17th Annual Short Course in Global Trade Analysis

Climate Change Negotiations

GTAP-E Group

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Bangkok, Thailand

Introduction

- Background of Kyoto Protocol
  - History
  - Commitment
  - Current status
- GTAP-E simulation (Burniaux and Truong, 2002): three scenarios
  - Without emission trading
  - With emission trading among Annex 1 countries
  - With worldwide emission trading

Extensions

1. Re-balancing Emission Reductions
2. Can EEx (Net Energy Exporters) Manipulate the Kyoto Protocol?
3. Can Technological Development Save the World?
4. Carbon Tax Schemes.

(1) Re-balancing emission reductions

The question

- GTAP-E scenarios show Kyoto with emissions trading has diverse implication for welfare and efficiency
- How important is participation, in particular, the participation of the US.
- Can re-balancing of emission quota cuts with all countries taking part in "*CO2 quota reduction*" make it more acceptable to all countries?

- Original Kyoto Protocol implementation (base or S1) vs. Kyoto implementation without the US (S2)

- (S3) rebalance % emission quota; and compare S3 with S1.
  - Examine how different is the resulting “actual % reduction in S3” vs. “actual % reduction the S1”. Are they significantly different?

Scenario – Alternative rebalancing of emission reductions

	Initial Quota	Kyoto Reduction (S1)	Kyoto Quota (S1)	Alternative Reduction (S3)	New Rebalance (S3)
1 USA	1,500	-35.6	966	-25	1125
2 EU	911	-22.4	707	-20	729
3 EEFSU	777	12.9	877	12.9	877
4 JPN	337	-31.8	230	-25	253
5 RoA1	258	-35.7	166	-25	193
6 EEx	683	0	683	-10	615
7 CHIND	1,081	0	1,081	-10	973
8 RoW	623	0	623	-10	561
Total	6,170		5,333		5326
Percent.		-13.7		-13.7	

US participation is critical to significant emission reduction

Country/Regions	% Base Emission Reduction Global (S1)	% Emission Reduction without USA (S2)
1 USA	-12.34	0.33
2 EU	-5.88	-2.45
3 EEFSU	-12.76	-5.2
4 JPN	-6.36	-2.57
5 RoA1	-9.2	-3.87
6 EEx	-7.23	-2.85
7 CHIND	-32.56	-16.75
8 RoW	-8.47	-3.42
Total	-13.7	-6.5
Carbon tax for trading	29	10

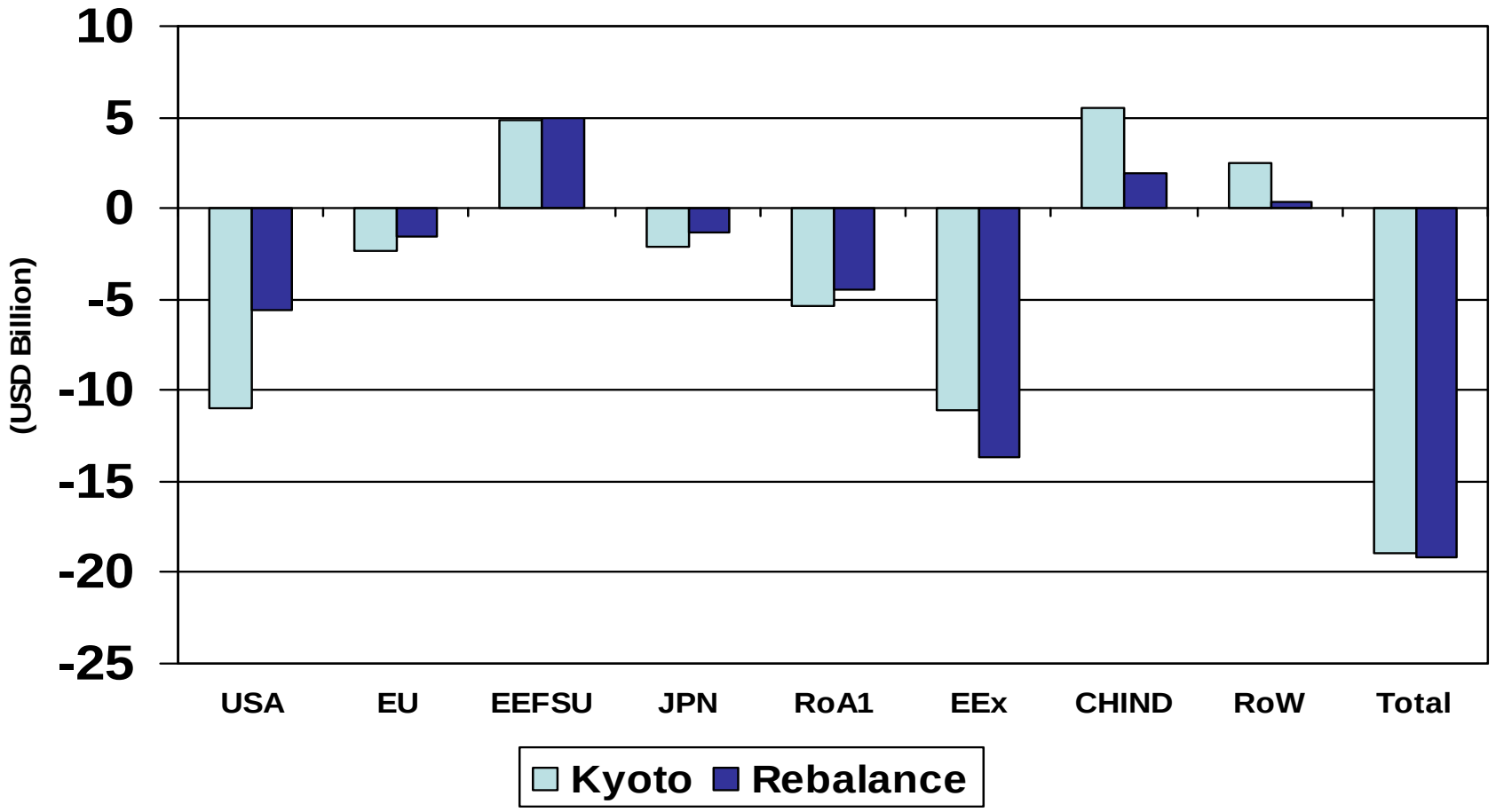
The impact of rebalancing on CO2 emission reduction is small - why?

	Kyoto Base (S1)	Alternative Rebalancing (S3)
1 USA	-12.34	-12.42
2 EU	-5.88	-5.93
3 EEFSU	-12.76	-12.88
4 JPN	-6.36	-6.41
5 RoA1	-9.2	-9.27
6 EEx	-7.23	-7.35
7 CHIND	-32.56	-32.84
8 RoW	-8.47	-8.57
Total	-13.7	-13.7
Global Carbon Tax	29	29

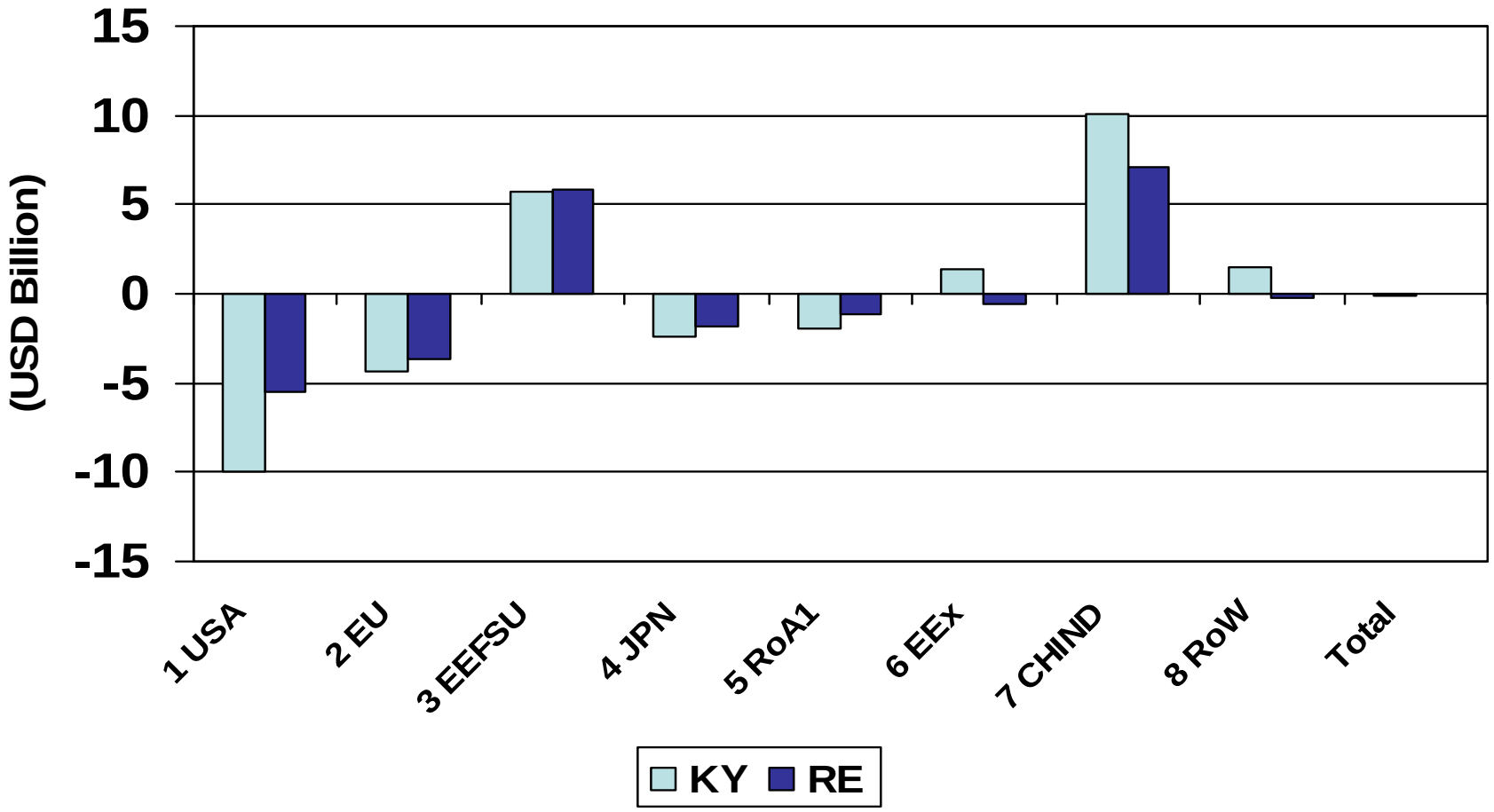
While emission reductions are similar, welfare and ToT impacts vary

	Worldwide emission trading- Kyoto targets		**Worldwide emission trading- Rebalancing targets**	
	Welfare	TOT	Welfare	TOT
USA	-0.15	0.17	-0.08	0.27
EU	-0.03	0.12	-0.03	0.13
EEFSU	0.64	0.04	0.69	0.05
JPN	-0.06	0.44	-0.04	0.49
RoA1	-0.40	-0.38	-0.34	-0.39
EEx	-0.53	-1.47	-0.67	-1.58
CHIND	0.49	0.78	0.20	0.65
RoW	0.10	0.32	0.02	0.31

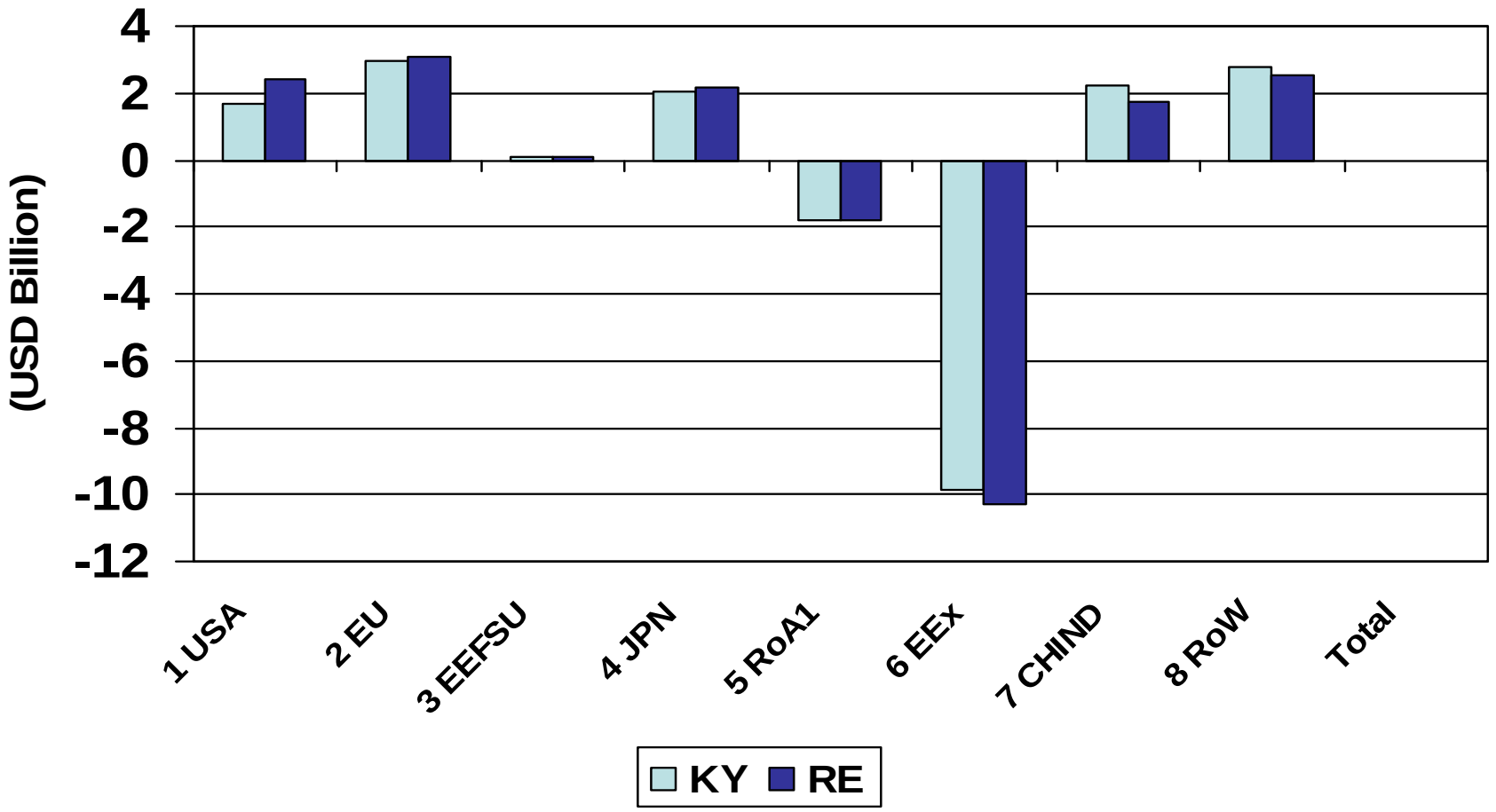
EV decomposition - welfare reduction is rebalanced



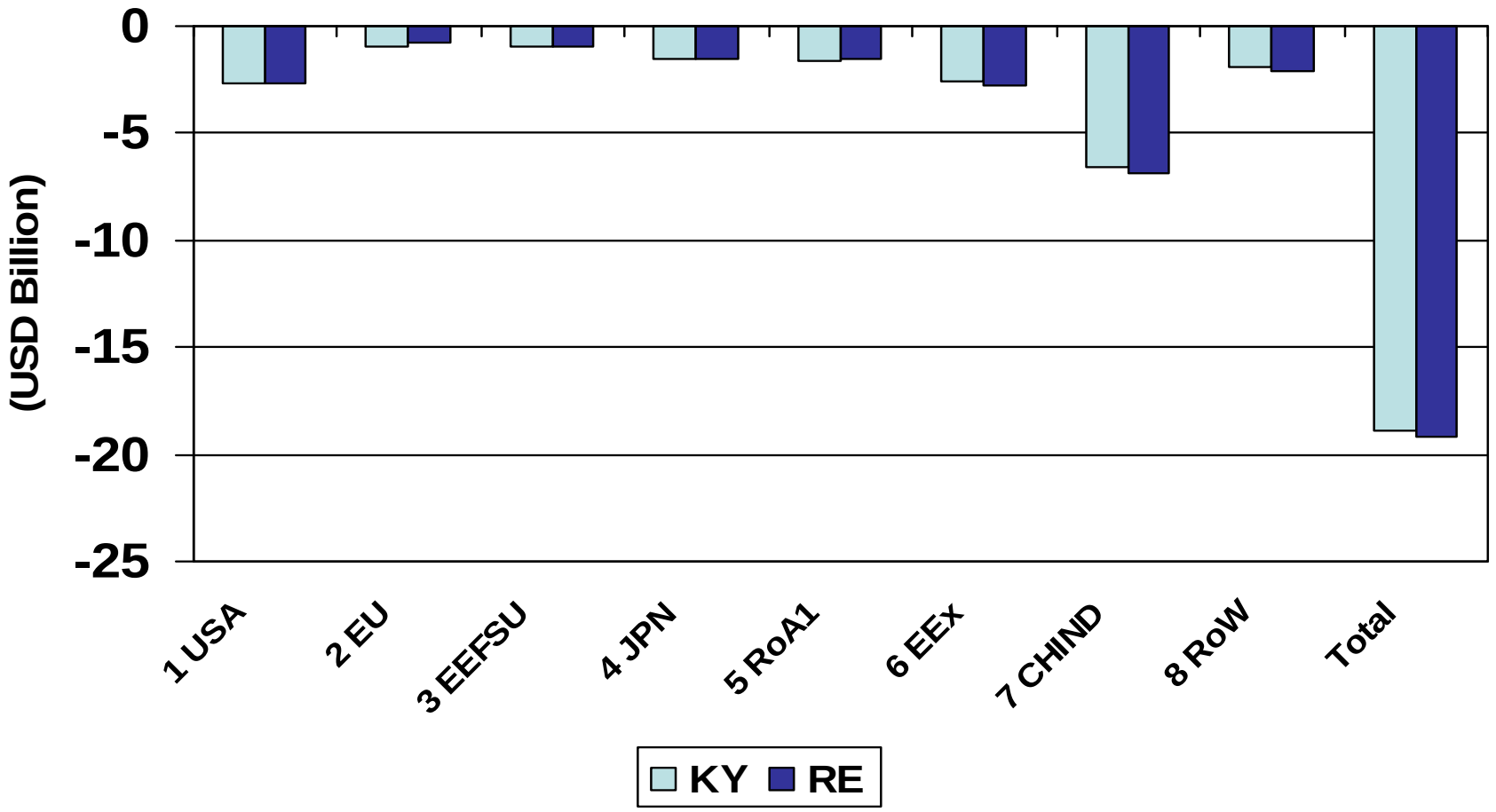
..largely because fewer emission transfers are reallocated at the same carbon price



..ToT differences are relatively small



… as are differences in allocative efficiency are small



(1) Conclusions

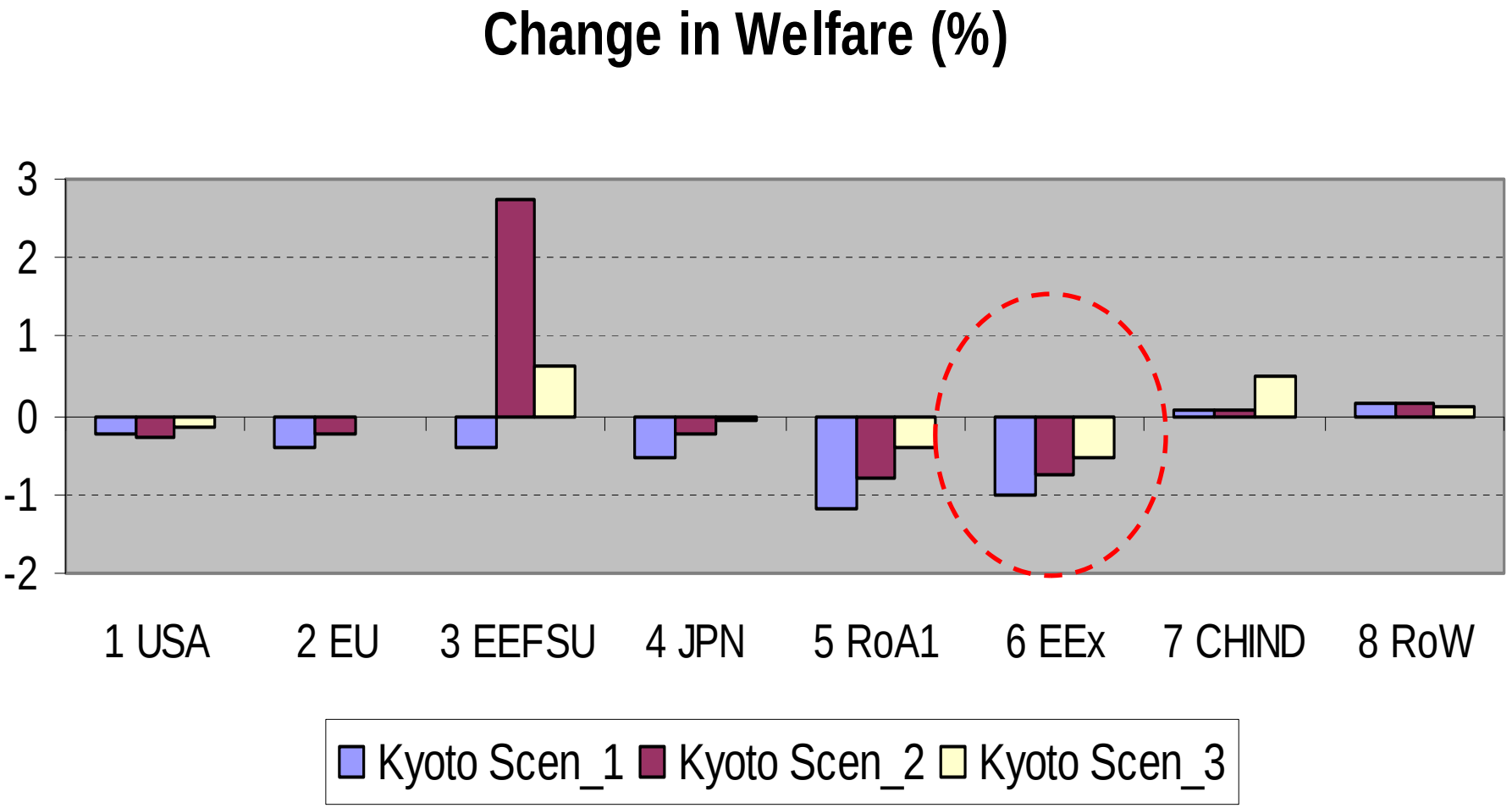
- Participation of US is key to successful reduction of CO2
- Significant rebalancing of targeted reductions to include China/Ind etc, has little impact on the level of reductions by each.
- Welfare losses/gains by region are rebalanced by changes in emission transfers, not changes in allocative efficiency.

(2) Can Net Energy Exporters Manipulate the Kyoto Protocol?

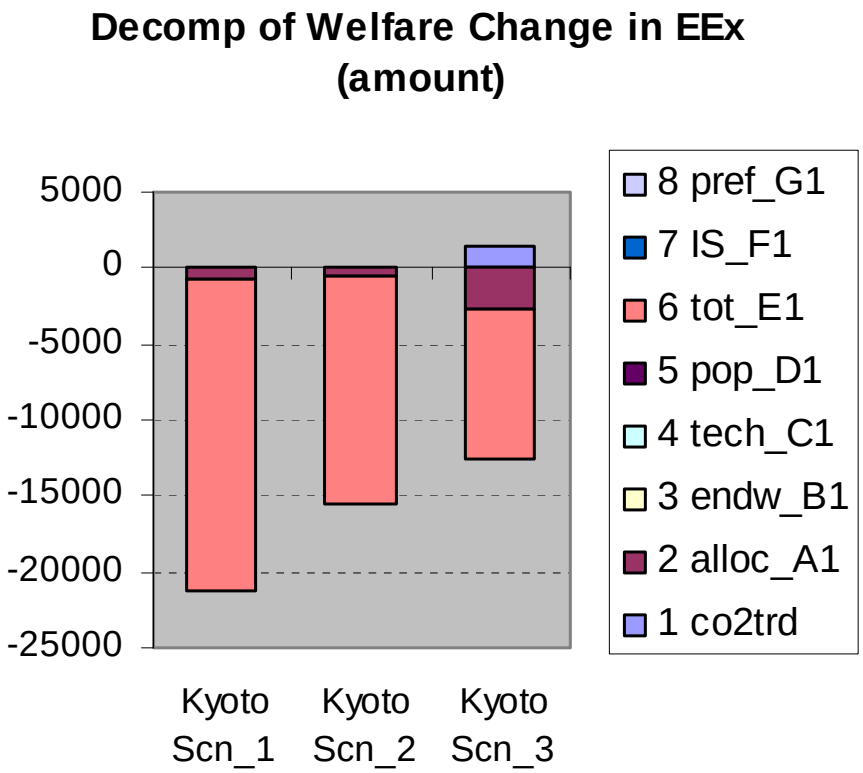
EEx countries

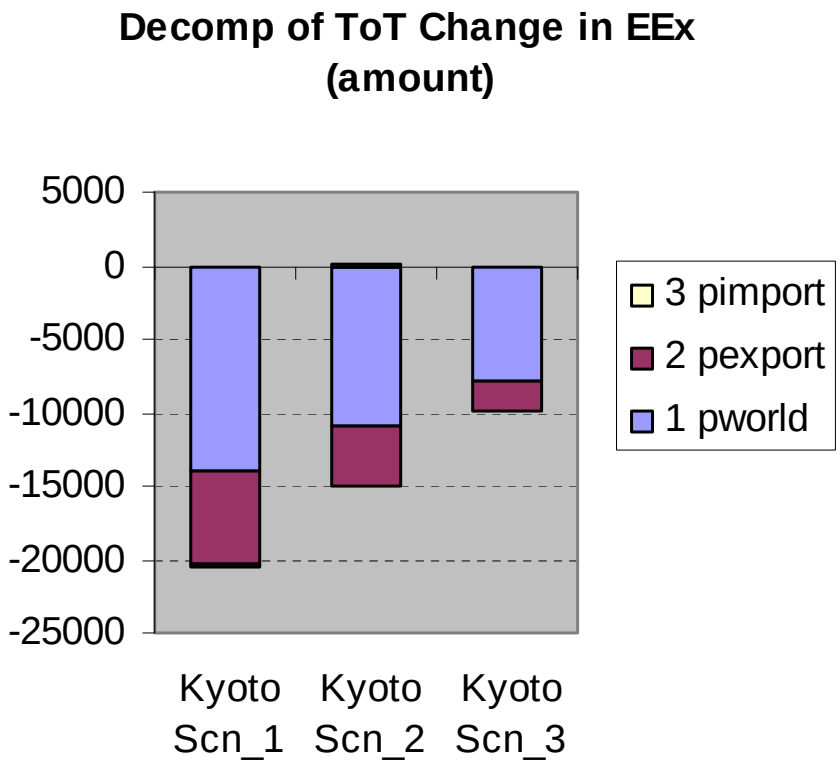
Indonesia, Malaysia, Viet Nam, Mexico, Colombia, Venezuela, rest of Andean Pact, Argentina, rest of Middle East, rest of North Africa, rest of southern Africa, rest of sub-Saharan Africa.

Who loses most from Kyoto Protocol?

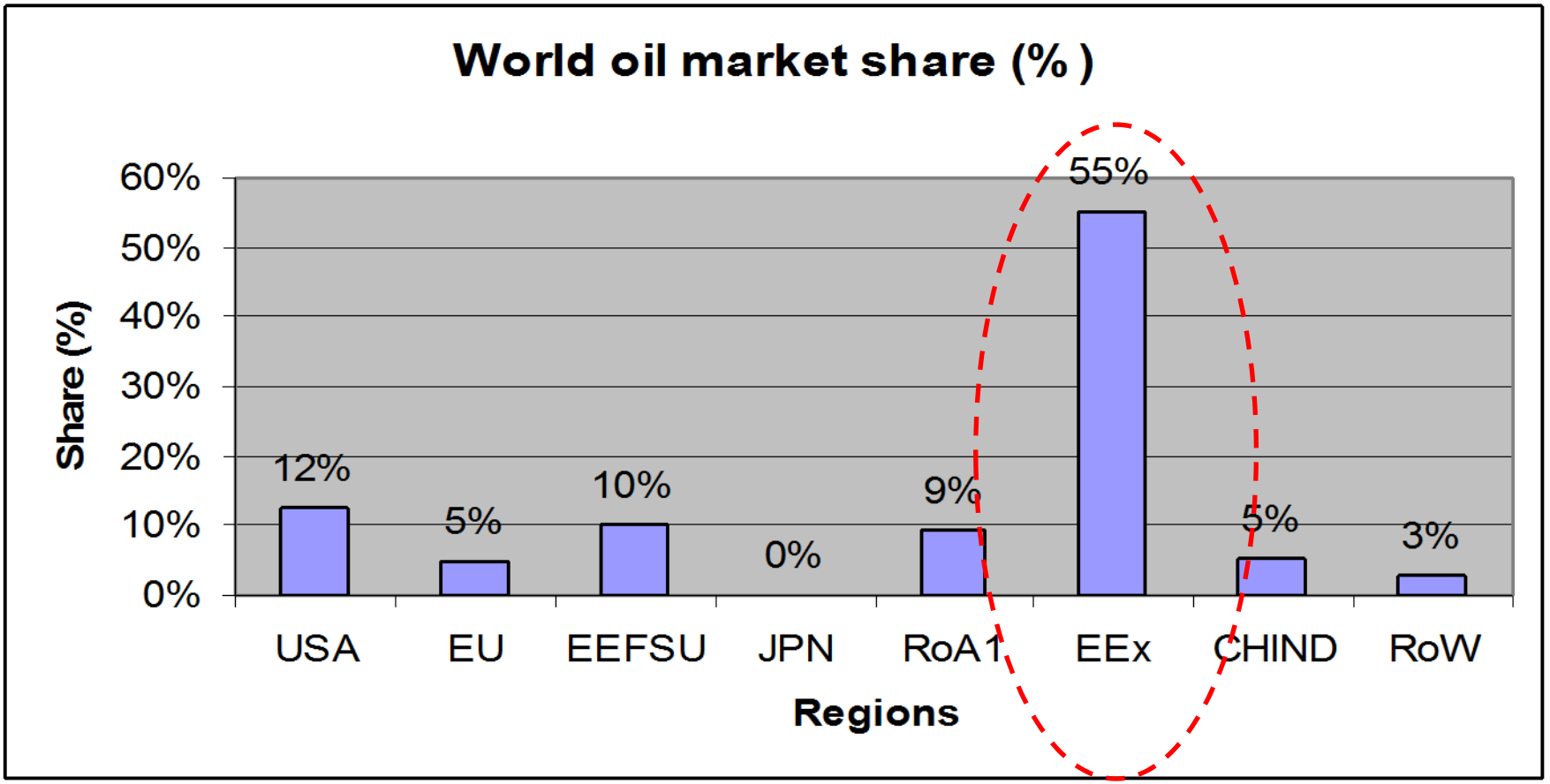


What drives EEx's welfare reduction?





How could EEx recover the welfare loss?

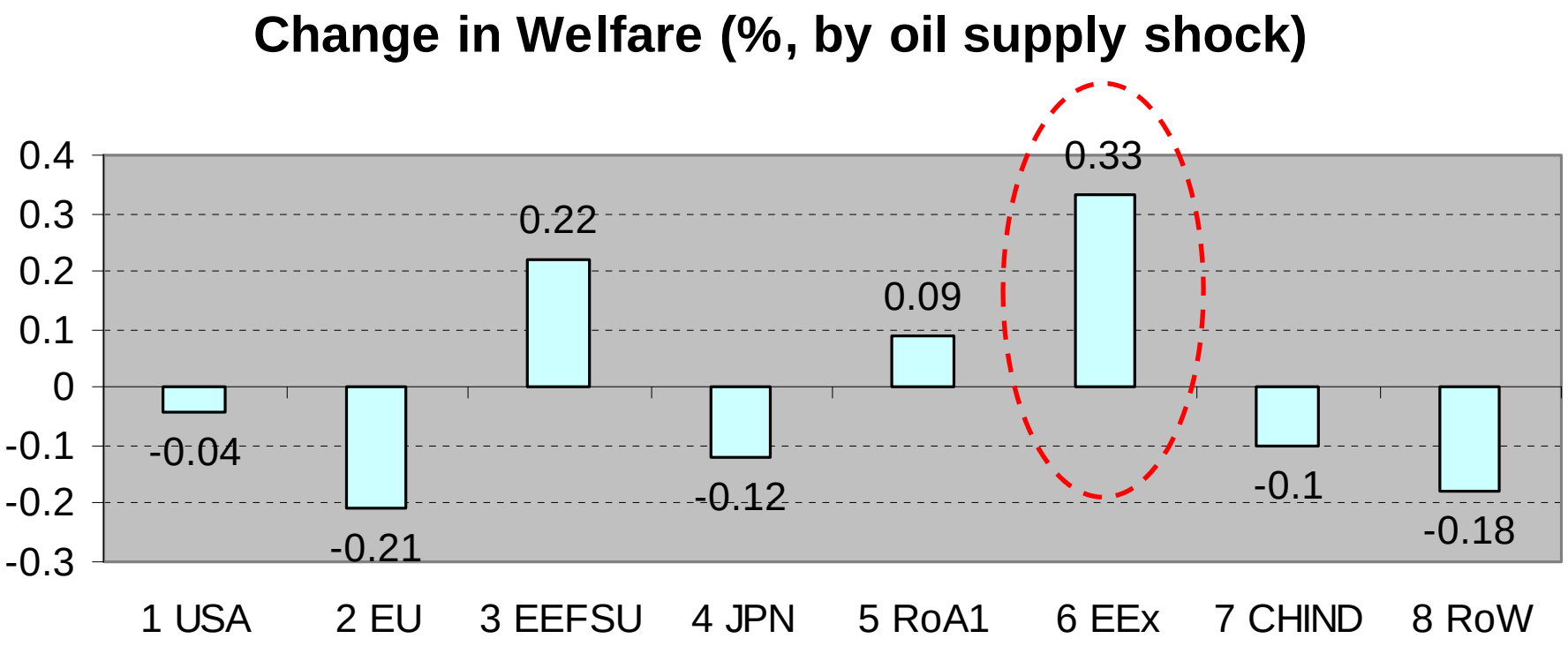


Oil supply shock

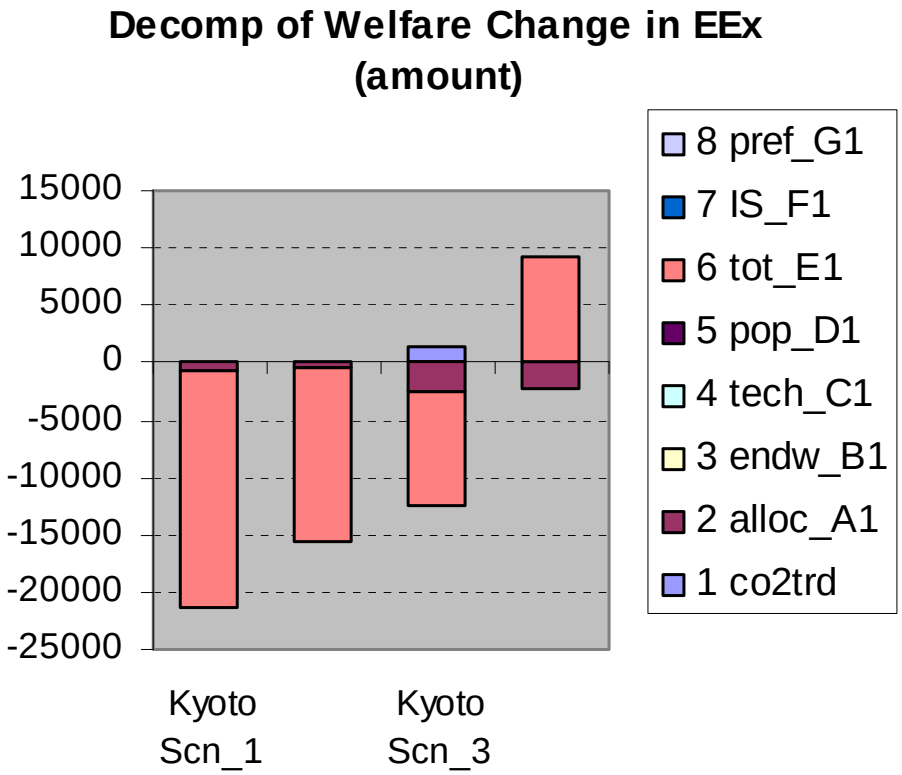
Methodology

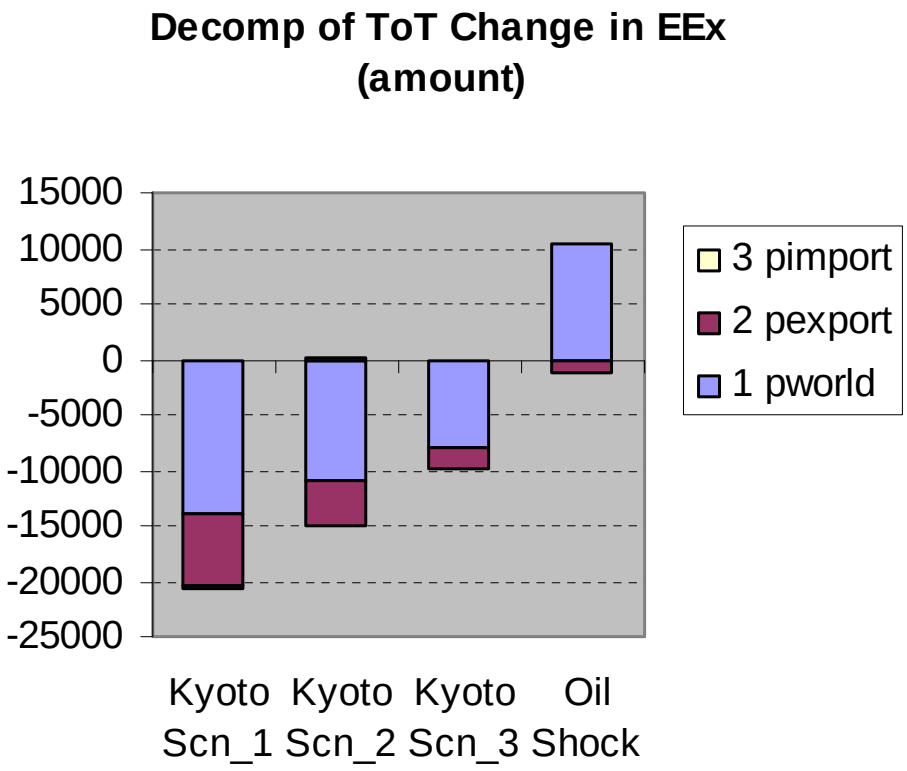
- swap qo("oil","EEx") = to("oil","EEx");
- shock qo("oil","EEx") = -10;

Welfare gain from oil supply shock

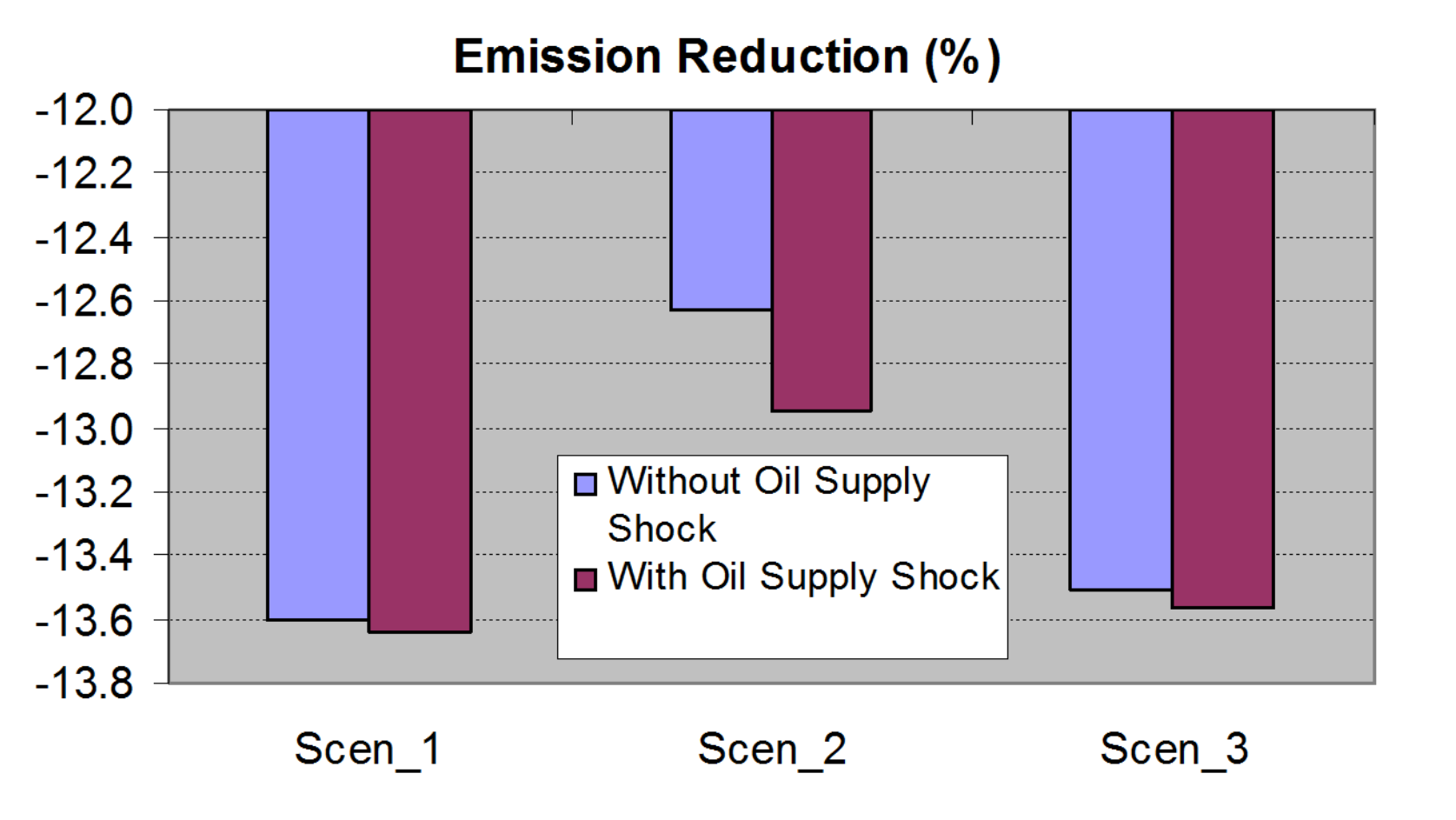


What is behind this welfare gains?





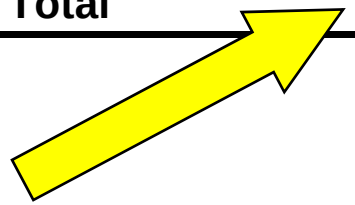
What is the impact of oil supply shock on Kyoto Protocol?



Why oil supply shock reduces emissions?

Impact of oil supply shock on emission

Energy	World share of energy input (%)	Emission per output	Chage of output (%)	Change of output (amount)	Change of emission (million tons of carbon)
Coal	4.2	0.0244	2.0	1,910	47
Oil	19.0	0.0001	-3.2	(13,765)	-1
Gas	8.4	0.0057	1.5	2,918	17
Oil products	27.2	0.0044	-3.0	(18,404)	-81
Electricity	41.2	0	0.6	6,072	0
				Total	**-19**



1. **Expansion effects: Emission decreases due to less oil consumption.**
2. **Substitution effects: More demand for electricity (clean energy !!!).**

(2) Conclusions

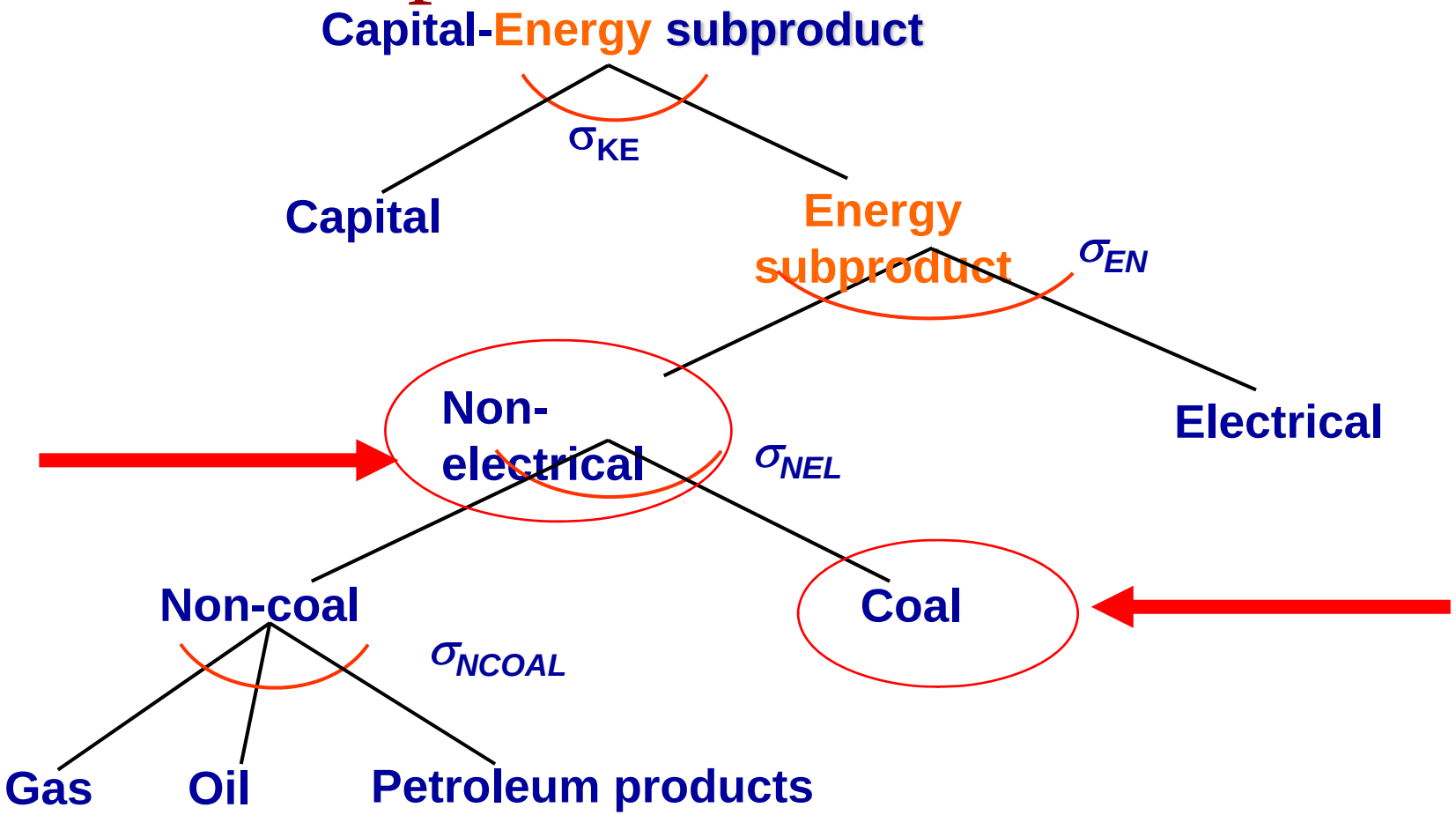
- EEx could recover welfare losses from Kyoto Protocol by reducing oil production to the world market.
- Oil supply shock can promote emission reduction.

(3) Can Technological Developments Save the World?

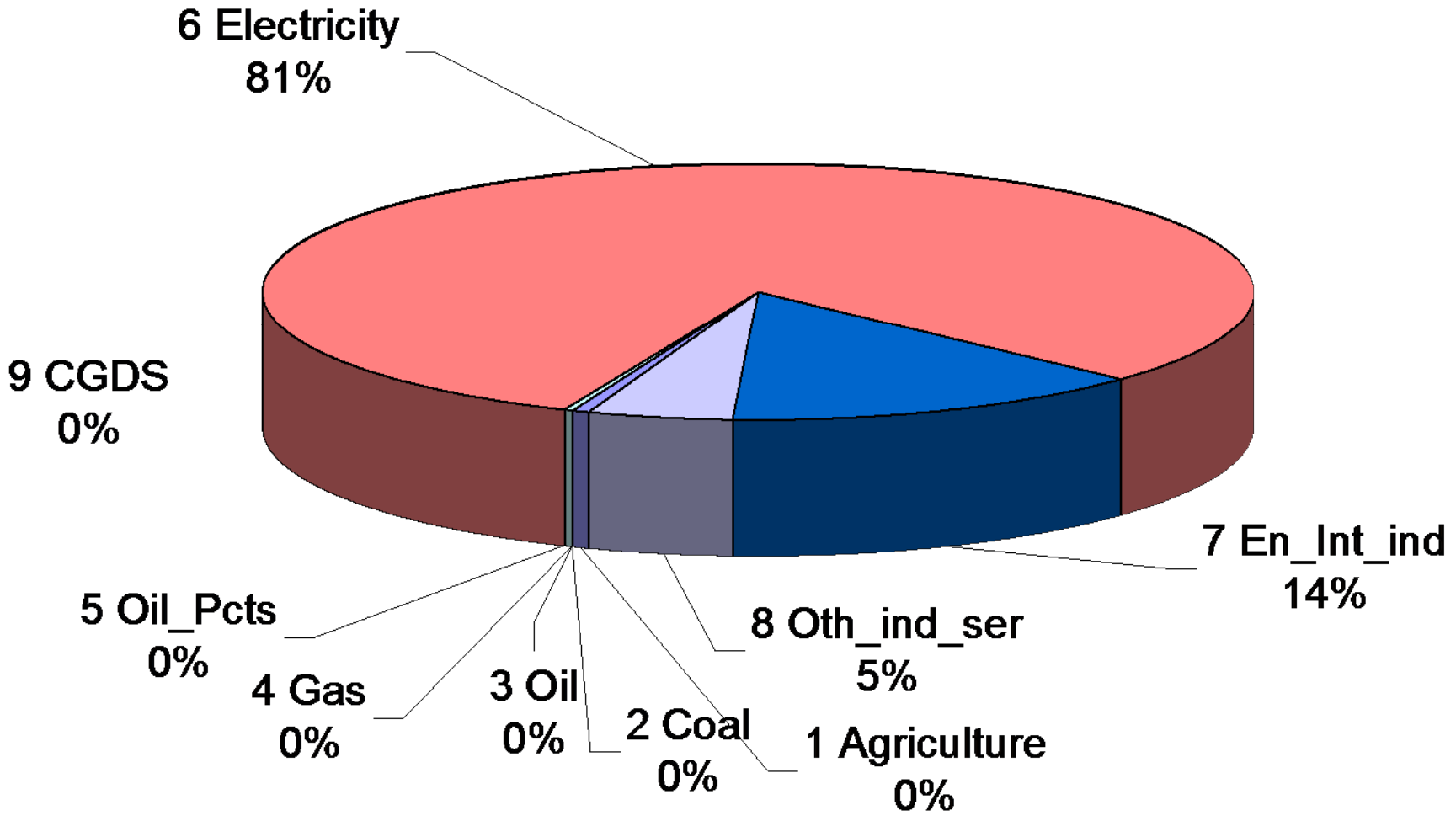
Motivation / Question / Method

- Motivation:
  - Commonly held belief that improvements in emissions efficiency will reduce total emissions
- Question:
  - How much improvement in emissions efficiency is needed to meet Kyoto agreements?
- Methodology:
  - Shock emissions to Kyoto levels and let the model tell us the required level of tech change.

Working at the energy sub-product level



Point of Focus: Coal



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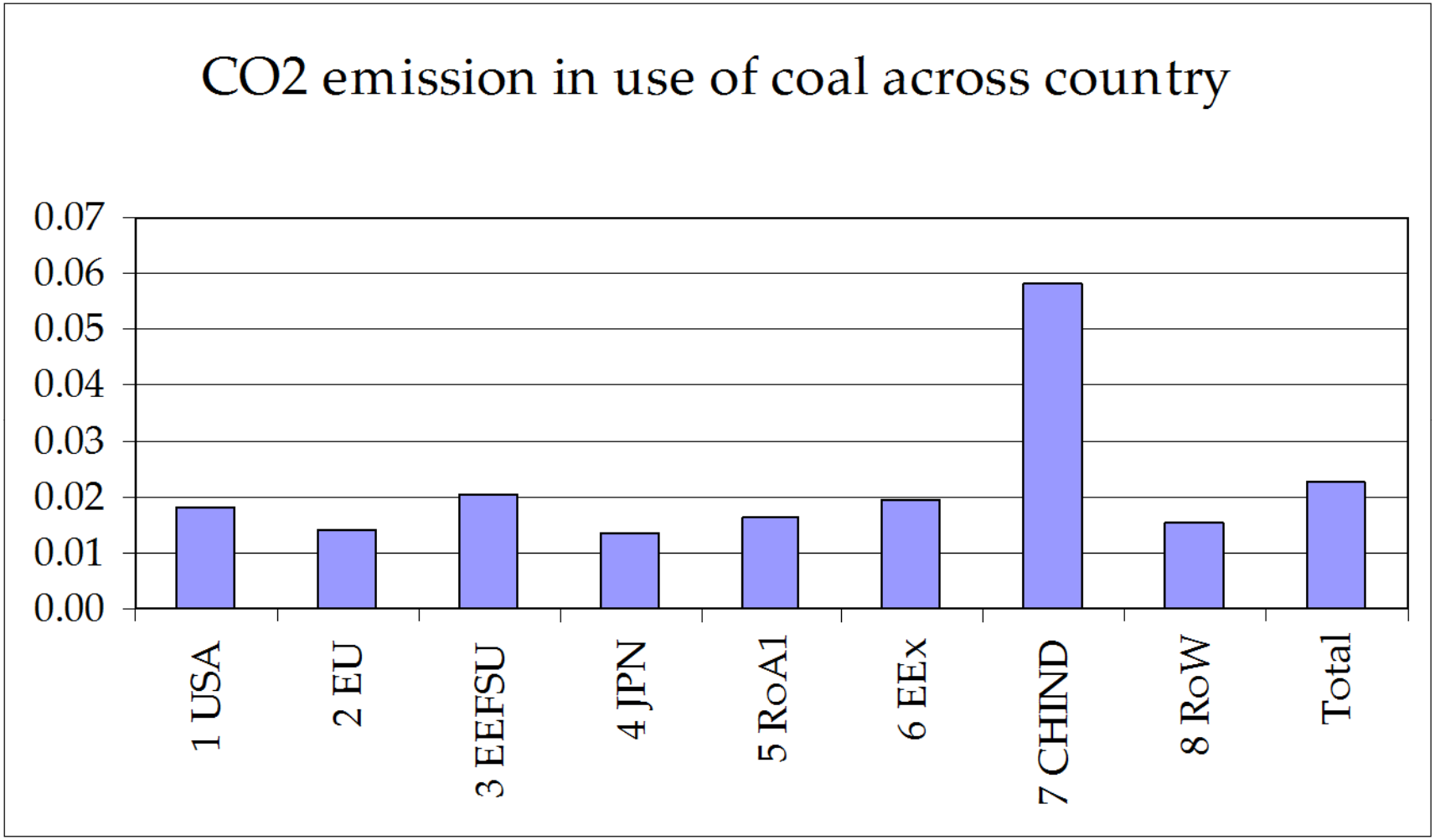


What kind of tech development?

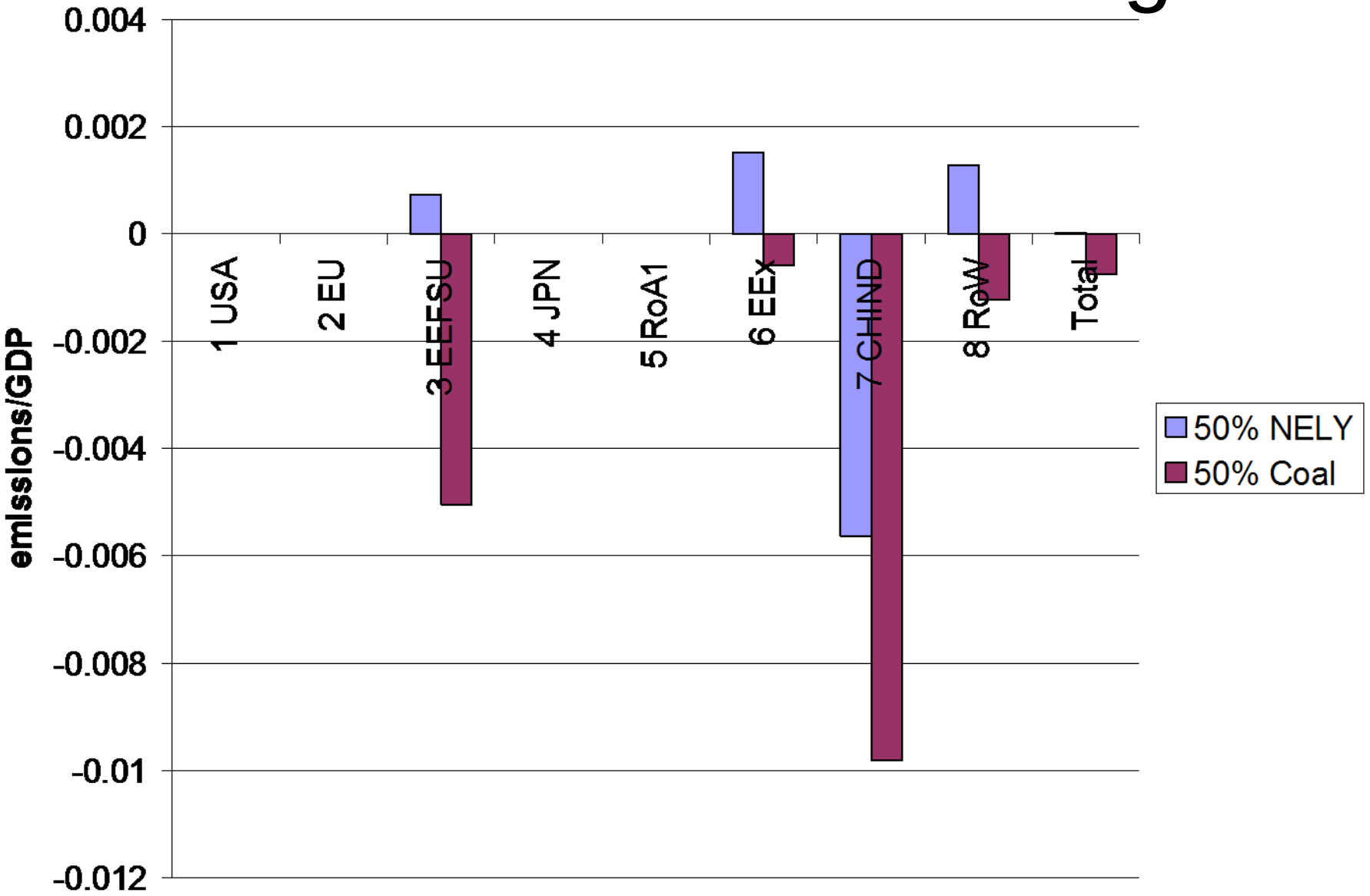
- 2 forms of technological development:
  - efficiency of coal use
    (more energy output for amount of coal)
  - emissions efficiency of coal use
    (less emissions per unit of coal)
- Current model only allows the first
- Apparently it is “easy” for user to modify

Closures / Shocks / Outcomes

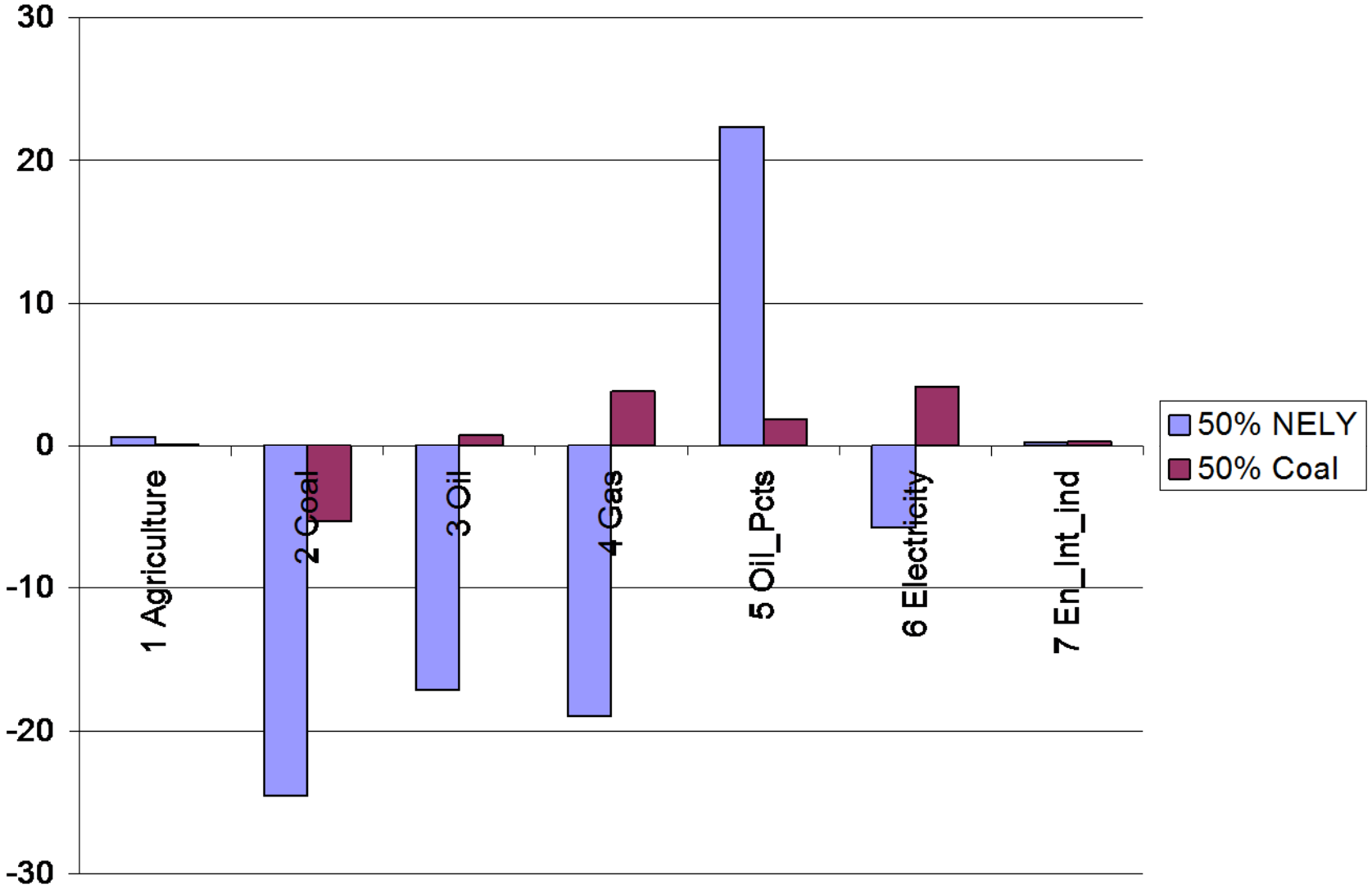
- Same as Kyoto with no ETS but with :

  swap afall("coal", prod_comm, reg)=qf("nely", prod_comm, REG);
- Model will not solve….
- Why not? Maybe tech change in coal prod. **cannot** reduce emissions by enough
- Test by shocking
  - afall(“nely", prod_comm, reg); and
  - afall(“coal",prod_comm, reg)

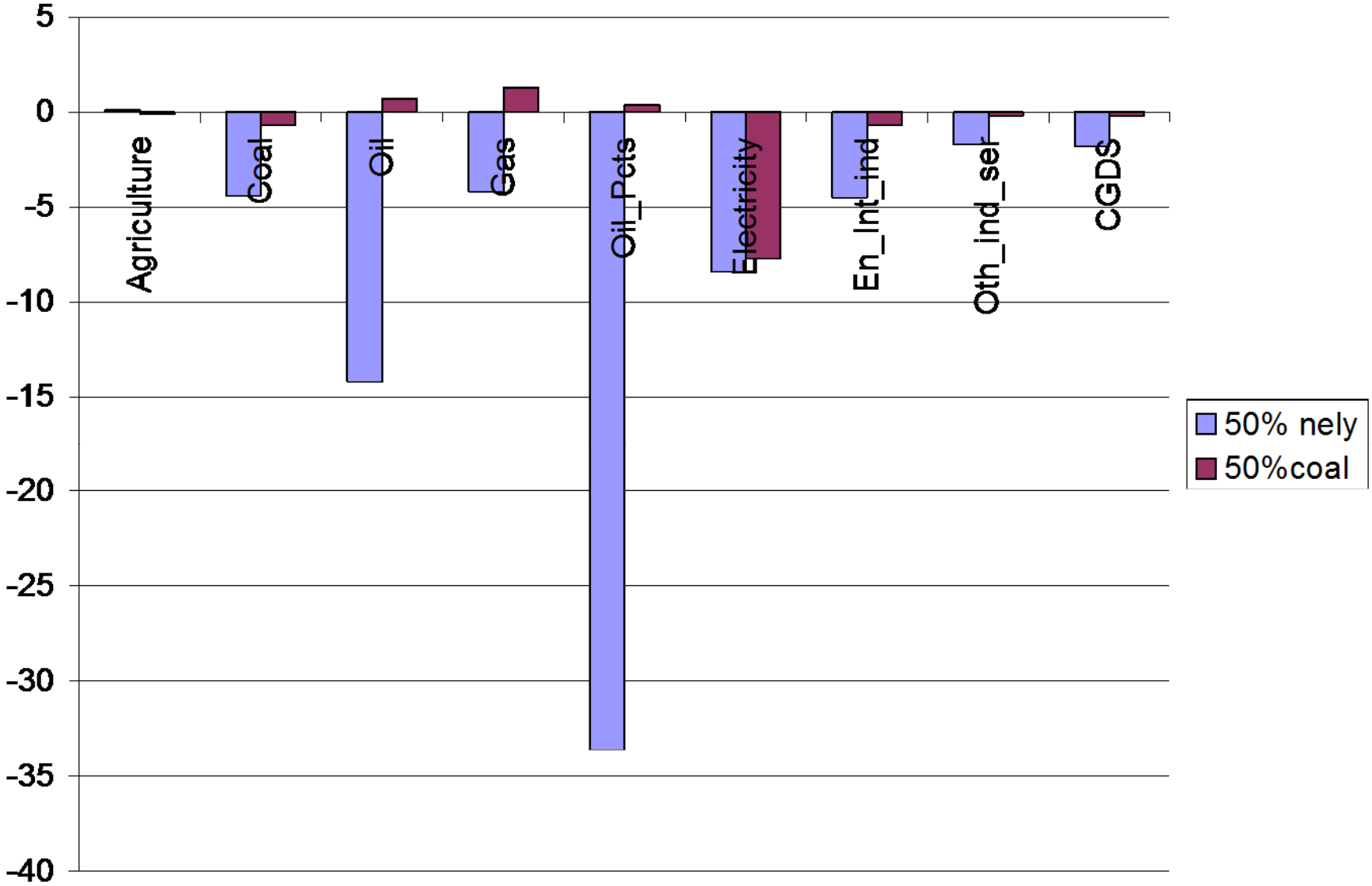
Annex 1 emissions unchanged



USA qo: decrease in coal output, increase in oil products



USA pm: Changes in qo driven by price



Conclusions / Further work

- Tech change may contribute towards lowering emissions
- But it is unlikely to be the only factor to solve the problem
- We need other mechanisms.
- Further step could be to modify model to allow changes in emission intensity of coal

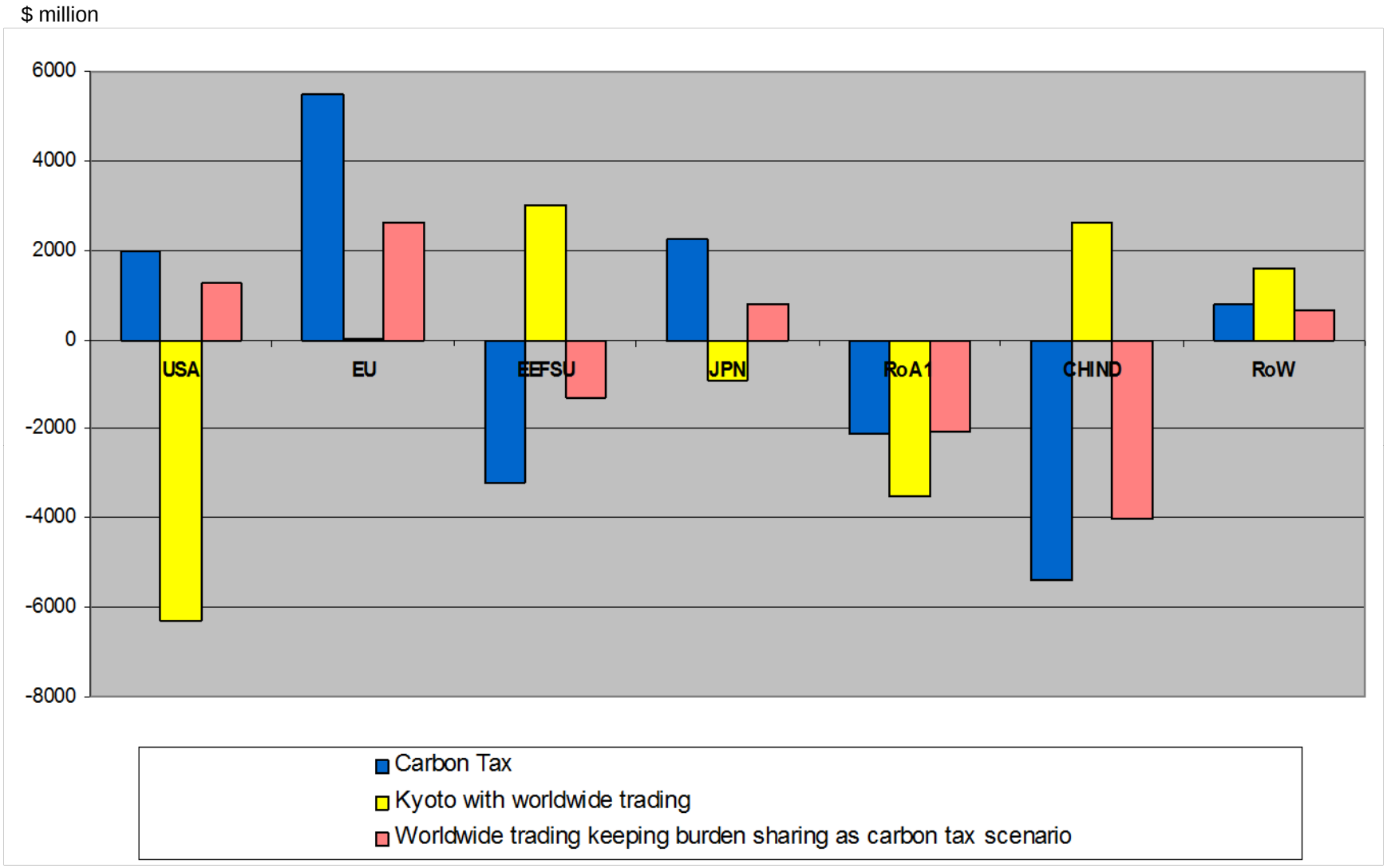
(4) Carbon Mitigation Schemes

Policy Options

- End goal: 10% global CO2 emissions reduction target

- What is the most efficient way to achieve this reduction? Price vs. Quantity?
  - Option 1: uniform carbon tax
  - Option 2: global emissions trading

Policy Comparison

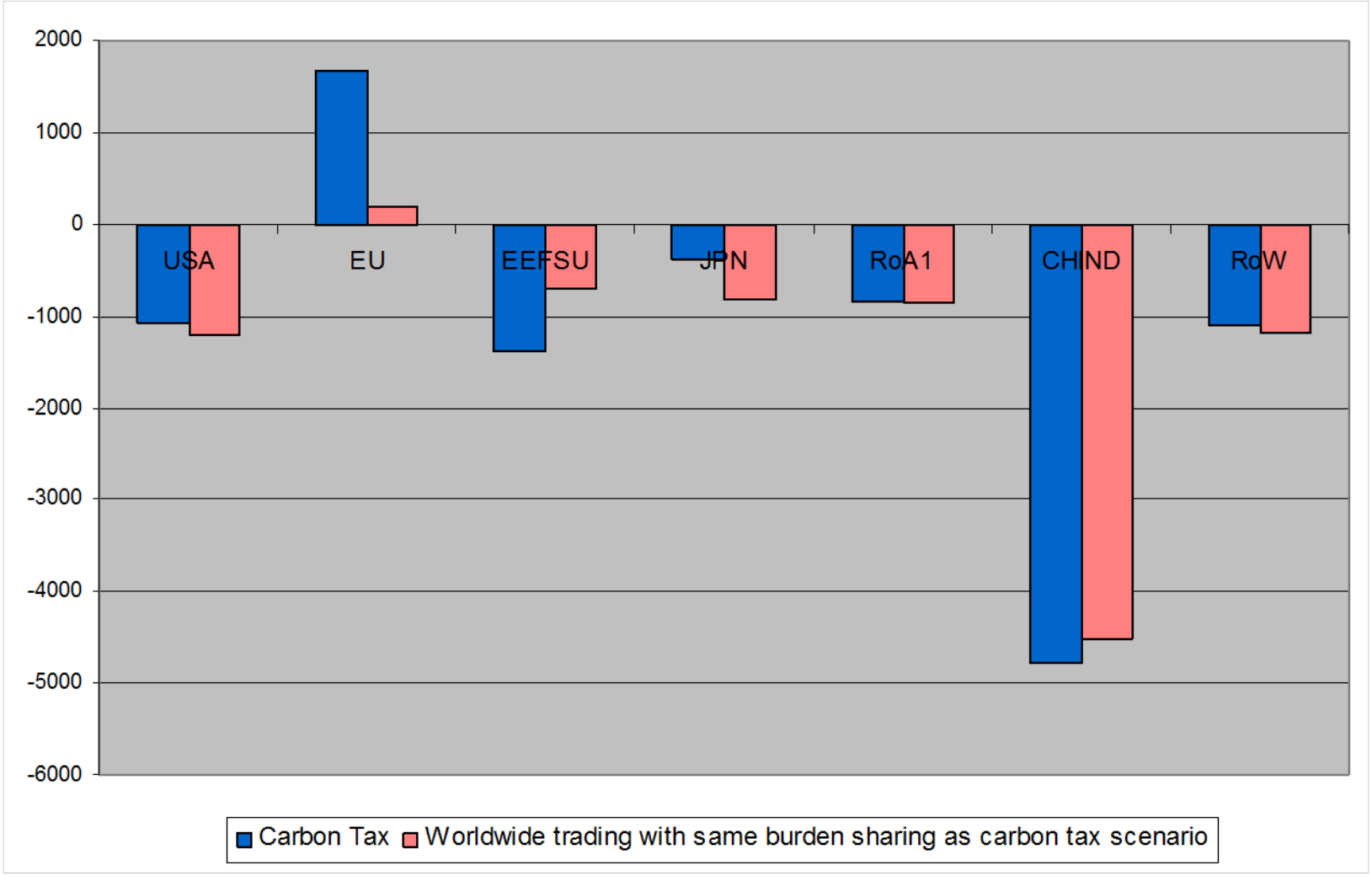


Observations

- Globally, carbon tax is more efficient, but worldwide trading seems more fair
- Welfare impacts vary among policy options
  - Developing vs. developed
- Drivers of welfare change
  - Allocative efficiency
  - Terms of Trade
- Limitations
  - Ignore current negotiations, dev of carbon markets, political viability
  - Incomplete picture

Allocative Efficiency

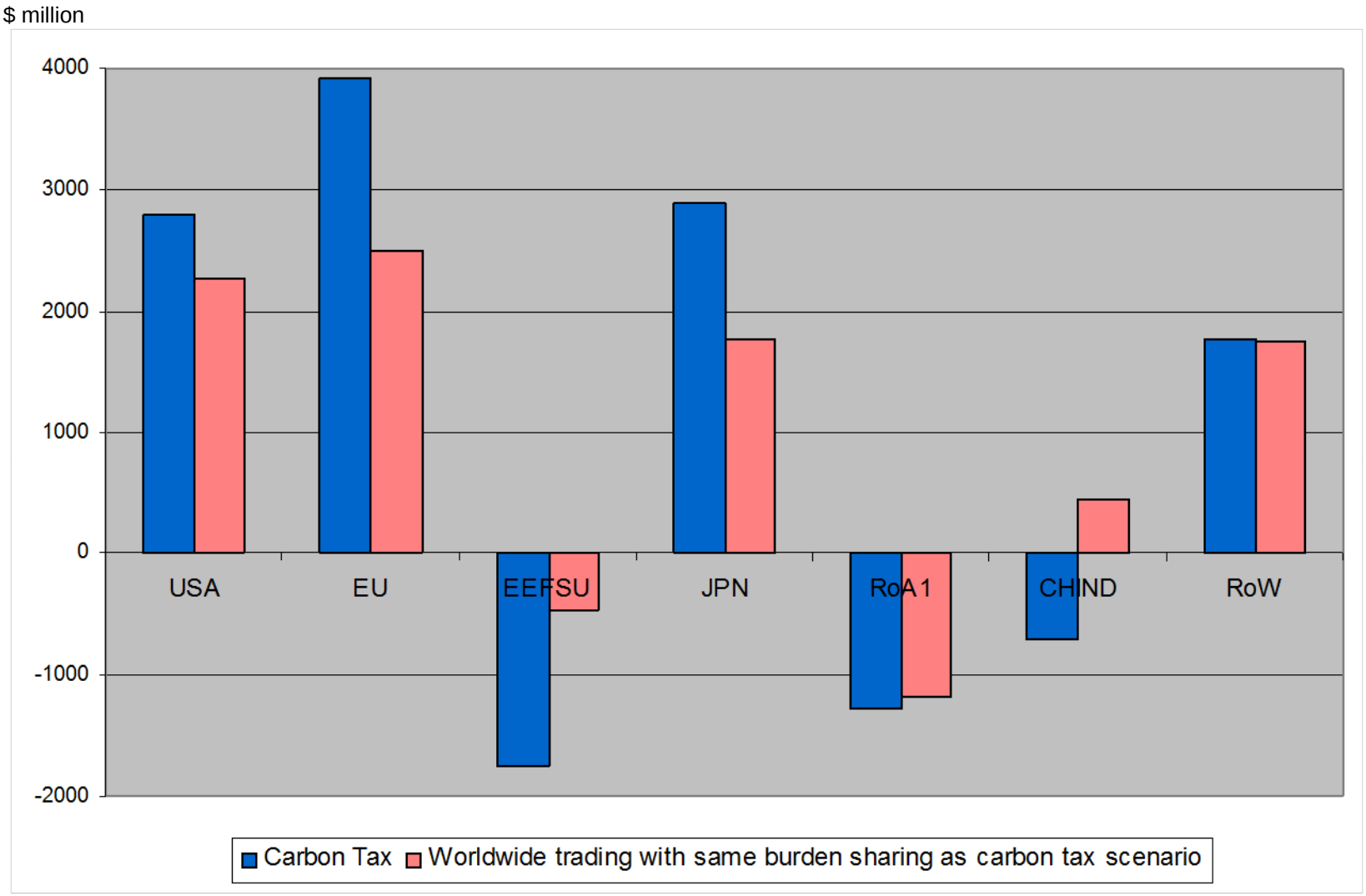
$ million



Allocative Effects

- Cost structures of industries matter
  - A uniform global carbon tax disproportionately impacts energy-intensive industries – they have a larger emissions rate per unit of output
  - Developing countries have more energy-intensive industries, in relation to developed countries
  - Therefore, developing countries – China and India – are disproportionately affected by the uniform carbon tax

Terms of Trade



Terms Of Trade

- A global carbon tax disproportionately taxes developing nations
- Price changes affect real exchange rates, which result in TOT changes
- These two policies affect developing and developed countries differently
- China and India’s TOT deteriorate with a global carbon tax, but improve with a global emissions trading policy

Conclusions

- The way we reduce emissions matters
- In formulating any carbon emissions reduction scheme, welfare implications should be consulted
  - In this example, allocative efficiency and TOT were the key drivers
- Distributional effects reveals how policy affects individual country welfare
- This is starting point for making well-informed climate policy decisions

Climate Change Negotiations: Lessons from extensions

- Getting the US should not be difficult if flexibility is shown by all
- Net energy exporting countries may manipulate markets to alter impacts
- Technical change may help, but need other other mechanisms
- Alternative carbon schemes may have differing distributional implications.