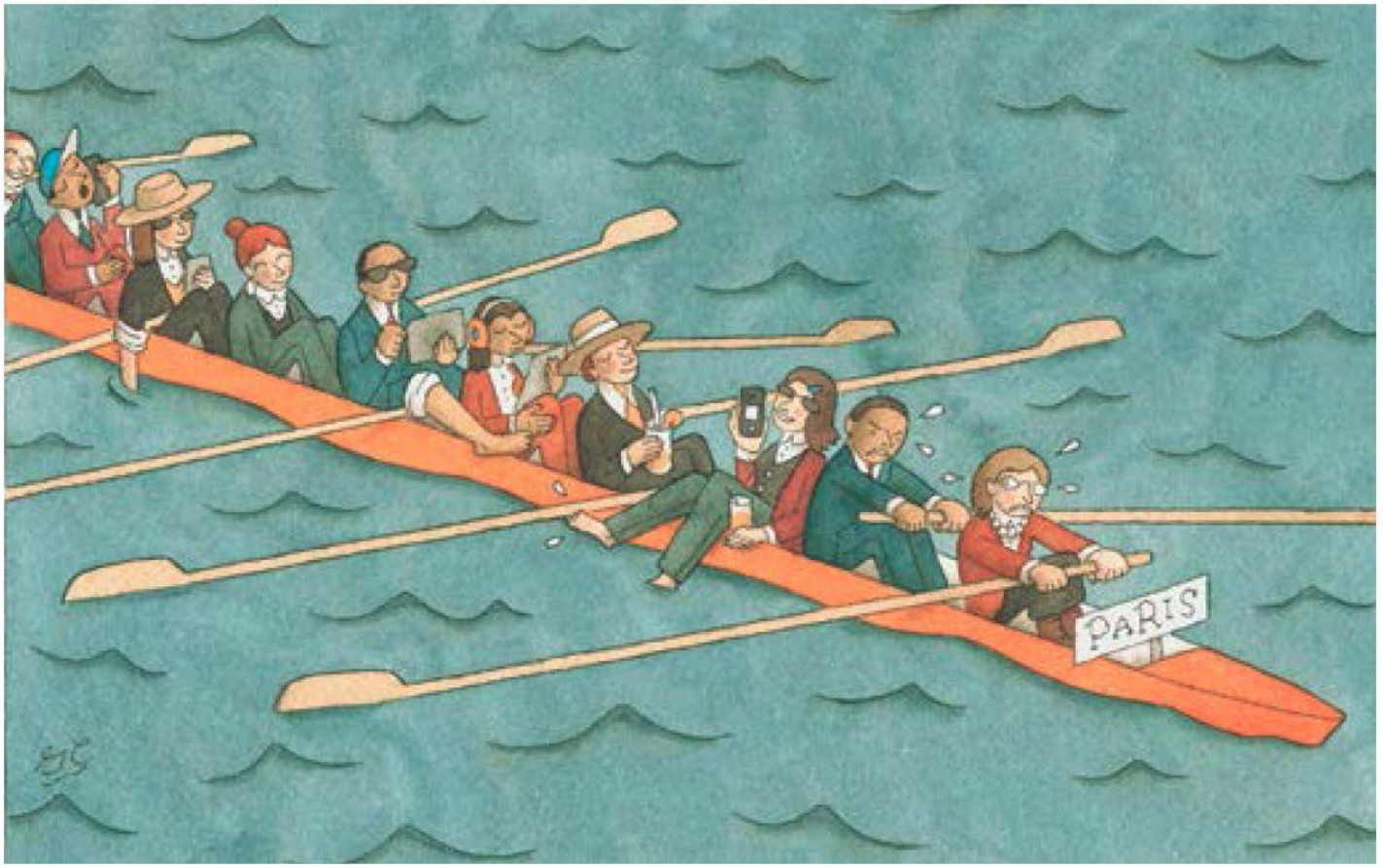


Price carbon — I will if you will

Peter Cramton, Maryland / EUI / Cologne

with David MacKay, Axel Ockenfels, and Steven Stoft

14 December 2015

Symposium: International Climate Negotiations

Cramton, Ockenfels, Stoft (eds.), Gollier, Stiglitz, Tirole, Weitzman

Economics of Energy & Environmental Policy, 4:2, September 2015

Price Carbon—I Will If You Will

MacKay, Cramton, Ockenfels & Stoft
Nature, 15 October 2015

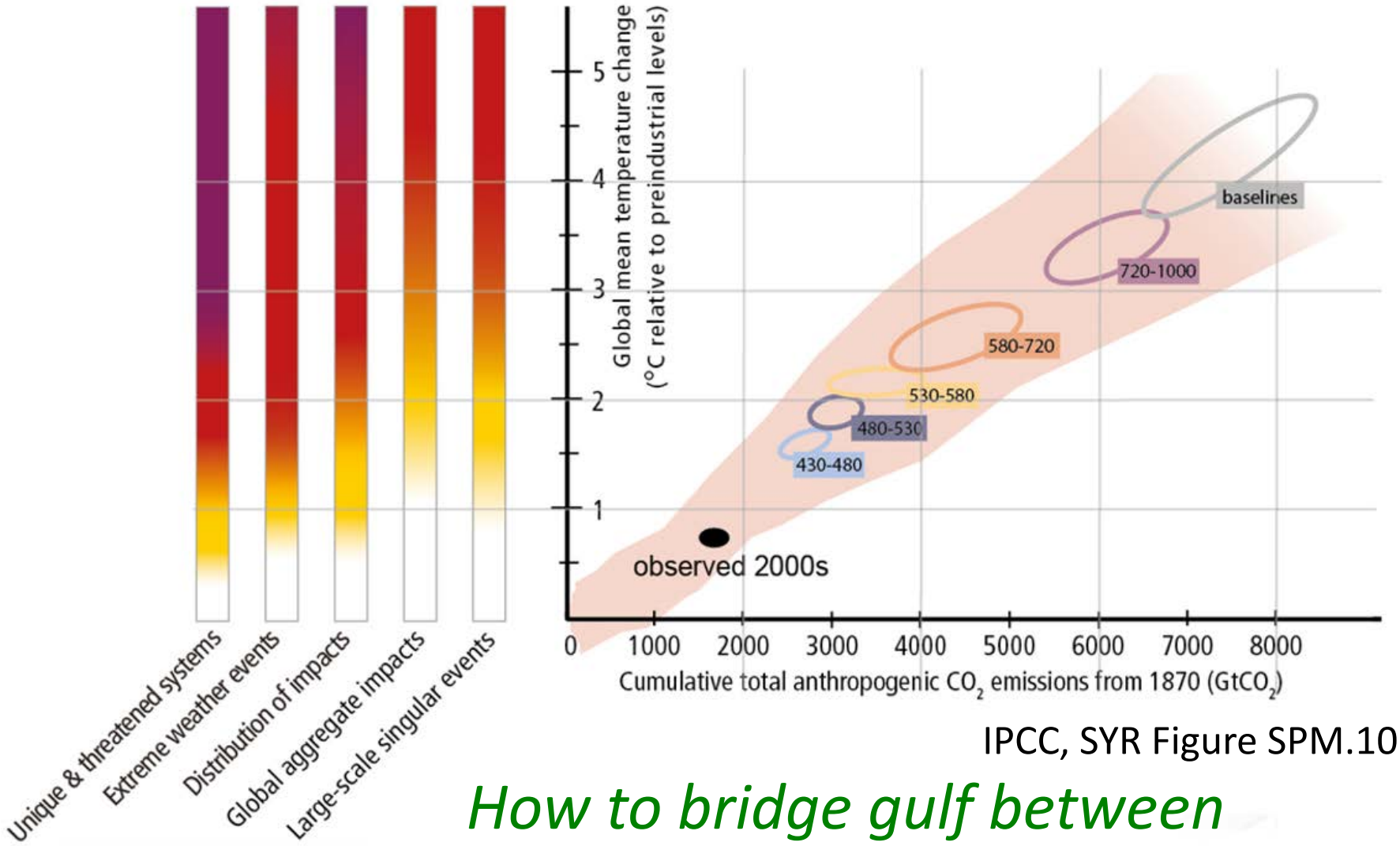
Global Carbon Pricing—We Will If You Will

Cramton, MacKay, Ockenfels & Stoft
MIT Press, under review, 2016

carbon-price.com

SECRETARIE EXECUTIVE CCNUCC
PRESIDENT

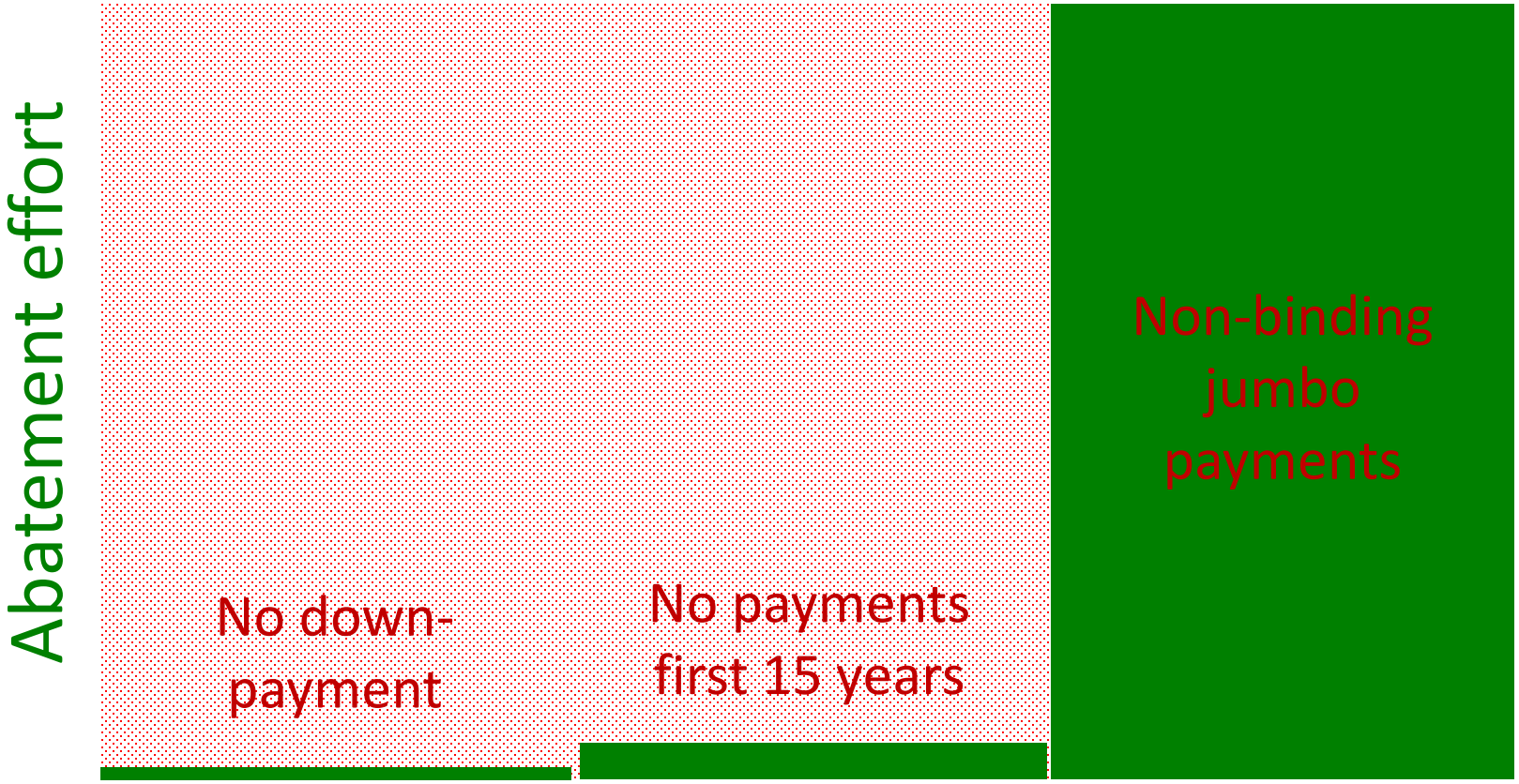
Consensus Aspiration: ~~2~~ 1.5° C goal



IPCC, SYR Figure SPM.10

How to bridge gulf between goal and intentions?

Paris Agreement



Until 2020	Until 2030	Until 2100
max political power	moderate power	no power or blame
no excuses	some excuses	many excuses
national policy	national plans	global aspiration

Economics:
Price carbon

- Direct
- Efficient
- Transparent
- *Promotes international cooperation*

Remarkably, "price" never appears in 31 page COP21 Final Agreement

Treaty Design: Promoting cooperation in international negotiations

Individual commitments (intended nationally determined contributions) cannot promote cooperation

APPENDIX I: QUANTIFIED ECONOMY-WIDE EMISSIONS TARGETS FOR 2020

DEVELOPED COUNTRY	*Quantified economy-wide emissions targets for 2020*	
	Emissions reduction in 2020	Base year

APPENDIX II: NATIONALLY APPROPRIATE MITIGATION ACTIONS OF DEVELOPING COUNTRY PARTIES

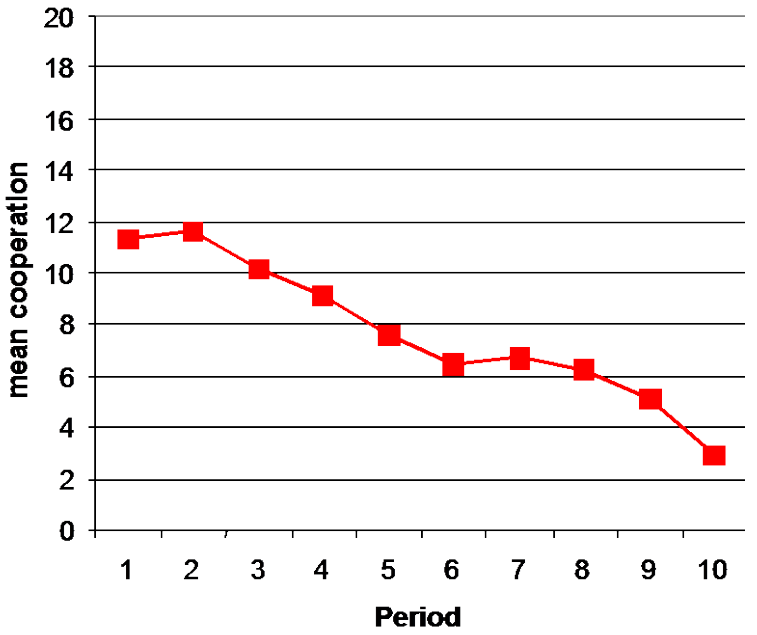
DEVELOPING COUNTRY	*Actions*

Individual commitments cannot promote cooperation

- 10 players; individual endowment = $10
- Each $ pledged will be doubled and distributed evenly to all players
- Voluntary pledges are enforced
- Result: *Zero* cooperation, all pledge $0

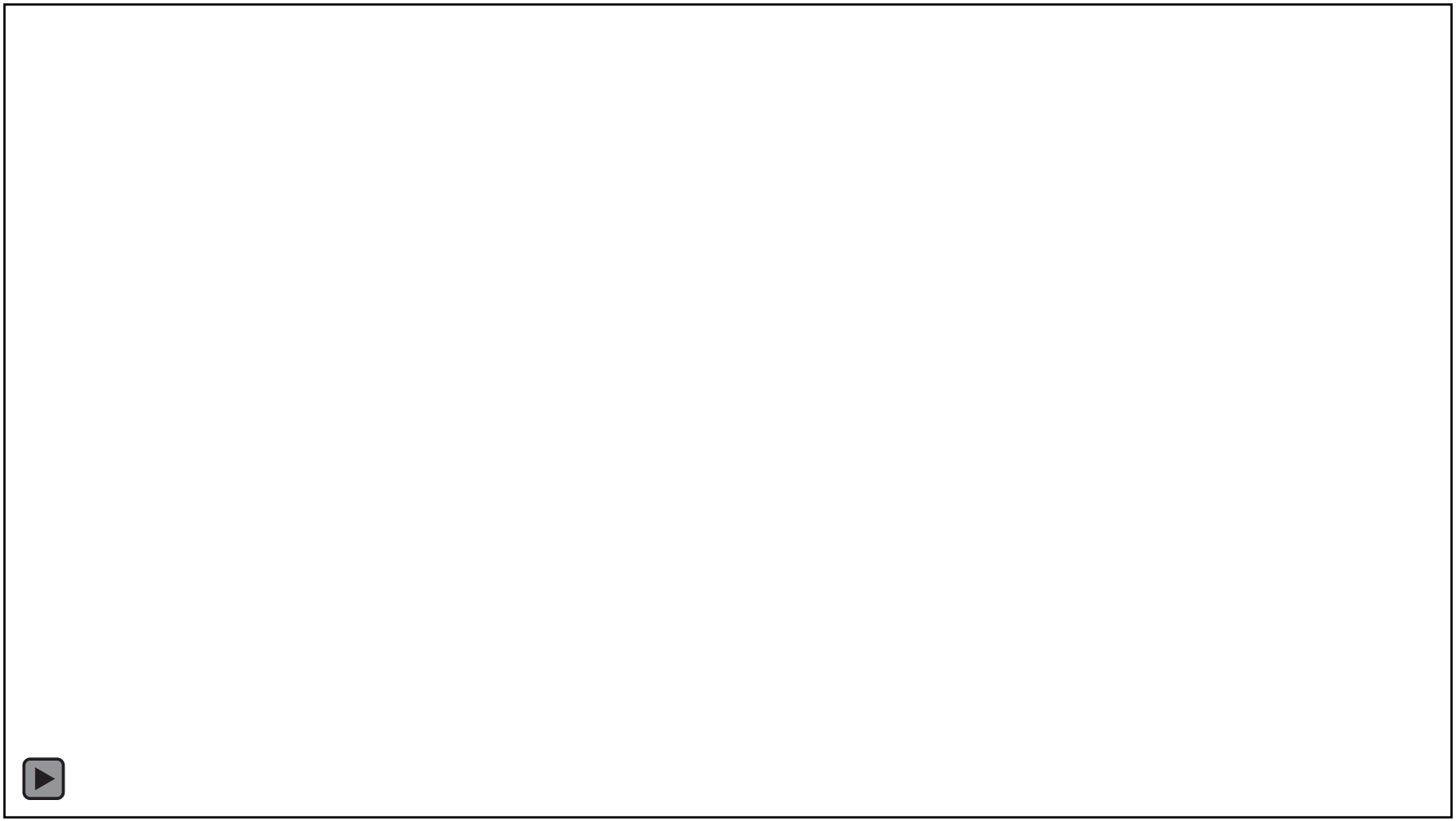
Dynamics of individual commitments: "Upward spiral of ambition"?

- History: Japan, Russia, Canada, and New Zealand left the Kyoto agreement
- Ostrom (2010), based on hundreds of field studies: insufficient reciprocity leads to a "*downward cascade*"
- Supported by theory and laboratory experiments



Common commitment:
“I will if you will”

Trump: “I won’t ‘cause you won’t”



"I will if you will" promotes cooperation

- 10 players; Individual endowment = $10
- Each $ pledged will be doubled and distributed evenly to all players
- *Pledge is commitment to reciprocally match the minimum pledge of others*
- Voluntary pledges are enforced
- Result: *Full* cooperation, all pledge $10

Price is focal
common commitment

- Direct, efficient, common intensity of effort
- Consistent with tax or cap & trade (flexible at country level)
- Consensus that price should be uniform reduces dimensionality problem:

$$P_{Country} = P_{global}$$

- (No such consensus exists for quantity commitment)

Price commitment reduces risk

- Countries keep carbon revenues
- Eliminates the risk of needing to buy credits

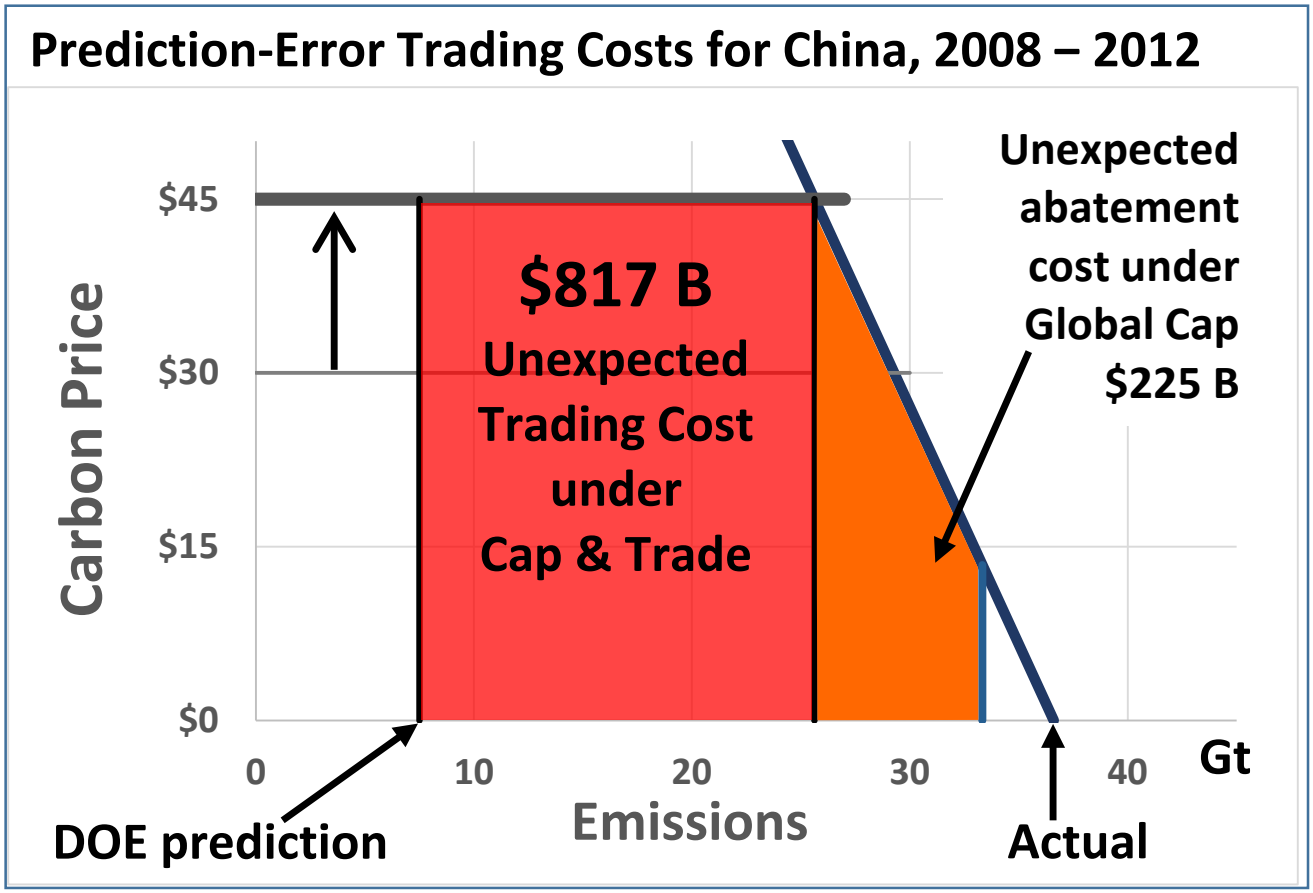
But are quantity commitments equivalent?

China, you will be safe, if you accept a "Business-as-Usual" target for 2008 – 2012.

—Jeffery Frankel, 1998

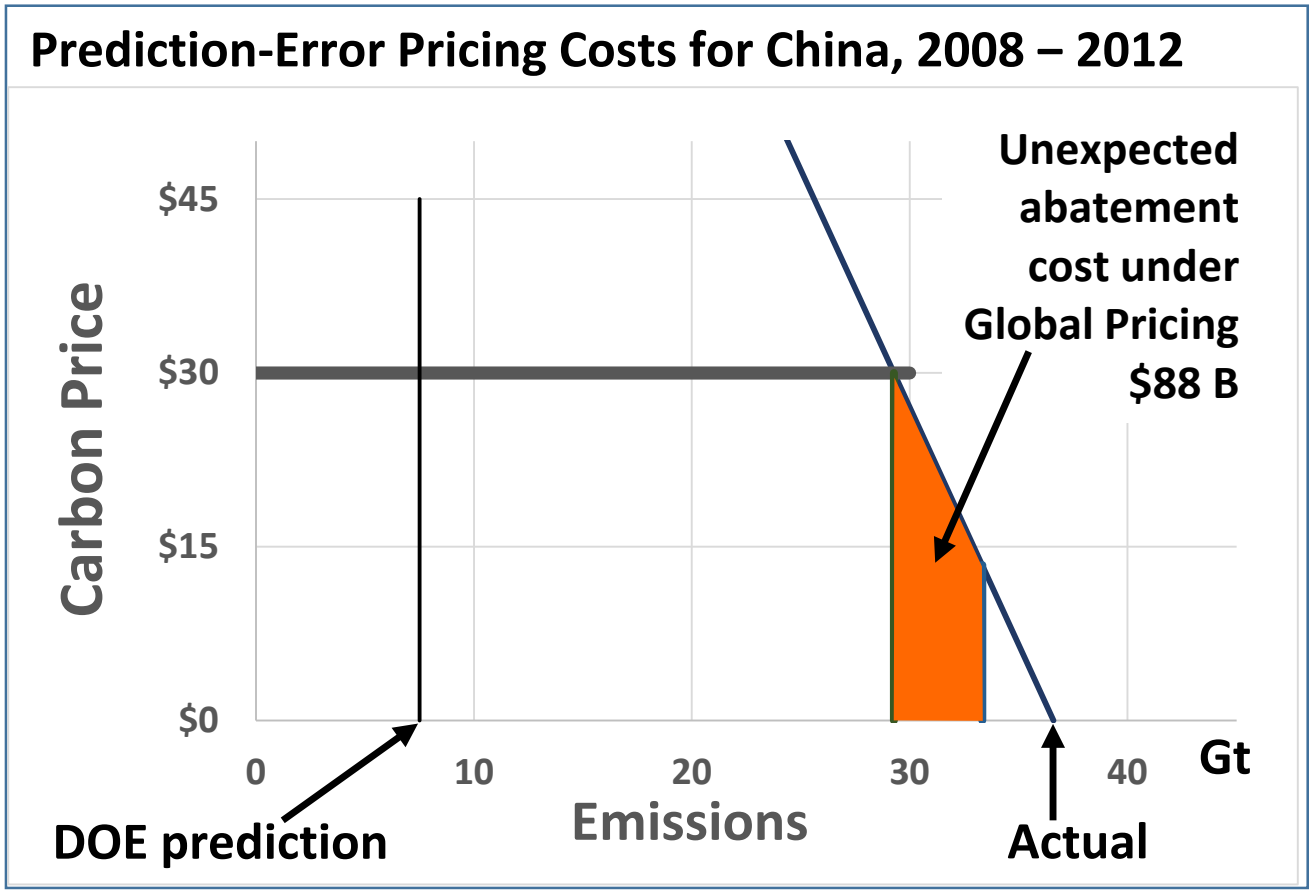
- Business as Usual means what experts think
- 1999 US Dept. of Energy: **7.5 Gt of CO_2**
- Reality in 2008 – 2012: **36.6 Gt of CO_2**

Cap targets P = $30, but then P ➔ $45



- China's unexpected costs > $1 trillion
- $817 B Payments to US, EU, India ??

Carbon Pricing: P = $30



- China's unexpected costs = $88 B
- Payments clean up China's pollution

Sharing the burden

- Use Green Fund to maximize abatement
- As before, reduce dimensionality
  - Carbon price = intensity of cooperation
  - “Generosity parameter” = intensity of Green Fund
- Last resort enforcement with trade sanctions

Designing the Green Fund

$$\text{Payment into Green Fund} = \text{Generosity parameter} \times \text{Excess emissions} \times \text{Global carbon price}$$

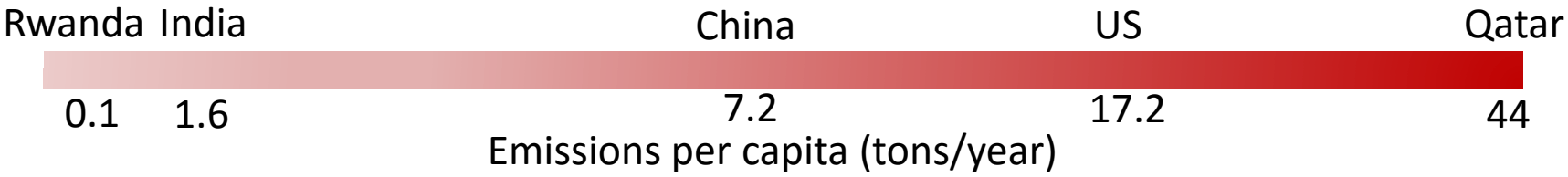
- Excess emissions = deviation from world per capital average (+ for US, - for India)
- This addresses "differentiated responsibilities"
  - Rich, high-emission countries pay into fund
  - Poor, low-emission countries receive from fund

Maximizing treaty strength

- If G is high, rich countries will want P* low
- If G is low, poor countries will want P* low
- Some moderate G maximizes the P* that a super-majority will accept

A mechanism for the willing (G20?)

- Countries with little stake in the Green Fund (near average emissions) first determine G
  - G will be determined so that both rich and poor countries benefit from an effective agreement



- Then countries vote for P*; low price wins
  - No country i commits to a $P^* > P_i$, so any country could protect itself by naming a low P_i if G were unacceptable
- Mechanism promotes a strong agreement

Summary

- Keys to a strong climate treaty
  - "I will if you will" (common commitment)
  - Two parameters
    - Carbon price (common intensity of effort)
    - Green fund intensity (addresses asymmetries)
- Further research
  - Equilibrium simulations using standard climate models to identify best "climate club"
  - Develop details of treaty (e.g. voting mechanism)

Price Carbon
I will if you will

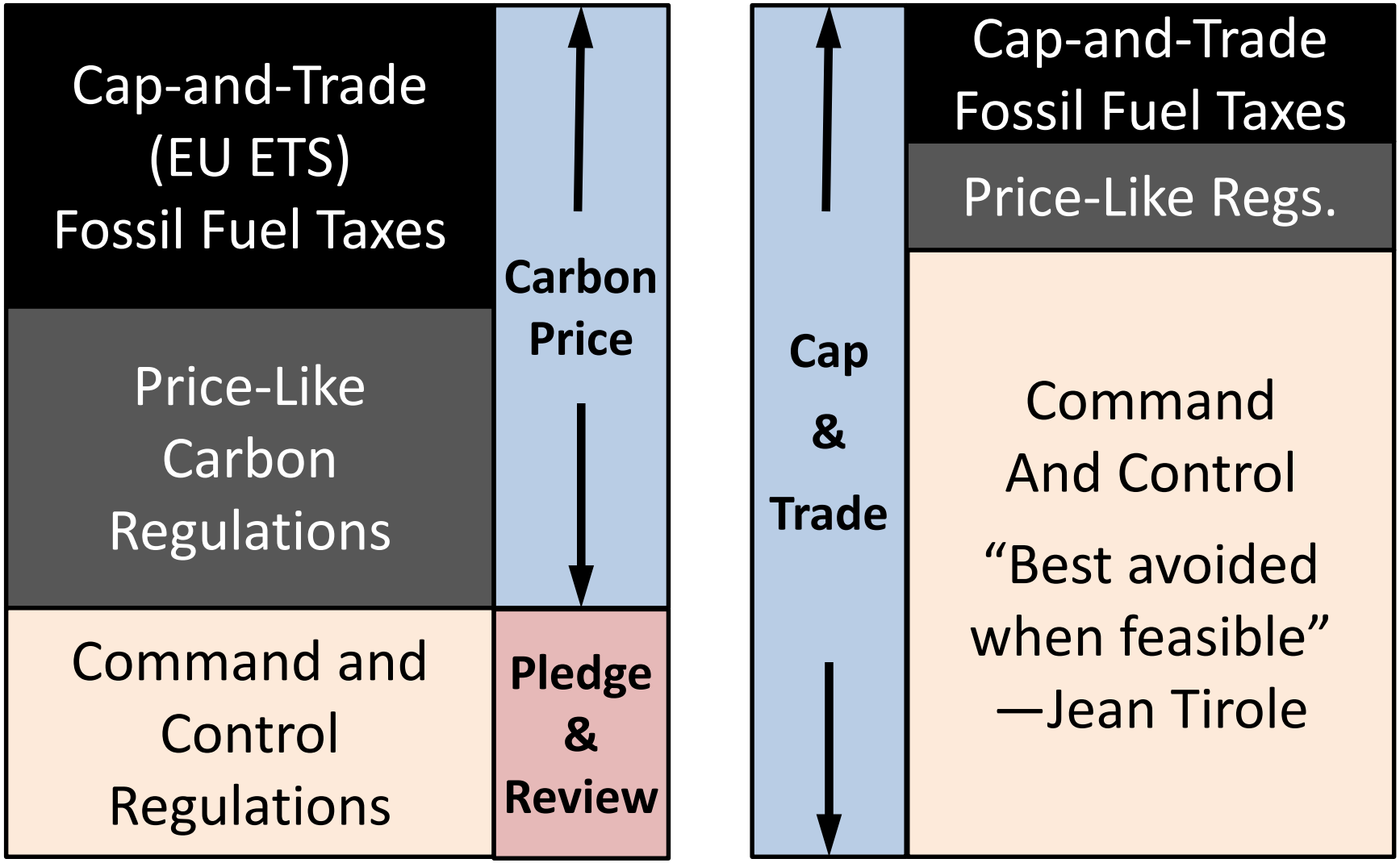
Backup

Carbon price vs. cap & trade

Price Carbon Emissions?

- Global Cap-and-Trade
  - Prices International Permits (Kyoto's AAUs)
  - No requirement to price ***emissions***
  - Kyoto mainly caused renewable regulations
- Global Carbon Price Commitment
  - Pricing emissions is what counts
  - For a while renewables get credit—but only for the (carbon they actually save) × (global price)

Pricing of Carbon *Emissions*



Why Global Cap-and-Trade Fails

- Trading risk pushes up individual “targets”
- Free-riding pushes up individual “targets”
- No one can find a common-commitment
- 2°C pushes the global cap down
- It will never add up

Climate games

Two International Games

- Public-Goods Game:
  - Each country chooses its abatement, A_j
- Cap-and-trade Game
  - Each country chooses its target, T_j
  - Sells carbon credits for $P \times (A_j - T_j)$
  - P = marginal cost of each country j
- Countries acts in their self interest

Payoff = Net-Benefit

$$\mathbf{NB_j = b_j\, A - c_j\, A_j^2 + P\,(A_j - T_j)}$$

- Climate benefit = $b_j \times$ (Total abatement)
- Abatement cost = $c_j \times$ (country abatement)^2
  - Marginal cost = $2\, A_j = P$
- Carbon Trade Revenue = $P \times (A_j - T_j)$
  - Only under cap-and-trade

Cap & Trade Can Beat Public Goods

Game #1	Public Goods		Cap and Trade		
Country	**A_j**	**P**	**T_j**	**A_j**	**P***
1	**0.5**	**$1**	**0.38**	**0.75**	**$1.5**
2	**0.5**	**$2**	**0.75**	**0.38**	**$1.5**
Total	**1.0**		**1.13**	**1.13**	

- Country 1: $b_j = 1$, $c_j = 1$
- Country 2: $b_j = 2$, $c_j = 2$

Or Not

Game #2	Public Goods		Cap and Trade		
Country	A_j	P	T_j	A_j	P*
1	0.17	$1	– 0.08	0.25	$1.5
2	1.00	$2	1.08	0.75	$1.5
Total	1.17		1.00	1.00	

- Country 1: $b_j = 1$, $c_j = 3$
- Country 2: $b_j = 2$, $c_j = 1$
- Negative Target → Cap > BAU emissions

THE GLOBAL QUANTITY-TARGET, AND PRICE-TARGET GAMES

Global-Target Games

- N identical countries in the world
- The **quantity**-target game
  - Each country names a target Q^T_j
  - Q^T = maximum (weakest) Q^T_j
  - National caps = Q^T / N
- The **price**-target game
  - Each country names a target P^T_j
  - P^T = minimum (weakest) P^T_j
  - National carbon prices = P^T
  - Currency = Global index of major currencies (USD, euro, …)

Identical Countries → Identical Games

- Every P^T matches some Q^T that would cause global price P^T
- Vote for P^T or its matching Q^T
- The same holds in each identical country

Optimal Cooperation

- *"I will if you will."*
- If you vote for a high P and set price, then P is high for all (and optimal)
- Voting for Q also works optimally

Price handles some asymmetries

- Country 1: Temperate w/ renewable resources
- Country 2: Hot with only coal
- With a P-target, country 2 accepts high price because carbon revenues stay in country 2
- With a Q-target, Country 2 must pay country 1 a lot of money (to buy carbon credits)
- P-target minimizes transfers among countries

But what if countries disagree about price

- Poor countries
  - Have a lower cost/ton of abatement

    ➔ a greater social cost of abatement
  - Have a higher discount rate

    ➔ less benefit from future climate
- Poor countries will vote for a low global P^T
- And the lowest price wins

LINK THE GREEN FUND TO PRICE

Green Fund Payment and Reward

- Green Fund Payment Received =

$$G \cdot \Delta E_j \cdot P^T$$

- ΔE_j = (World emission) – (Country emission) on a per-capita basis.
- G = the strength of the Green Fund

Green-Fund Game Payoff Function:

$$\mathbf{NB_j = b_j A - c_j A_j^2 + G \cdot \Delta E_j \cdot P^T}$$

Green-Fund Game

- Example Game with Three Countries
  - "U.S." = High, "China" = Average, "India" = Low emissions / capita
  - So China neither pays nor is paid Green Funds
  - India wants a low global price
  - As with other games,

    Self interest and no cheating

Green-Fund Game Rules

1. China picks G
2. Then, all three vote for P^T
3. All get the Net-Benefit payoff

Strategy

- China will raise India's vote for P^T by picking G>0, but not too high because the U.S. would vote for a lower P^T than India

Without the Green Fund

Country	pop	*e*	Voted P	*P**	A_j %
	billions	ton/cap.	$/ton	$/ton	%
U.S.	0.3	18	$31	$10	6.7%
China	1.2	5	$31	$10	6.7%
India	1.0	1.1	$10	$10	9.1%

The Green-Fund Game

Country	pop	*e*	Voted P	A_j %	A_j Cost	G. F. Benefit
	billions	ton/cap.	$/ton	%	¢/capita/day	
U.S.	0.3	18	$26	18%	11.5¢	–4¢
China	1.2	5	$31	18%	3.2¢	0.0¢
India	1.0	1.1	$26	24%	1.0¢	1.2¢
World	2.5	5	$26	18%	3.3¢	0.0¢

- Poorest countries gain even ignoring climate benefits!

The Green-Fund Game vs. Cap and Trade

Game	Global price, P	P as a % optimal	A as a % optimal
Green-Fund Game	**$26.40**	**93%**	**93%**
Global Cap and Trade	**$9.51**	**33%**	**33%**
Optimal Outcome	**$28.52**		

- Cap-and-trade has individual caps, no Green Fund, and same physical world

Green-Fund Game Mechanisms

- The Green-Fund is also **a climate incentive**
  - Reduce your E/capita and pay less / get more
  - This works equally on every country
- Let near-average E/capita country vote for G
  - Then pick the **median vote for G**
- Trading **carbon-revenue credits** could make compliance more agreeable