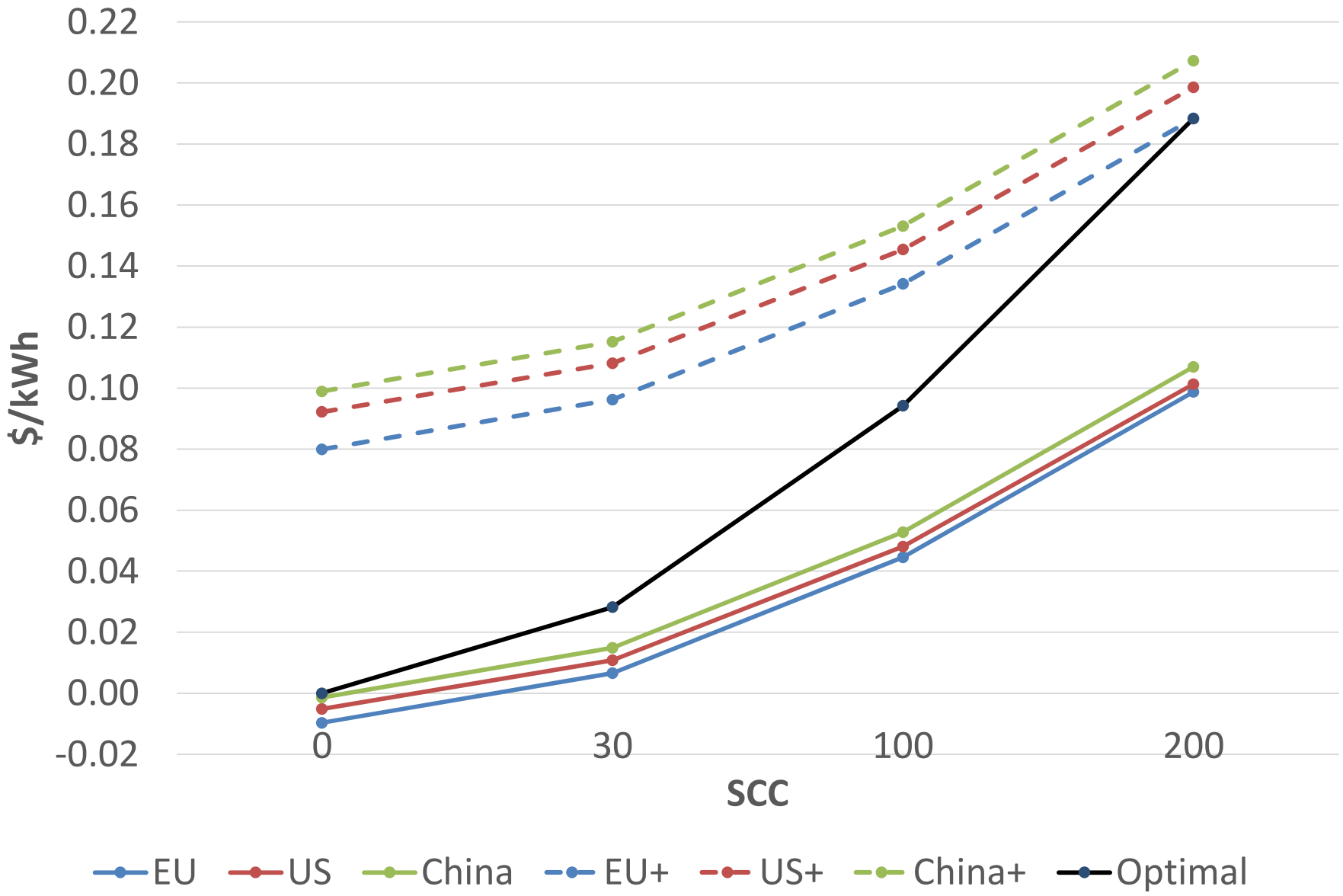
- Market shares: EU = ½, US = CN = ¼
  - Similar to relative shares among top 10 firms: US 16%; EU 38%; China 16%
- In political distortion scenarios, $\omega = \$0.10$

REN21 Renewable Energy Policy Network for the 21st Century

FIGURE 20. MARKET SHARES OF TOP 10 WIND TURBINE MANUFACTURERS, 2012

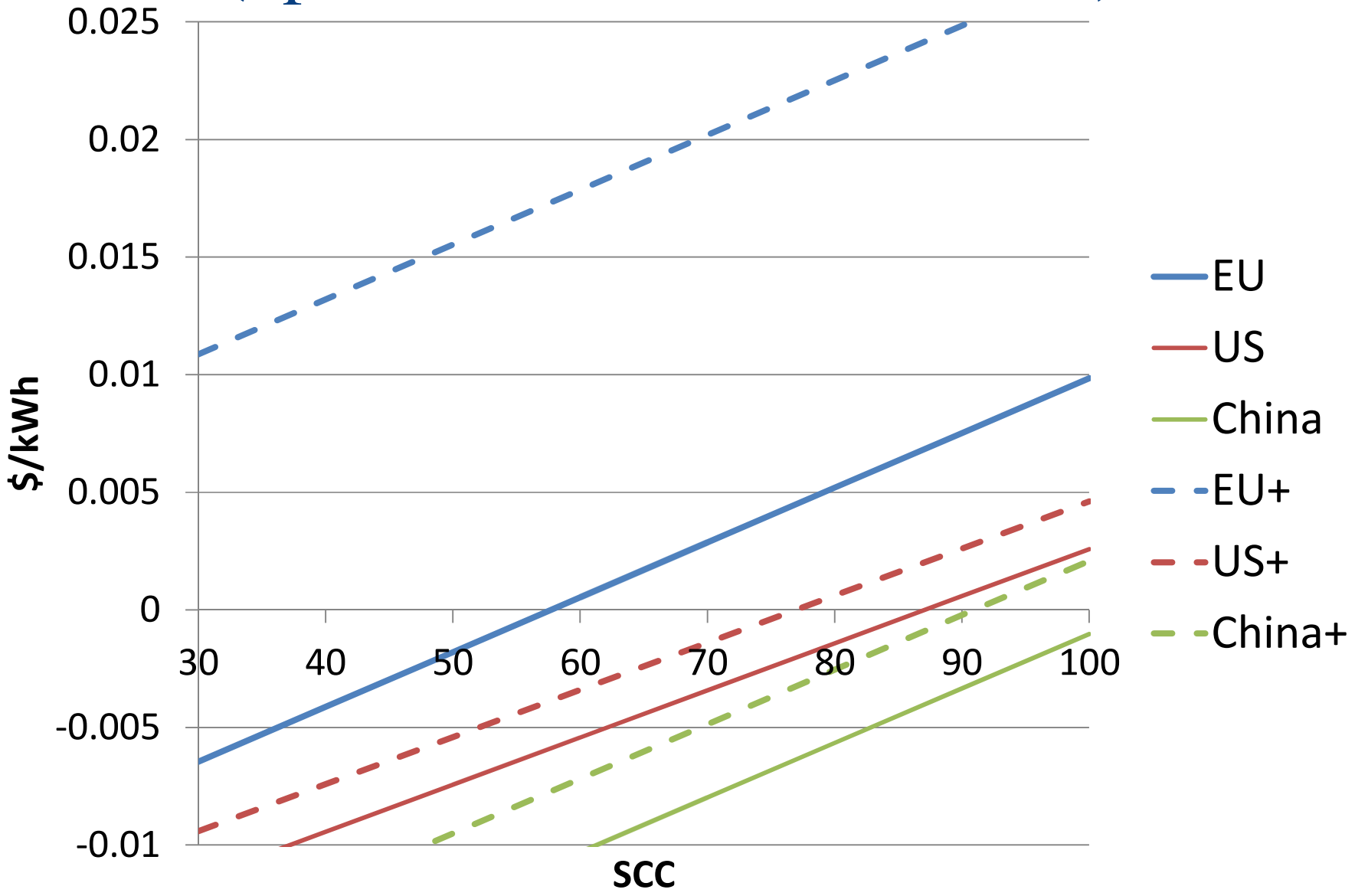


Optimal, strategic upstream subsidies γ_i

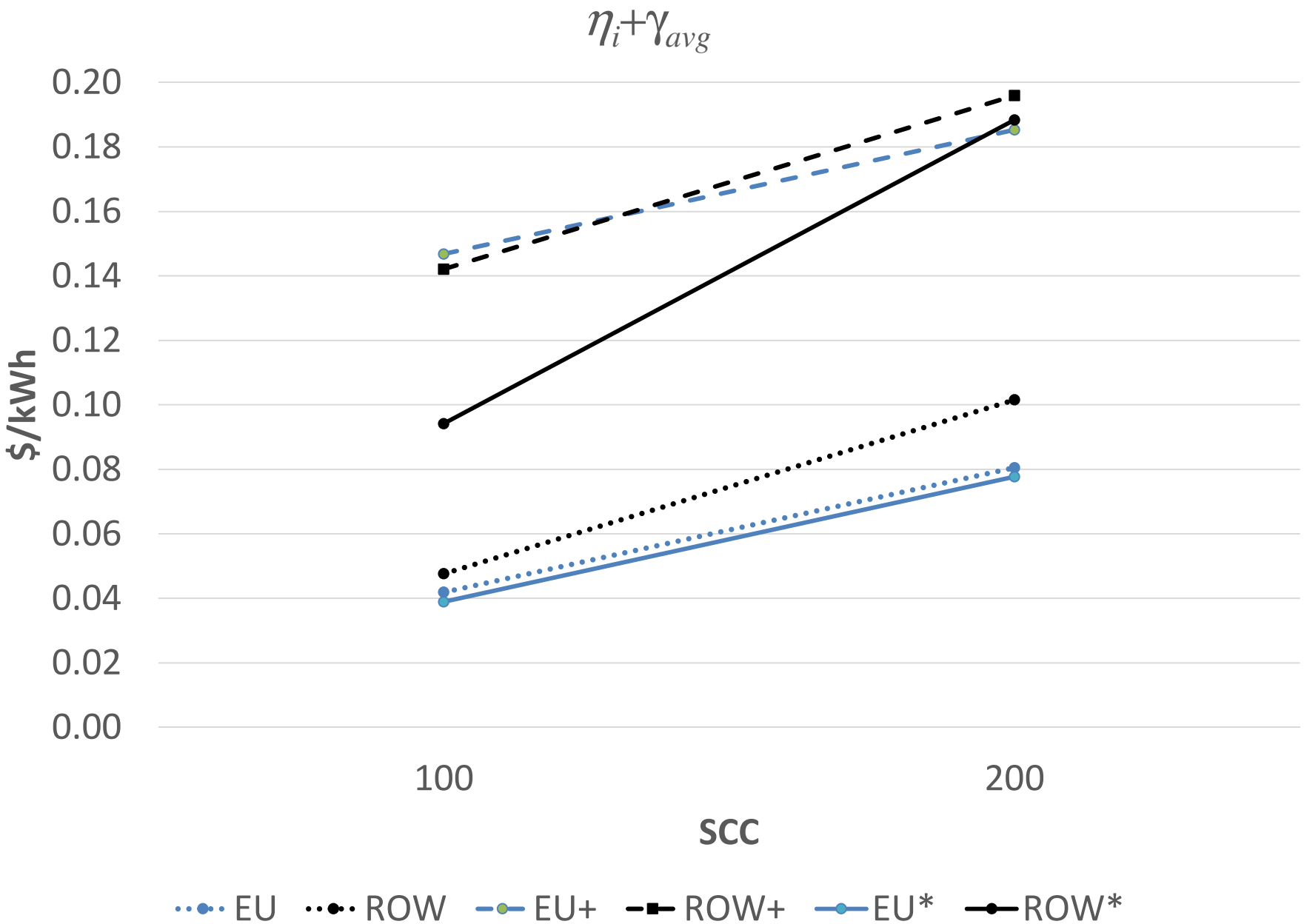


Optimal contributions to ROW

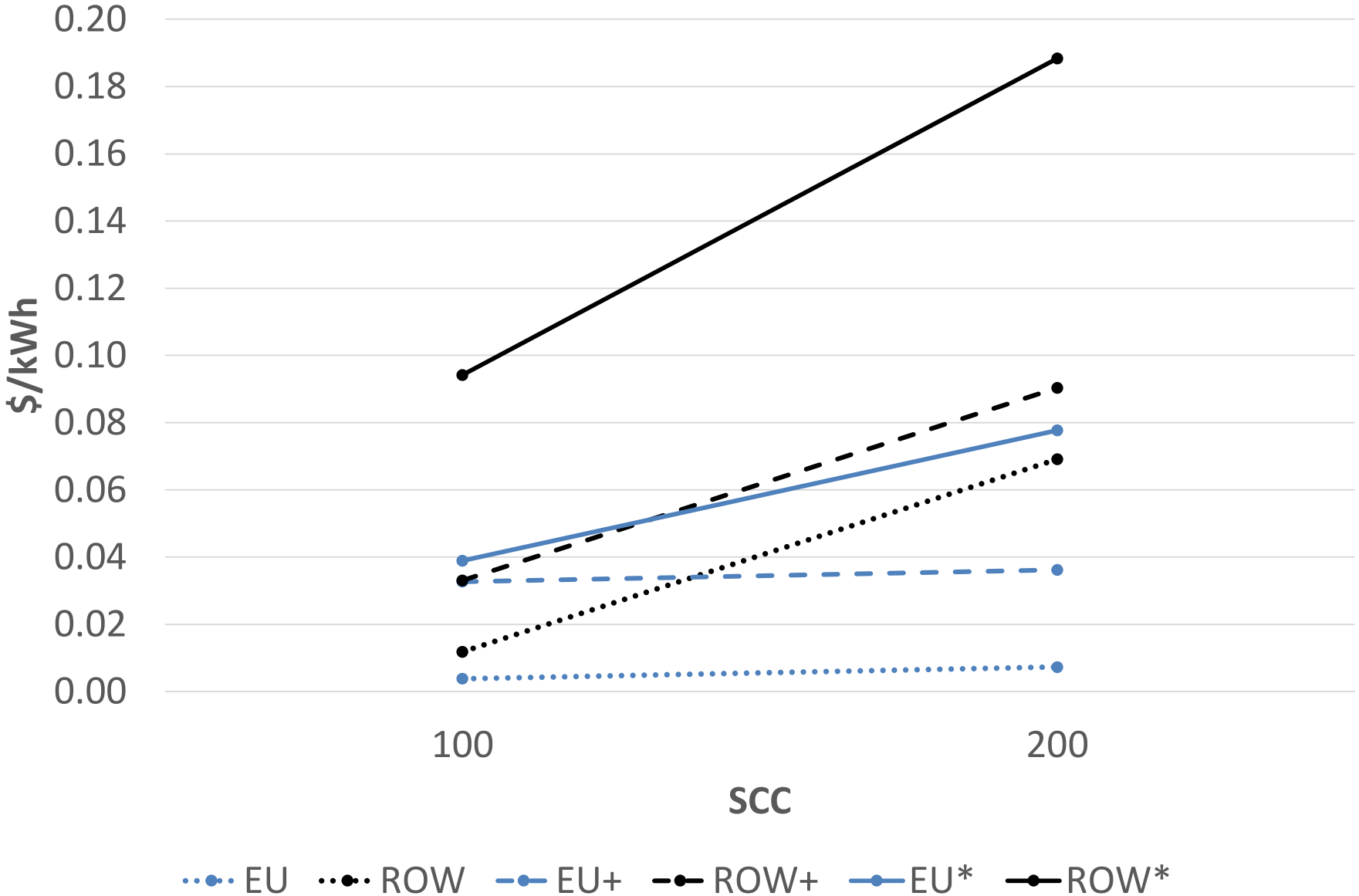
(upstream subsidies restricted)



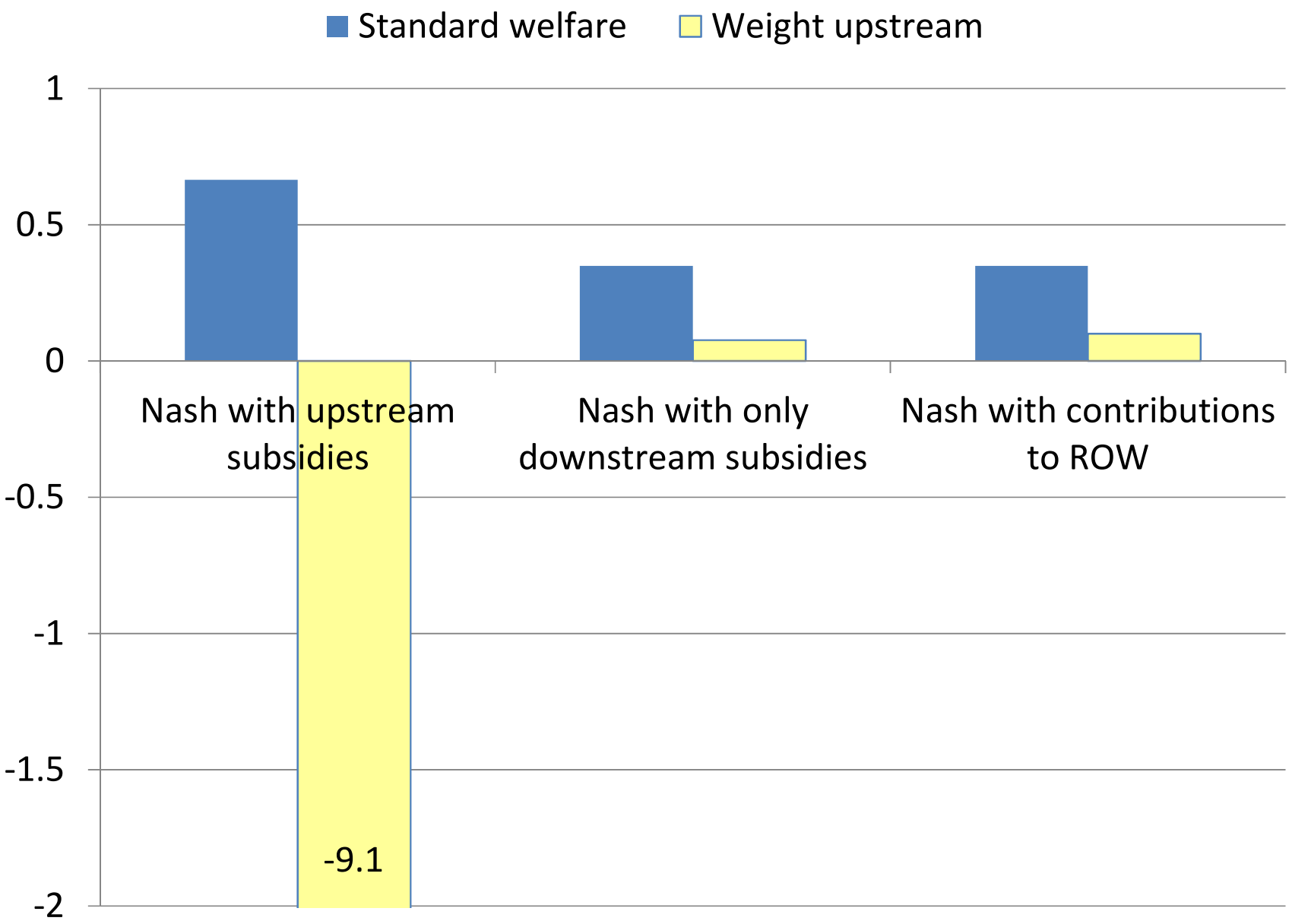
Total subsidies when unconstrained



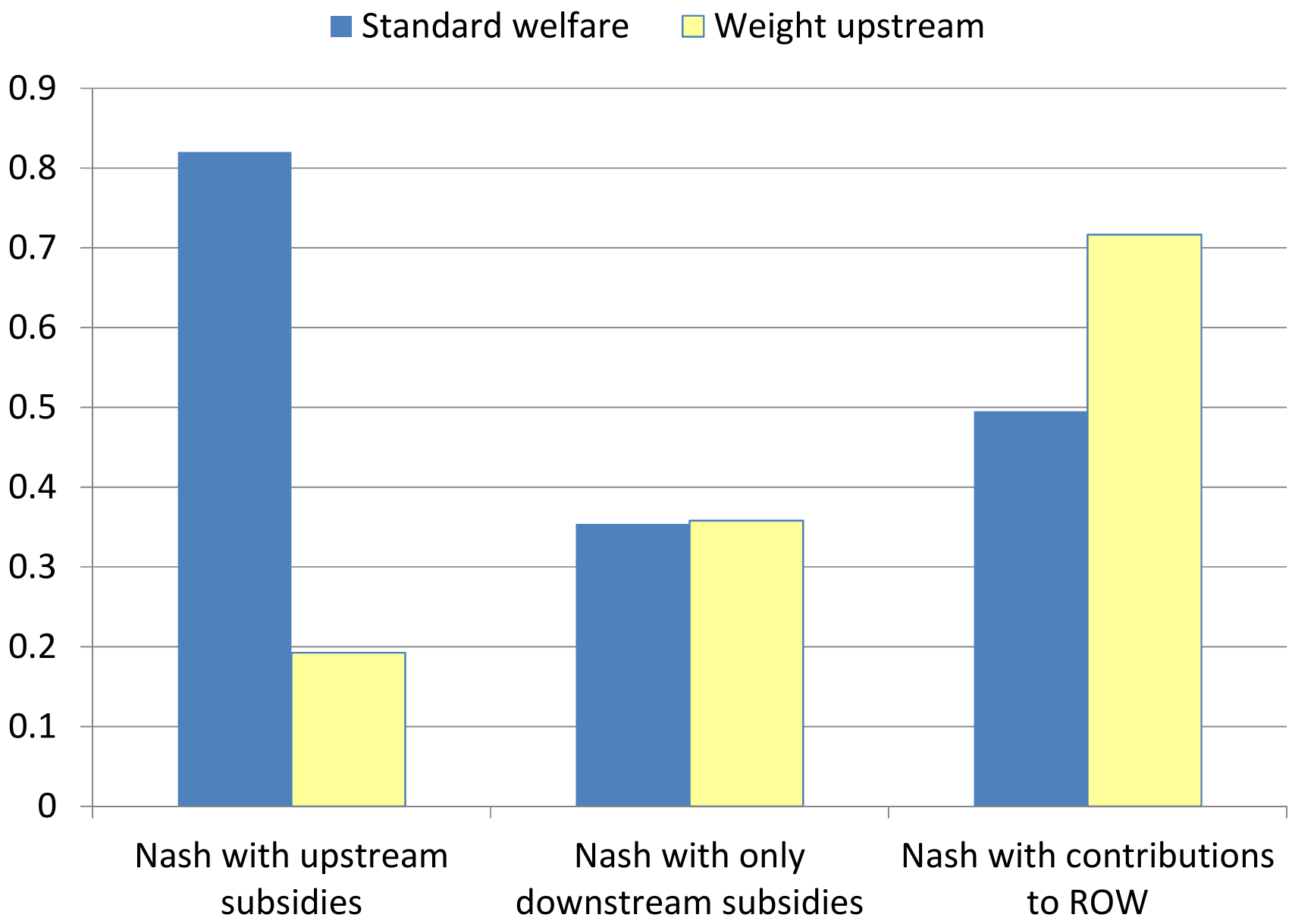
Total subsidies with contributions instead of upstream subsidies



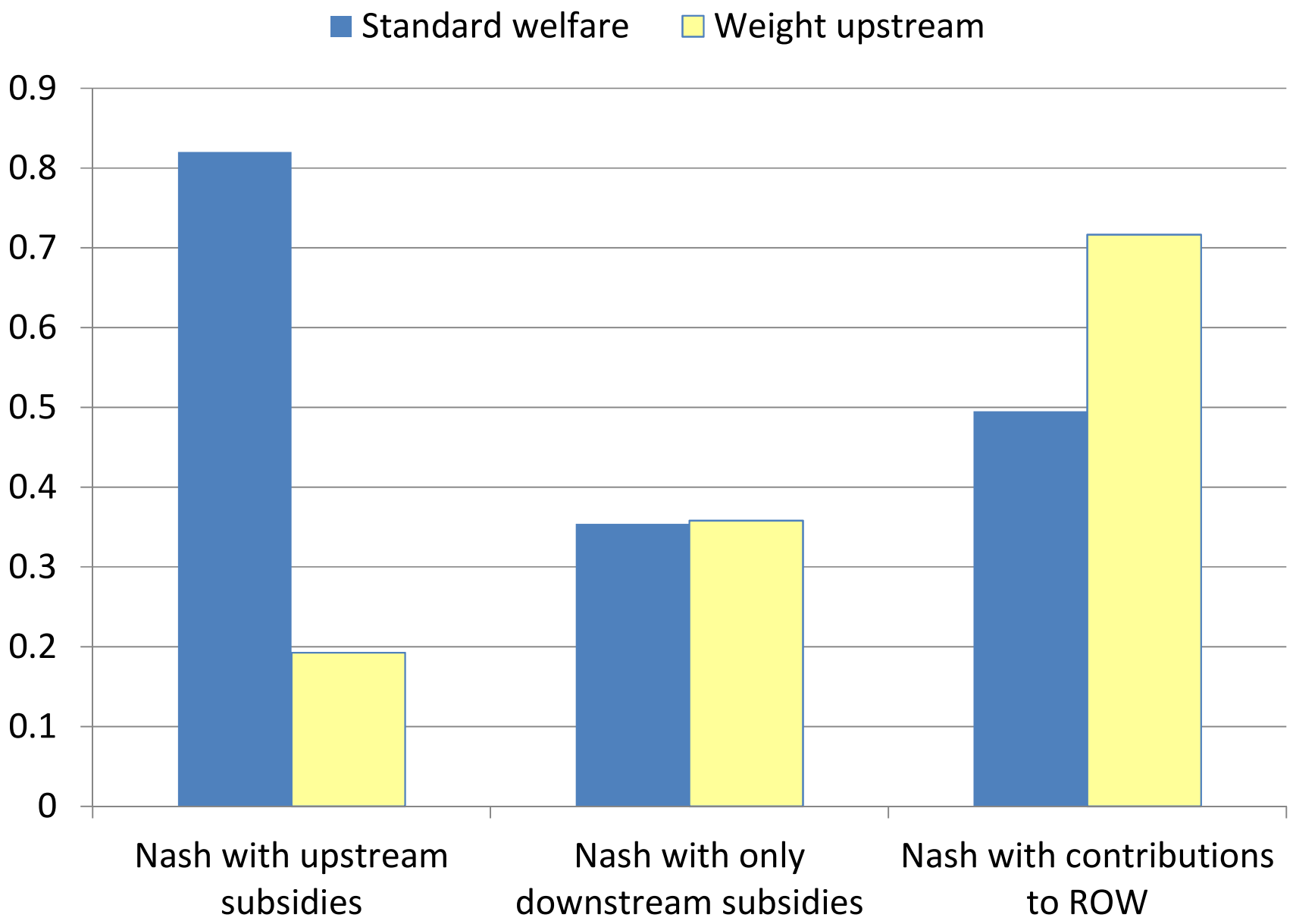
Welfare change (share of optimal), SCC=30



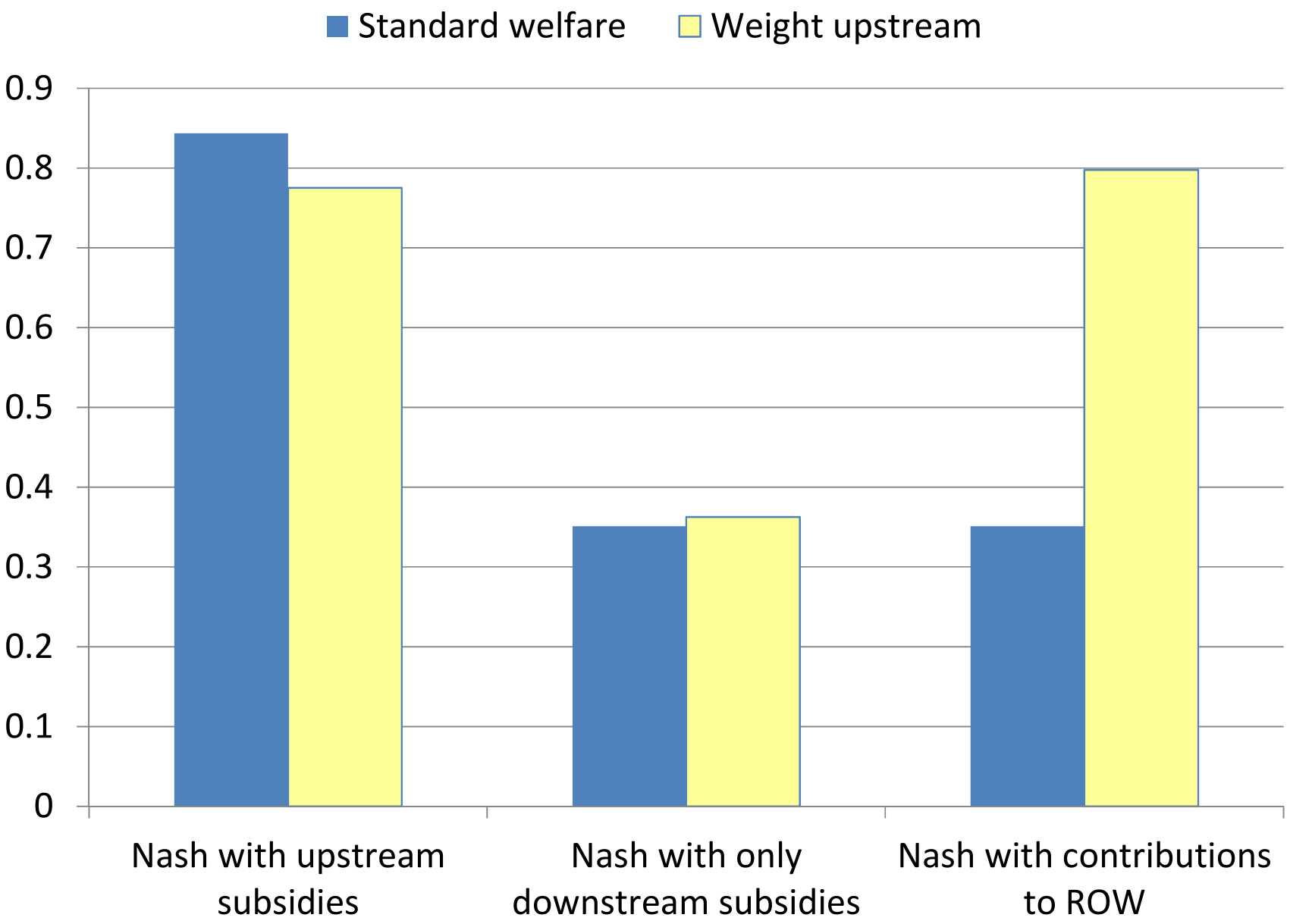
Welfare change (share of optimal), SCC=100



Welfare change (share of optimal), SCC=200



Welfare change, SCC=100 but $v_i = 30$



Conclusions

- Some legitimate rationales for subsidizing renewable energy—particularly upstream—even with other climate policies in place
  - Strategic incentives to overprice exports
  - Underpriced / undervalued externalities
  - Market power, barriers for new technologies
- Some legitimate rationales for restricting unwarranted upstream subsidies
- Climate finance a more successful alternative if clean technology exporting countries have strong political distortions
- Need for thoughtful WTO rules for environmentally oriented manufacturing subsidies

Thanks!

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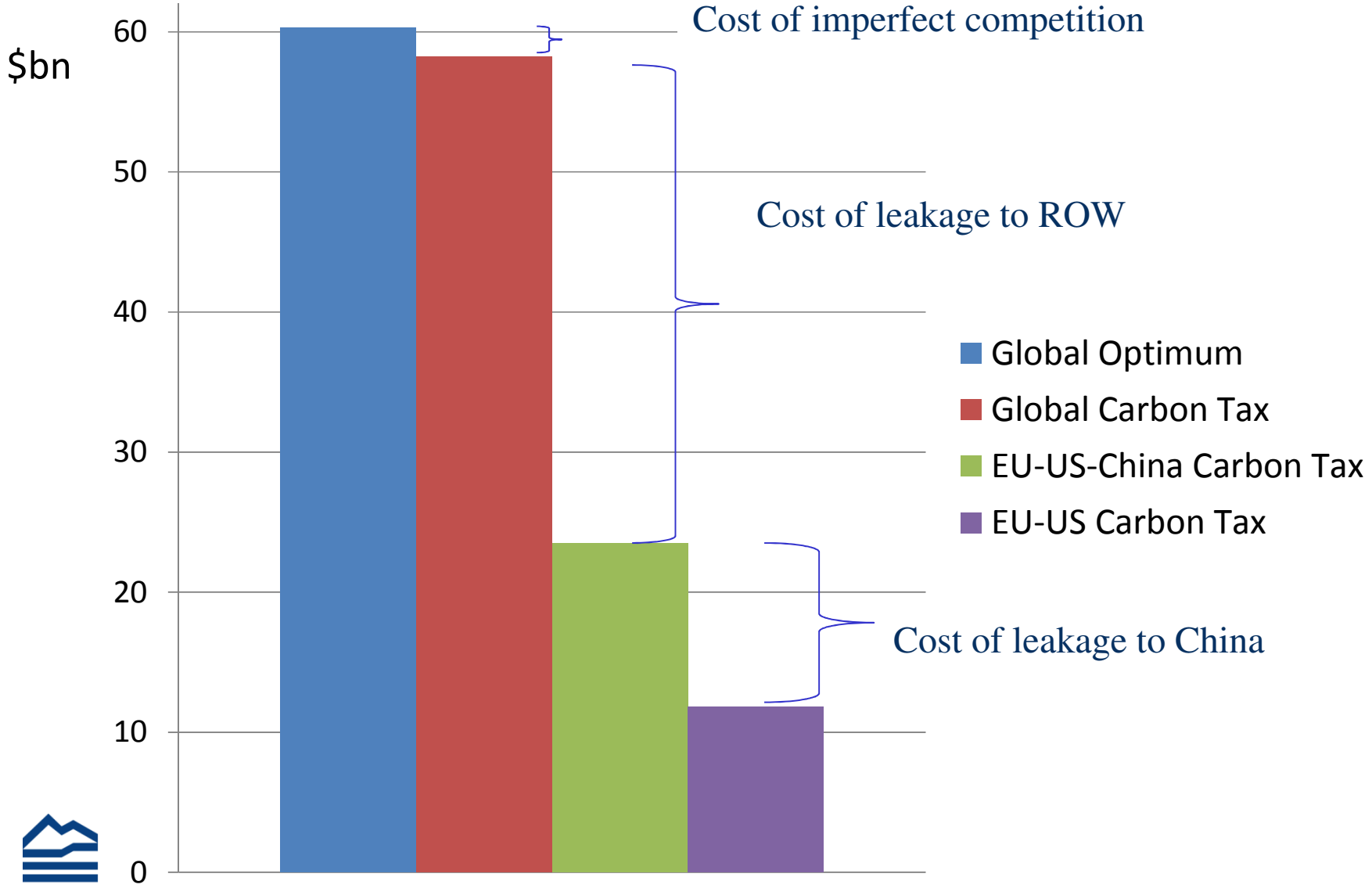
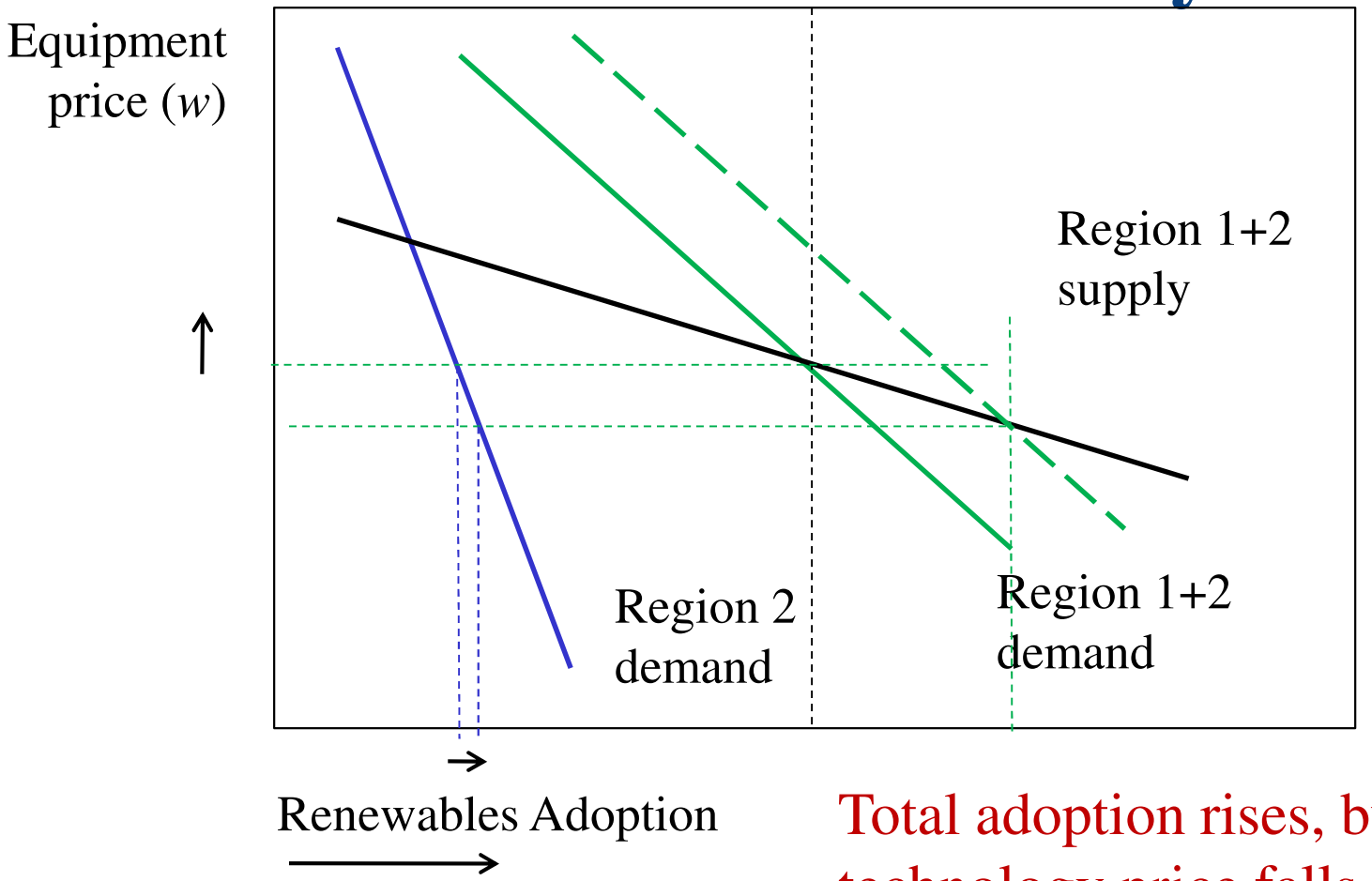
- Related research is indebted to Norwegian Research Council, Mistra Foundation ENTWINED program, SEEK program

Global welfare change from No Policy

(IC and all value MB at SCC of $30)



Renewable technology market with downward-sloping supply: Downstream subsidy



Total adoption rises, but technology price falls, crowding in foreign adoption

RFF/Stanford/NYT Poll (2015)