Shock and Sensitivity

Bineswaree Bolaky

Kosuke Shiraishi

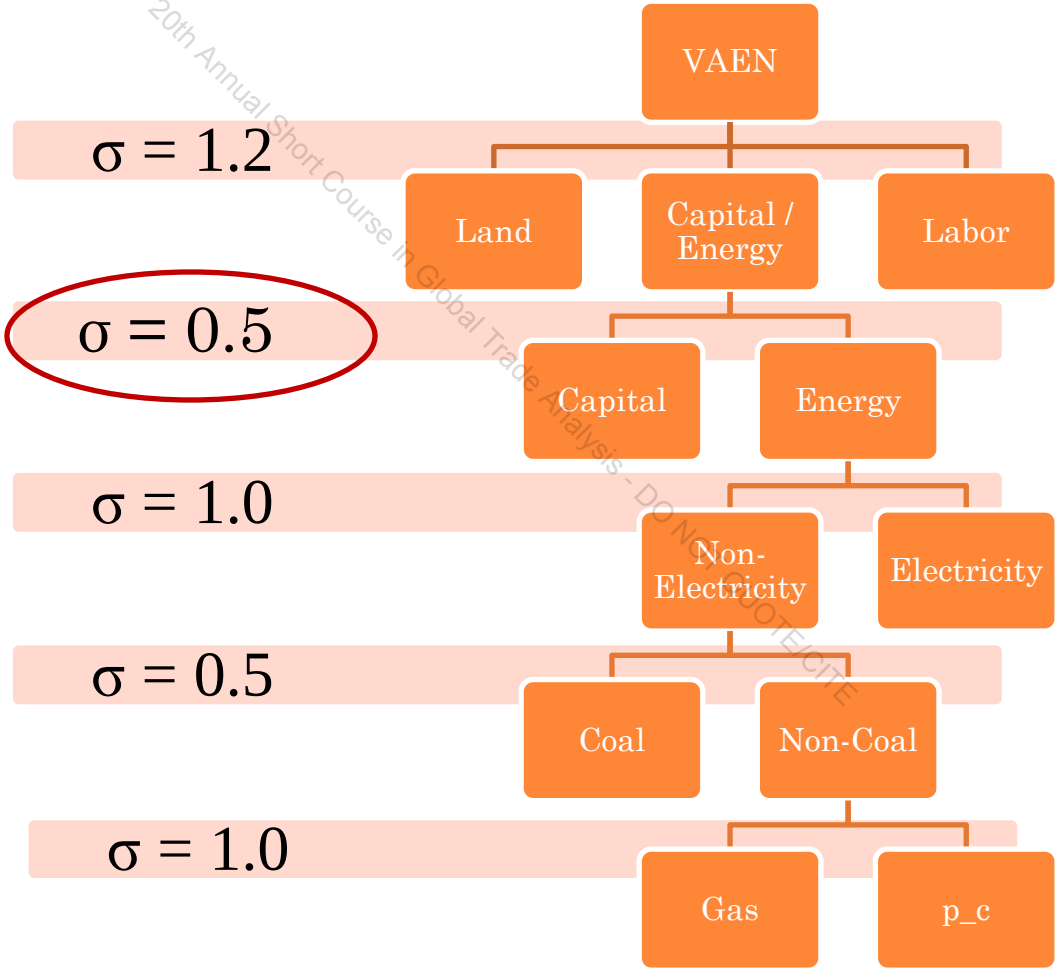
Michael Medina

Elasticity Sensitivity

- Started from the GTAP-E version with the worldwide emission trading scenario (best case option)
- Altered the elasticity between capital and energy in the production of energy commodities (30%↑ or $\sigma = 0.65$)
- Looked at the sensitivity of welfare in response to a change in elasticity
- Investigated differences in sensitivity by region

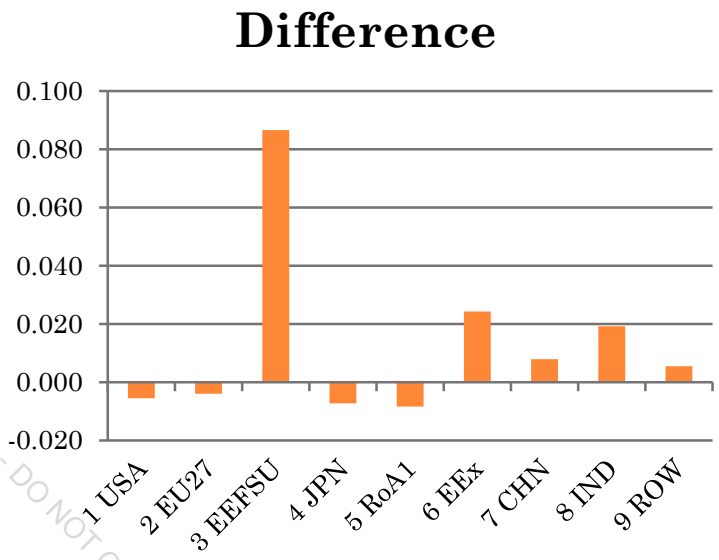
Energy Commodity Production

Increased to σ = 0.65



Elasticity Increase Impacts

Region	Worldwide Trading Response	WTR with 30% elasticity increase	Difference
1 USA	-0.05	-0.04	-0.01
2 EU27	-0.01	0.00	0.00
3 EEFSU	0.09	0.01	0.08
4 JPN	-0.03	-0.02	-0.01
5 RoA1	-0.23	-0.22	-0.01
6 EEx	-0.37	-0.40	0.03
7 CHN	0.22	0.21	0.01
8 IND	0.16	0.14	0.02
9 ROW	0.05	0.05	0.01



- Welfare is not very sensitive to the elasticity between capital and energy
- EEFSU has the largest response to the elasticity change

Welfare Decomposition - EEFSU

WELFARE	WTR	WTR w/ 30%	Percent Diff
CO2 TRD	2672.26	2378.42	11.00%
Alloc Eff	-904.69	-1109.07	22.59%
ToT	-1102.27	-1258.24	14.15%
Invest	62.39	48.53	22.22%
Total	727.69	59.64	91.80%

Alloc Eff	WTR	WTR w/ 30%
Coal	-328.4	-288.84
Oil	-80.03	-129.77
Gas	-161.81	-253.48
Oil_pcts	-98.62	-156.61
Electricity	-191.15	-201.48

ToT	WTR	WTR w/ 30%
Oil	-1096.03	-1140.27

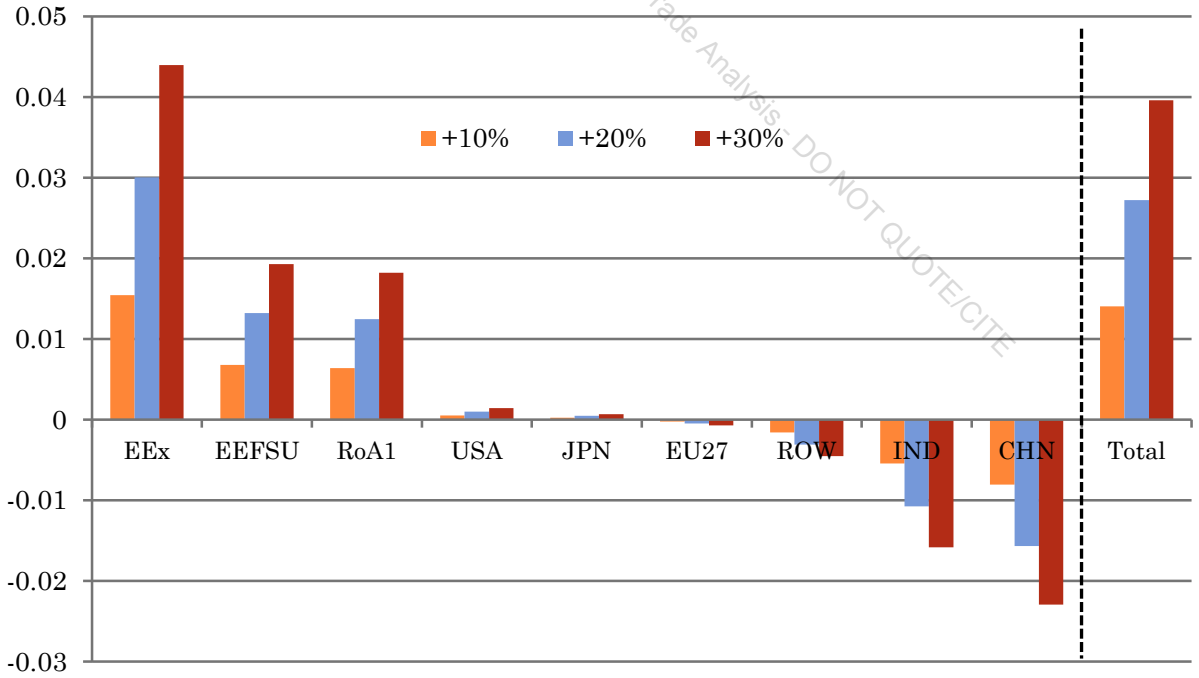
- EEFSU is an oil/gas exporter
- Regions shift from energy to capital more easily
- Less shifting from coal to non-coal

Sensitivity analysis

Change in the Elasticity between Coal and Non-Coal
Result: (Welfare change compared to base case scenario)

- 30% increase in SE

Gain	Lose	Not much different
EEx, EESFU, RoA1	China, India, ROW	US, EU, Japan



Welfare decomposition

- Result attributed to change in:
  1. Emission trading revenue
  2. TOT

Difference with the basecase

	EEx	EEFSU	RoA1	USA	JPN	EU27	CHN	IND	ROW
CO2 TRD	-71	-148	106	186	90	141	-231	-30	-43
Alloc Eff	125	135	58	177	25	44	101	18	97
TOT	699	118	91	-217	-112	-242	-125	-47	-164
Invest	-7	-3	4	-41	15	3	17	-3	15
Total	747	102	259	105	19	-55	-238	-63	-95

* Only variables that had a change are shown

Carbon emission trading

- Producers use less coal, switch to other emission commodities.
- Buyers of Hot Air paying less because they can switch to less-dirty fuels.

Difference with basecase

gco2(r,i)	Coal	Oil	Gas	Oil_pcts
EEx	-1.54	0.2	0.52	0.12
EEFSU	-1.76	0.39	0.85	0.16
RoA1	-0.93	0.41	0.72	0.15
USA	-0.69	0.69	0.69	0.17
JPN	-1.14	0.75	0.75	0.1
EU27	-0.62	0.54	0.66	0.03
CHN	-0.27	0.82	2.16	0.77
IND	-1.1	1.89	1.84	0.28
ROW	-1.2	0.72	0.83	0.16

Difference with basecase

	DVCO2TRA(r)
EEx	-102.8
EEFSU	-217.23
RoA1	156.31
USA	274.4
JPN	132.56
EU27	207.51
CHN	-340.94
IND	-45.77
ROW	-64.07

Terms of trade

- Energy exporters enjoy an increase in export prices
- Export prices in Energy intensive industry mostly accounts for the decrease

Difference with basecase

	Export Pr	Import Pr	Total
EEx	0.06	0.02	0.09
EEFSU	0.04	0.01	0.05
RoA1	0	0.03	0.01
USA	-0.02	0	-0.02
JPN	-0.03	0	-0.03
EU27	-0.03	0.01	-0.01
CHN	-0.04	0.02	-0.02
IND	-0.04	-0.01	-0.07
ROW	-0.03	0.01	-0.02

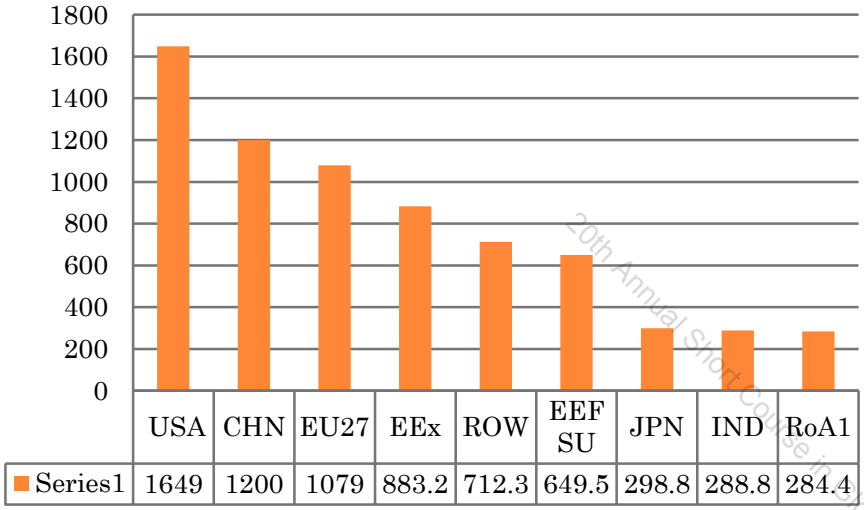
Hypotheses/Research questions of interest

- Think of a positive productivity shock in the oil sector e.g. a fall in the costs of oil exploration and costs of commercially exploiting oil (better drilling technologies)

- Lets say by 5%

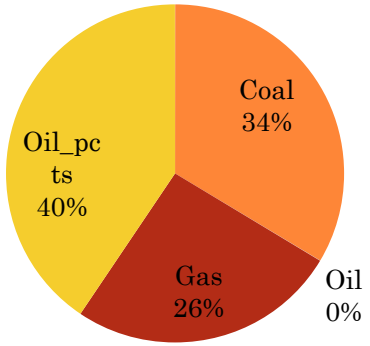
- How does this affect the incentives of countries or regions to engage in emissions trading as compared to no emissions trading? Impact on welfare and terms of trade?

Initial CO2 Emissions by region

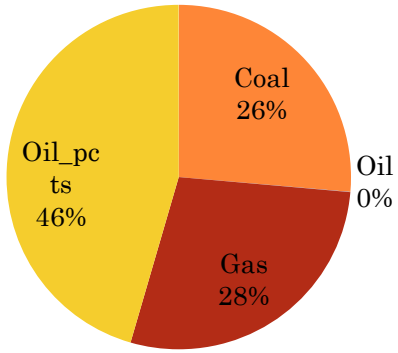


	USA	CHN	EU27	EEx	ROW	EEF SU	JPN	IND	RoA1
Series1	1649	1200	1079	883.2	712.3	649.5	298.8	288.8	284.4

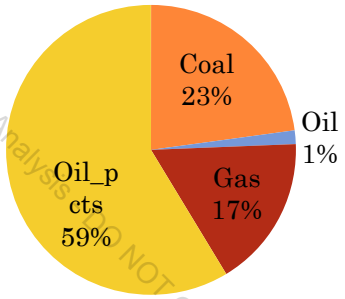
USA



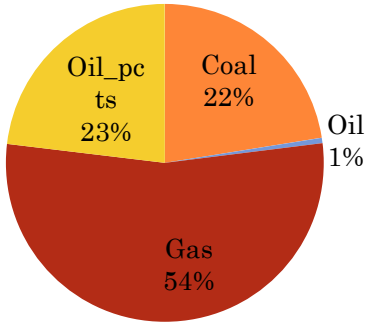
EU27



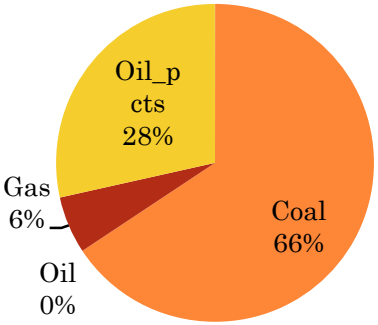
JPN



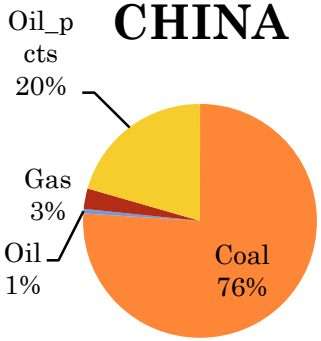
EEFSU



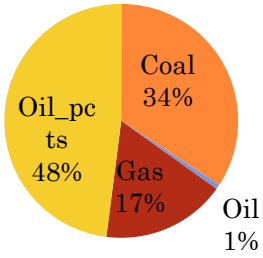
INDIA



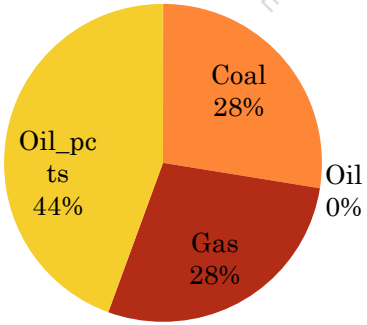
CHINA



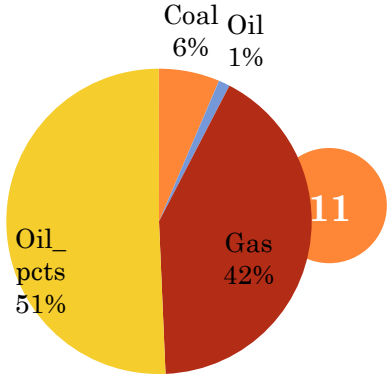
ROW



RoA1



EEx



Scenario 1: productivity shock in oil sector by 5 %

Region	With no use of flexibility mechanisms: baseline				With no use of flexibility mechanisms: scenario 1			
	% reduction in emissions	2004 USD per tonne of carbon	Welfare	TOT	% reduction in emissions	2004 USD per tonne of carbon	Welfare	TOT
USA	-17.0	67.7	-0.10	0.49	-17.0	**73.95**	**0.04**	1.05
EU	-17.0	90.0	-0.12	0.17	-17.0	**99.59**	**0.07**	0.38
EEFSU	1.6	0	-0.94	-1.11	**2.43**	0	-0.86	-2.68
Japan	-30.0	248.2	-0.41	0.90	-30.0	**267.23**	-0.31	1.63
RoA1	-40.0	276.0	-1.06	-0.15	-40.0	**288.04**	-1.01	-0.48
Eex	1.6	0	-0.61	-1.49	**3.37**	0	-0.55	**-3.51**
China	0.4	0	0.01	0.07	**0.78**	0	**0.28**	0.47
India	0.7	0	0.25	0.54	**1.3**	0	**0.81**	1.79
RoW	1.5	0	0.11	0.12	**2.9**	0	**0.47**	0.57

SOME DECOMPOSITION

	No emissions trading	Emissions trading-annex 1	Worldwide emissions trading
Ps(oil)	-7.2 (India) to -11.7 (Japan)	-6.7 (India) to -8.8 (EEFSU)	-6.9 (India) to -7.9 (Eex)
Ps(coal)	-0.05 (EEFSU) to -8.5 (Japan)	-0.1 (Row) to -3.2 (USA) except China and India	-0.7 (EEFSU) to-2.5 (India) except China
Ps(gas)	-0.3(RoA1) to 0.1 (India), 22.3 (Japan)	-1.2 (Row) to -3.8 (EU&EEFSU) except Japan and India	Falls except China where price rises by 18.4
Qo(oil)	0.1 (Row) to 1.4 (China), except USA and Japan	0.6 (USA) to 2.7 (EEFSU)	0.9 (China) to 2.8 (EEFSU)
Qo(coal)	-1.2 (China) to -45.4 (Japan)	-0.6 (China) to -27.6 (USA)	-7.5 (Eex) to -23.6 (India)
Qo(gas)	Falls except China and Japan	Falls except China and Japan	Falls everywhere. Largest fall in China

Scenario 1: productivity shock in oil sector by 5 %

Region	With worlwide emission trading: baseline				With worldwide emission trading: scenario 1			
	% reduction in emissions	2004 USD per tonne of carbon	Welfare	TOT	% reduction in emissions	2004 USD per tonne of carbon	Welfare	TOT
USA	-7.0	22.2	-0.05	0.18	**-6.73**	**25.73**	0.1	0.74
EU	-5.2	22.2	-0.01	0.07	**-4.68**	**25.75**	0.21	0.28
EEFSU	-9.5	22.2	0.09	-0.33	-10.09	**25.72**	0.25	-1.92
Japan	-4.5	22.2	-0.03	0.26	**-3.2**	**25.73**	0.12	1
RoA1	-7.4	22.2	-0.23	-0.22	**-7.06**	**25.79**	-0.15	-0.55
Eex	-4.7	22.2	-0.37	-0.70	**-3.84**	**25.81**	-0.34	-2.78
China	-16.6	22.2	0.22	0.13	**-18.11**	**25.68**	0.54	0.54
India	-15.8	22.2	0.16	0.55	**-16.89**	**25.65**	0.74	1.34
RoW	-7.6	22.2	0.05	0.14	-7.32	**25.74**	0.41	0.59

Region	Carbon trading revenues	Allocative Efficiency	Endowment	Technical change	Pop	Terms of trade	Inv savings	Total Welfare change
USA	-40.7%	-5.6%	0	30.2%	0	89.9%	26.2%	10731.2
EU	-14.2%	58.2%	0	6.8%	0	48.6%	0.5%	24150.2
EEFSU	164%	6.2%	0	263.9%	0	-329%	-5%	1949.2
Japan	-42.4%	34.6%	0	0.2%	0	123.8%	-16.2%	4873.0
RoA1	-78%	0.6%	0	110.9%	0	-124.3%	-9.3%	-3100.8
EEX	10.3%	11.2%	0	-259.9%	0	-376.3%	-5.1%	-8484.1
China	67.8%	-28.4%	0	22.1%	0	45.8%	-7.4%	8250.2
India	29.0%	9.3%	0	8.3%	0	49.6%	3.8%	4332.2
RoW	10.7%	14.6%	0	11.9%	0	69.8%	-7%	12583.6