Sharing the pie of future emissions
—— An integrated framework of multi-principle schemes

CUI Xueqin, Renmin University of China

Laurent Drouet, Fondazione Eni Enrico Mattei

Giacomo Marangoni, Fondazione Eni Enrico Mattei

2015. 01. 15

FEEM, Milan

Contents

- Background and motivation
- Data & Methodology
- Results & Discussions
- Conclusion
- Future work

Motivation

- Quota of future emissions is a global common resource
- Ways of sharing the quota is one of key issues in designing future international climate regime
- A variety of approaches from different perspectives has been proposed (equity, capacity, responsibility)
- The need of multi-principle approaches is highlighted by the varying stance and preference of developed and developing countries

➡

- **Develop a integrated framework to combine different perspectives**
- **Provide a more comprehensive and balanced view for the ongoing negotiation**

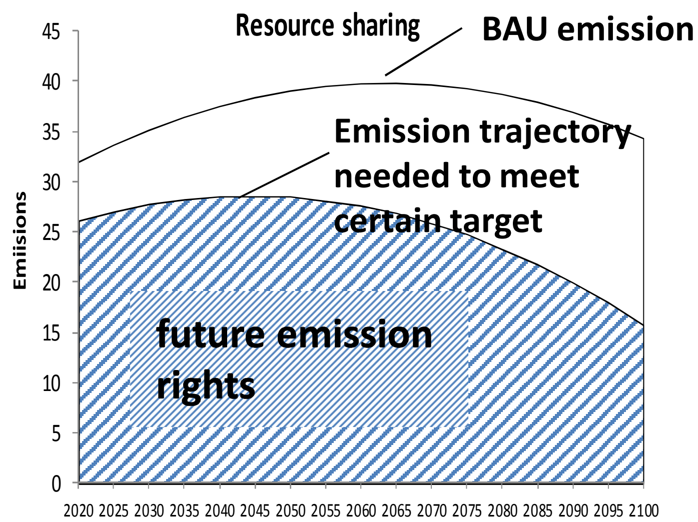
Principles usually considered in existing allocation schemes

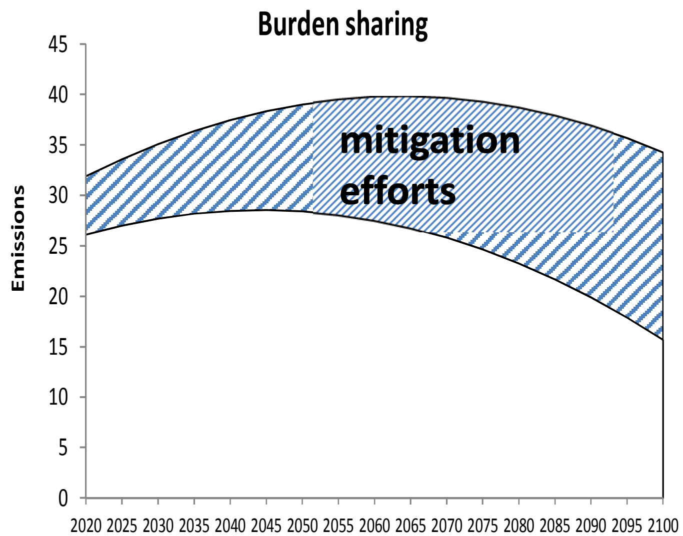
- 1. Equity: equal emission allowances per person
- 2. Inertia: current emission level, grandfathering
- 3. Capacity: ability to pay for mitigation
- 4. Responsibility: historical contribution to global warming
- 5. Cost effectiveness: mitigation potential/cost
- 6. Sustainable development: low income/emission people don’t take mitigation burden

➢ **Developing countries more in favor of 1, 3, 4, 6**
➢ **Developed countries more in favor of 2, 5**

Resource vs. Burden sharing

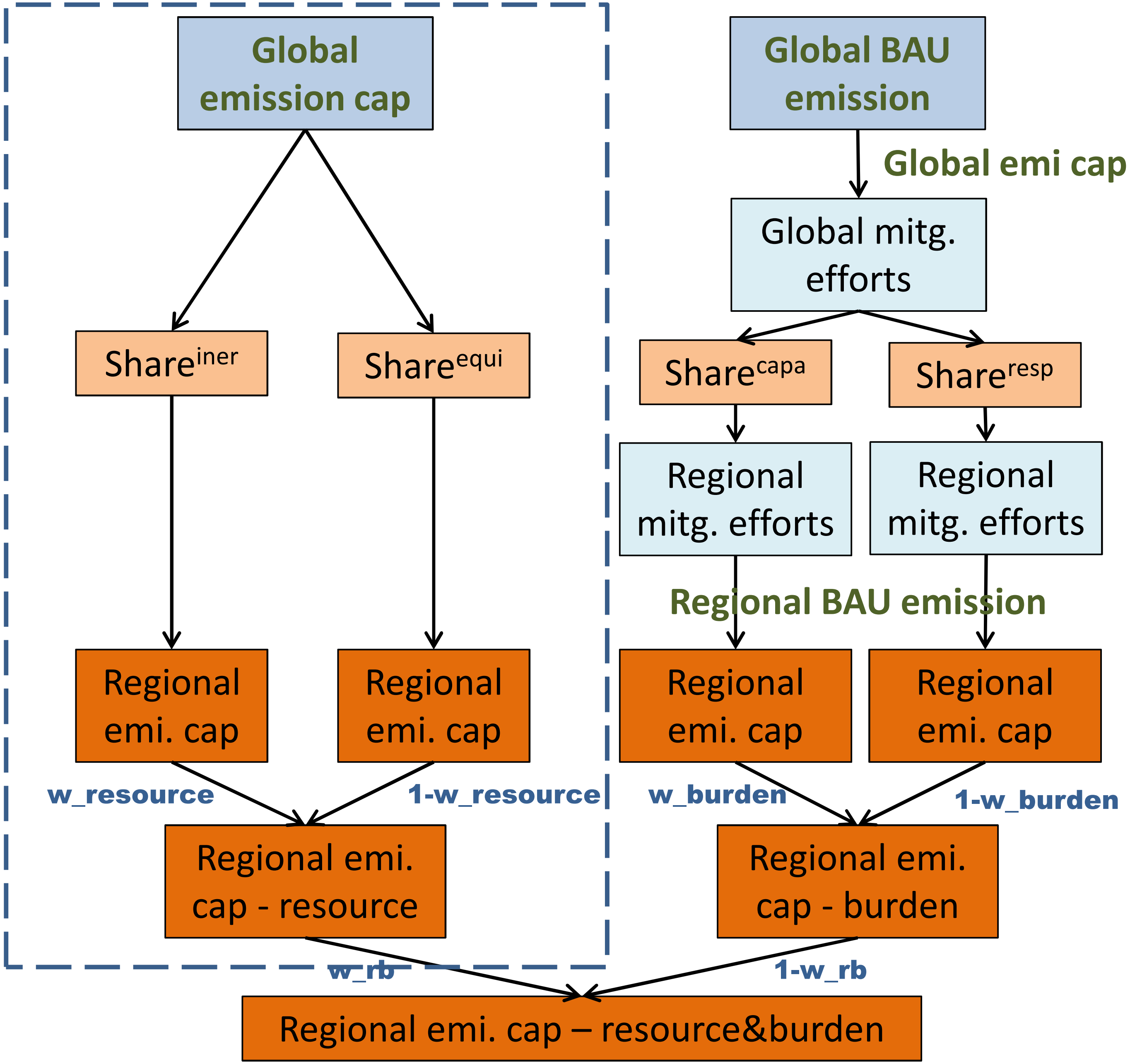
	Principle	Regional emissions trajectory	Negative emissions permit	Hot air
Resource sharing	Inertia (Grandfathering)	Same pace as the world across regions	No (as long as global emission is not negative	Yes
	Equity (Population)			
Burden sharing	Capacity (GDP)	Different timeframe of emission peaking	Yes	No
	Responsibility (Historical emissions)			



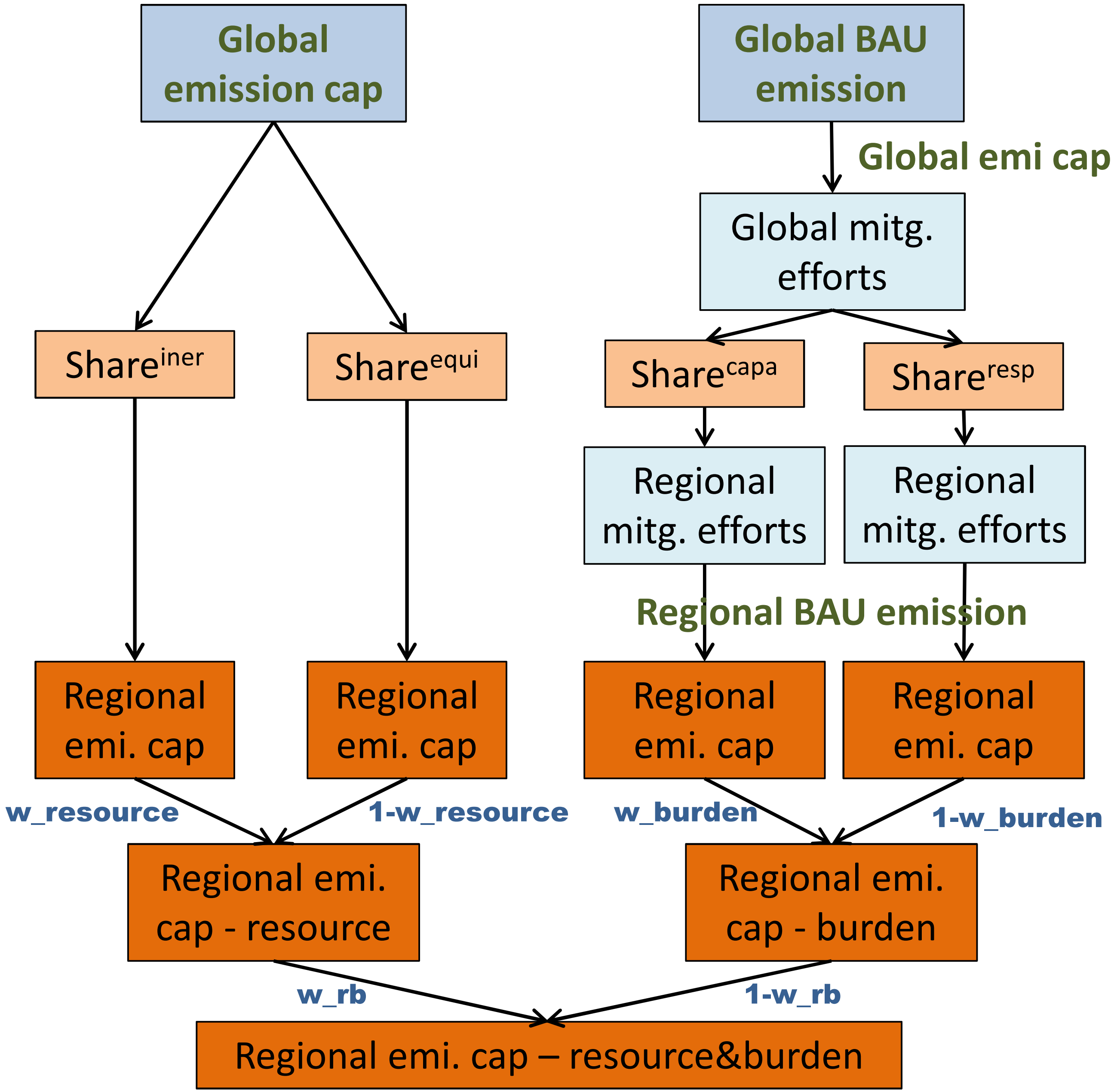


Multi-principle approaches

- A harmonized and integrated framework:
  - both burden & resource sharing
  - Four principles: Inertia, Equity, Capacity and Responsibility



Multi-principle approaches



Iner:

$$S_n^{iner} = \frac{e_{t0,n}}{\sum_n e_{t0,n}} = \frac{e_n^0}{E^0}$$

Equi:

$$S_n^{equi} = \frac{p_{t0,n}}{\sum_n p_{t0,n}} = \frac{p_n^0}{P^0}$$

Capa:

$$S_n^{capa} = \frac{g_{t0,n}}{\sum_n g_{t0,n}} = \frac{g_n^0}{G^0}$$

Resp:

$$S_n^{resp} = \frac{h_{t0,n}}{\sum_n h_{t0,n}} = \frac{h_n^0}{H^0}$$

Major contributions

- Extend to integrate burden sharing schemes
- Analysis of regional emission permits over time, rather than only cumulative quota
- Dynamic measurement of principles
- Monetary flows analysis based on IAMs

Data source

- Population: OECD SSP2 (SSP database)
- GDP: OECD SSP2, PPP (SSP database)
- Global & regional BAU emissions: No Policy scenario (WITCH)
- Global emission cap: WITCH
- Historical emissions: CO_2 from 1850 to 2010 excl. LULUCF (WRI CAIT)

Combination of principles

No.	Category	Name	Note	w_rb	w_right	w_burden
1	Resource sharing	Iner	Equivalent to Inertia	1	1	
2		Equi	Equivalent to Equity	1	0	
3		IN-EQ	Equal weights of inertia and equity	1	0.5	
4	Burden sharing	Capa	Equivalent to Capacity	0		1
5		Resp	Equivalent to Responsibility	0		0
6		CP-RS	Equal weights of capacity and responsibility	0		0.5
7	Blend	EQAll	Equal weights of four principles	0.5	0.5	0.5

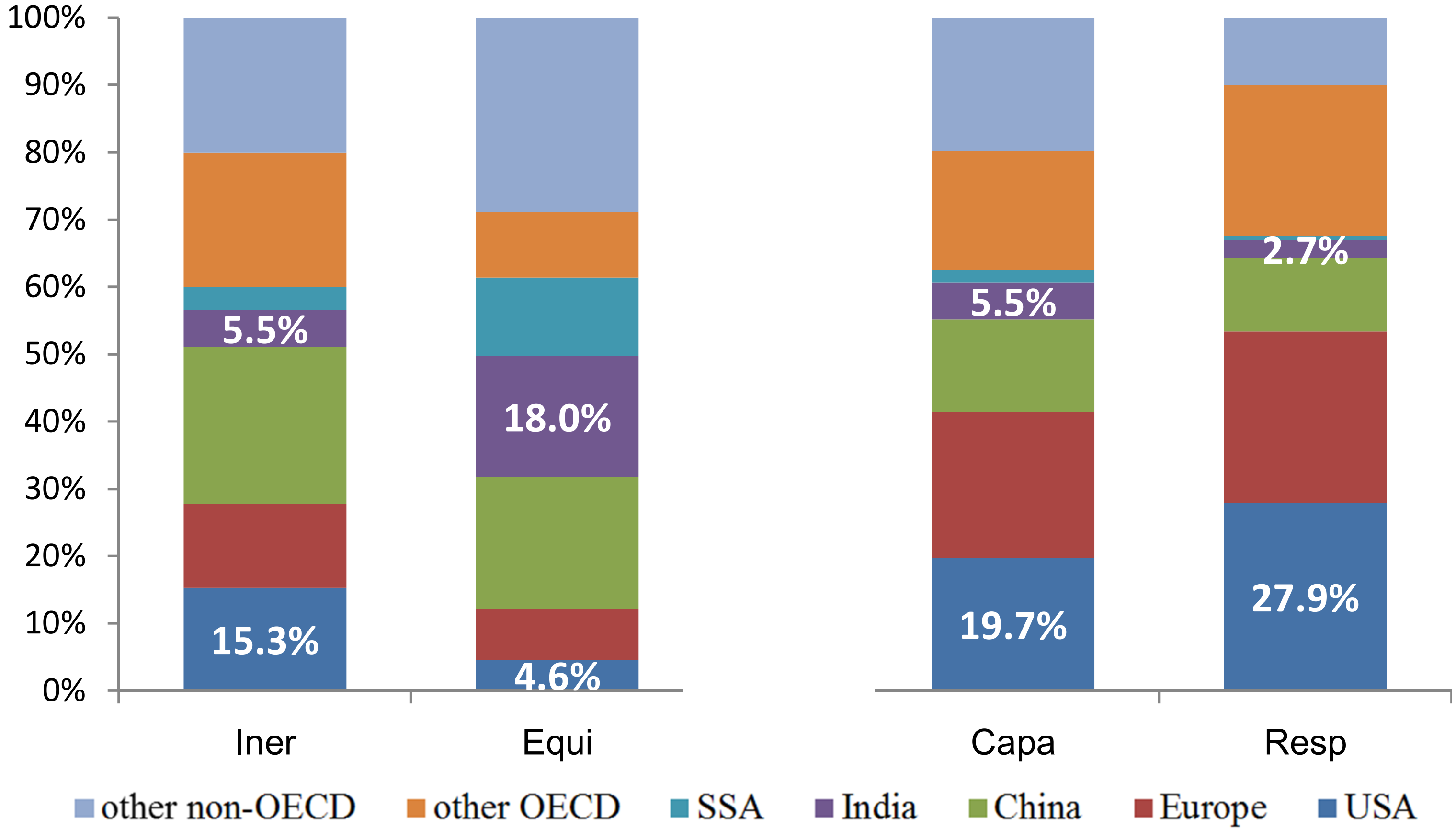
Shares of resource and burden

Resource sharing

Higher proportions,
higher emission permits

Burden sharing

Higher proportions,
higher mitigation efforts,
lower emission permits



Peaking time of permits under 2℃

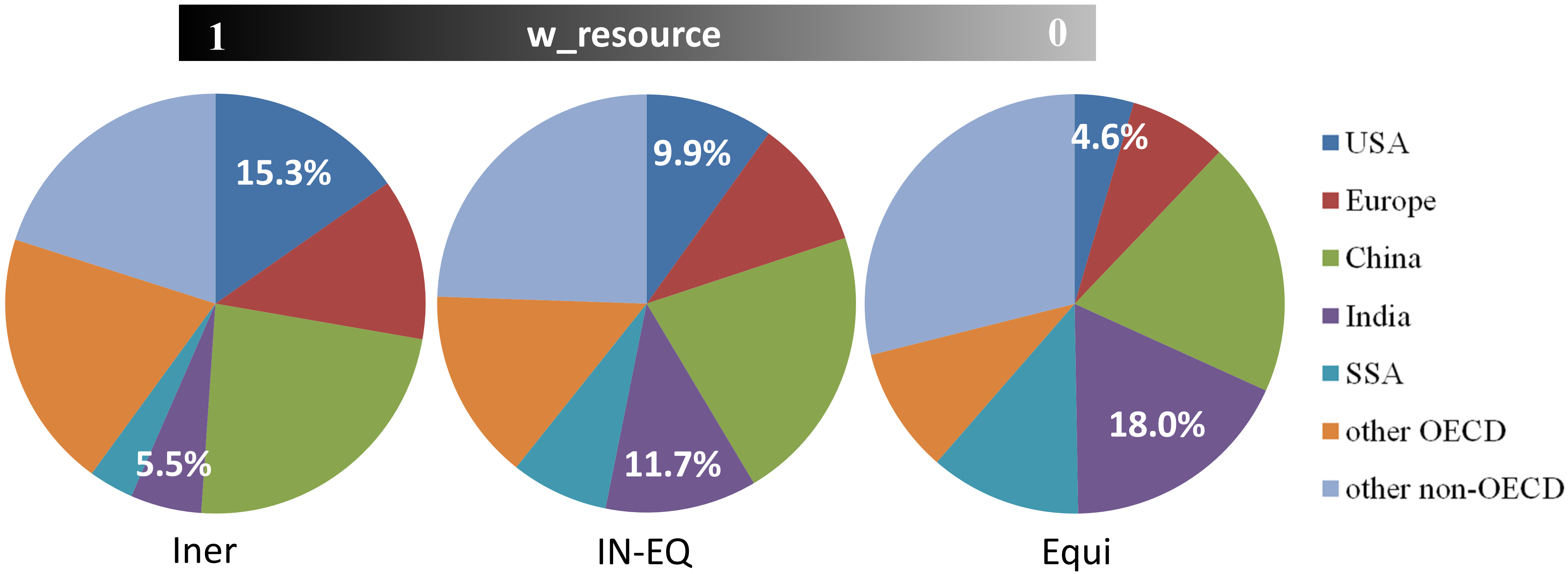
- Under RS schemes, all regions are at the same pace with global emission change
- Under BS schemes, time frame of peaking vary largely

	Resource Sharing			Burden Sharing			Blend
	Iner	Equi	IN-EQ	Capa	Resp	CP-RS	EQAll
usa	2025	2025	2025	before 2005	before 2005	before 2005	before 2005
oldeuro	2025	2025	2025	before 2005	before 2005	before 2005	before 2005
neweuro	2025	2025	2025	before 2005	before 2005	before 2005	before 2005
china	2025	2025	2025	2040	2045	2040	2040
laca	2025	2025	2025	2015	2015	2015	2015
mena	2025	2025	2025	2085	2085	2085	2085
ssa	2025	2025	2025	2090	2090	2090	2090
india	2025	2025	2025	2090	2090	2090	2090

Combination of resource sharing

$$S_n = w \times \frac{e_n}{E} + (1-w) \times \frac{p_n}{P} = \frac{p_n}{P} \times \left[1 + \boxed{\left(\frac{e_n / p_n}{E / P} - 1 \right)} \times w \right]$$

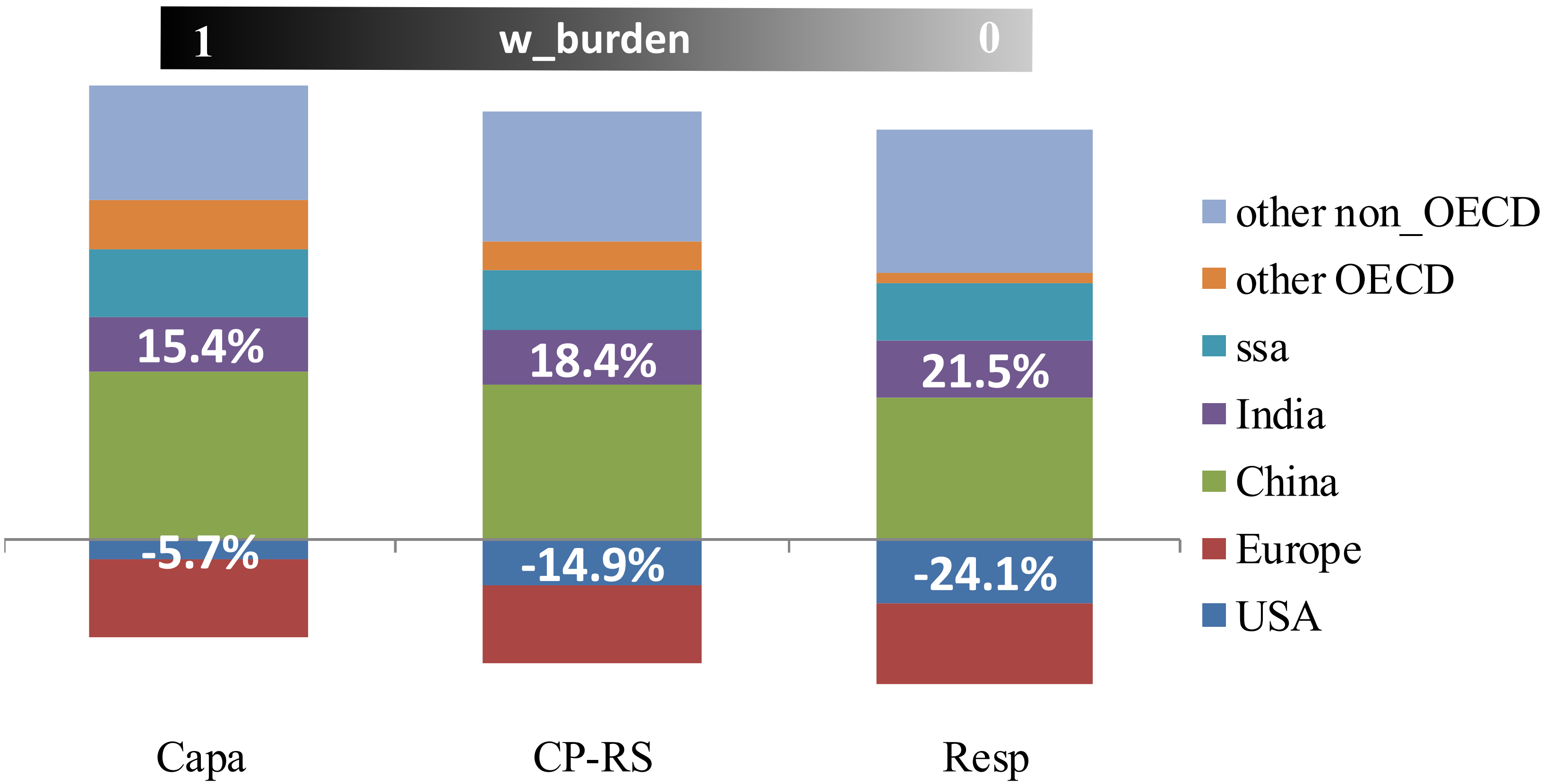
- For region n, e_n/p_n (regional per capita emission) > global average, $w\downarrow$, $S_n\downarrow$
- USA has larger permits under Inertia scheme than Equity, India the opposite



Combination of burden sharing

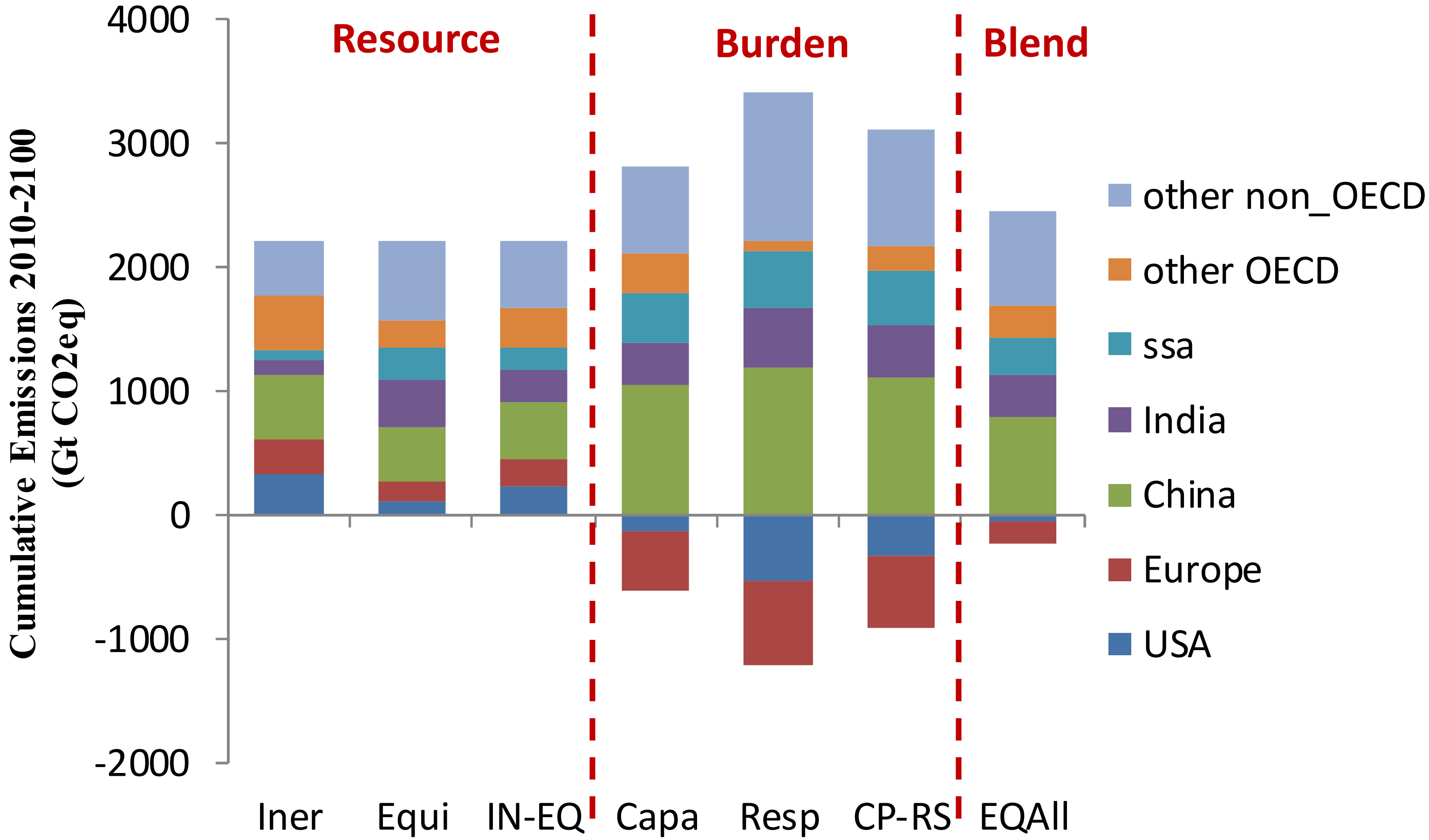
$$S_n = w \times \frac{g_n}{G} + (1-w) \times \frac{h_n}{H} = \frac{g_n}{G} \times \left[\frac{h_n/g_n}{H/G} + \left(1 - \frac{h_n/g_n}{H/G}\right) \times w \right]$$

- For region n, if $h_n/g_n > H/G$, $w\downarrow$ $S_n\uparrow$
- USA has smaller permits under Resp scheme than Capa, India the opposite

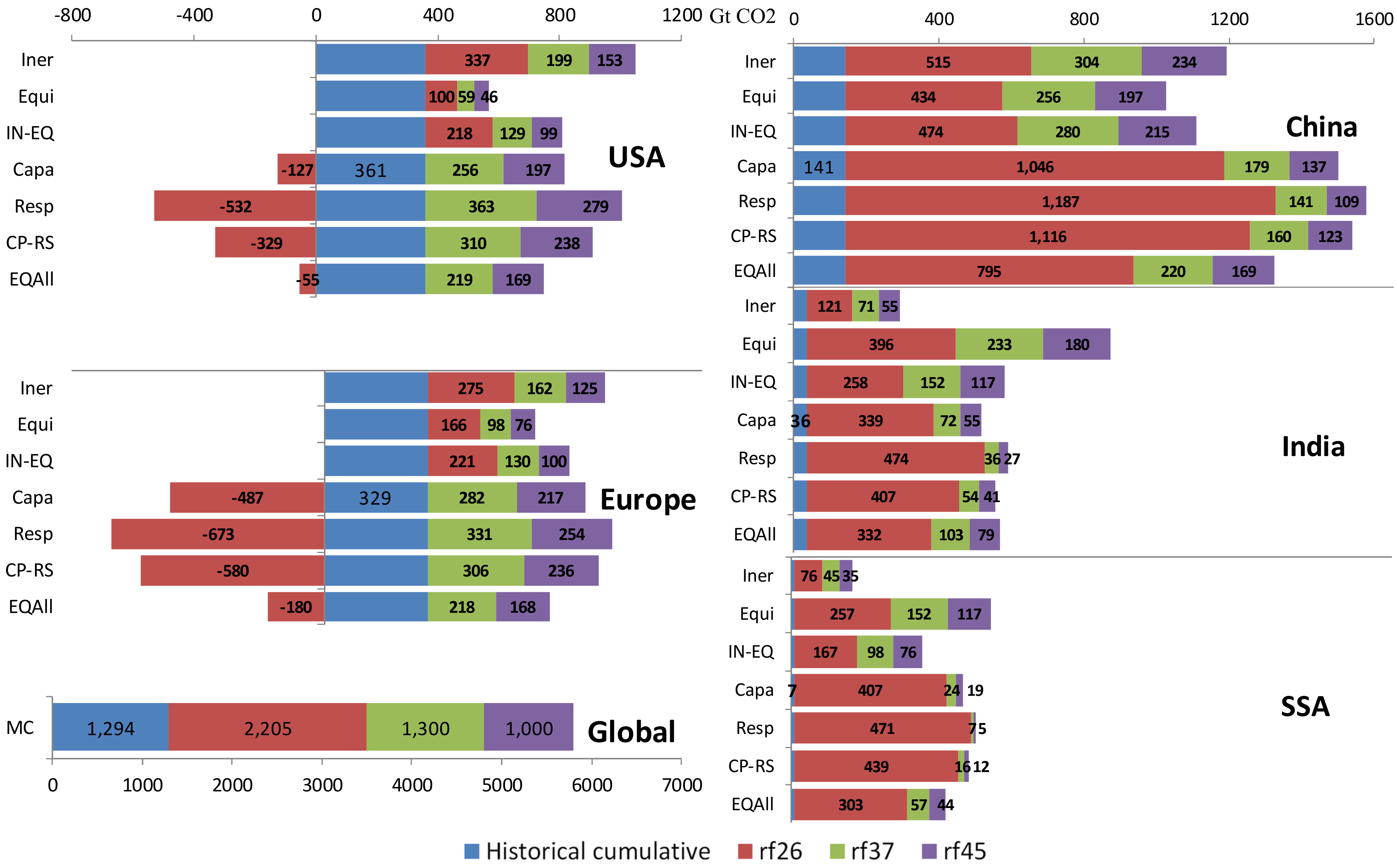


Regional distribution of emission permits

- Developing countries will have much more permits under BS
- Developed countries will have negative permits under BS
- Blending scheme provides in-between results

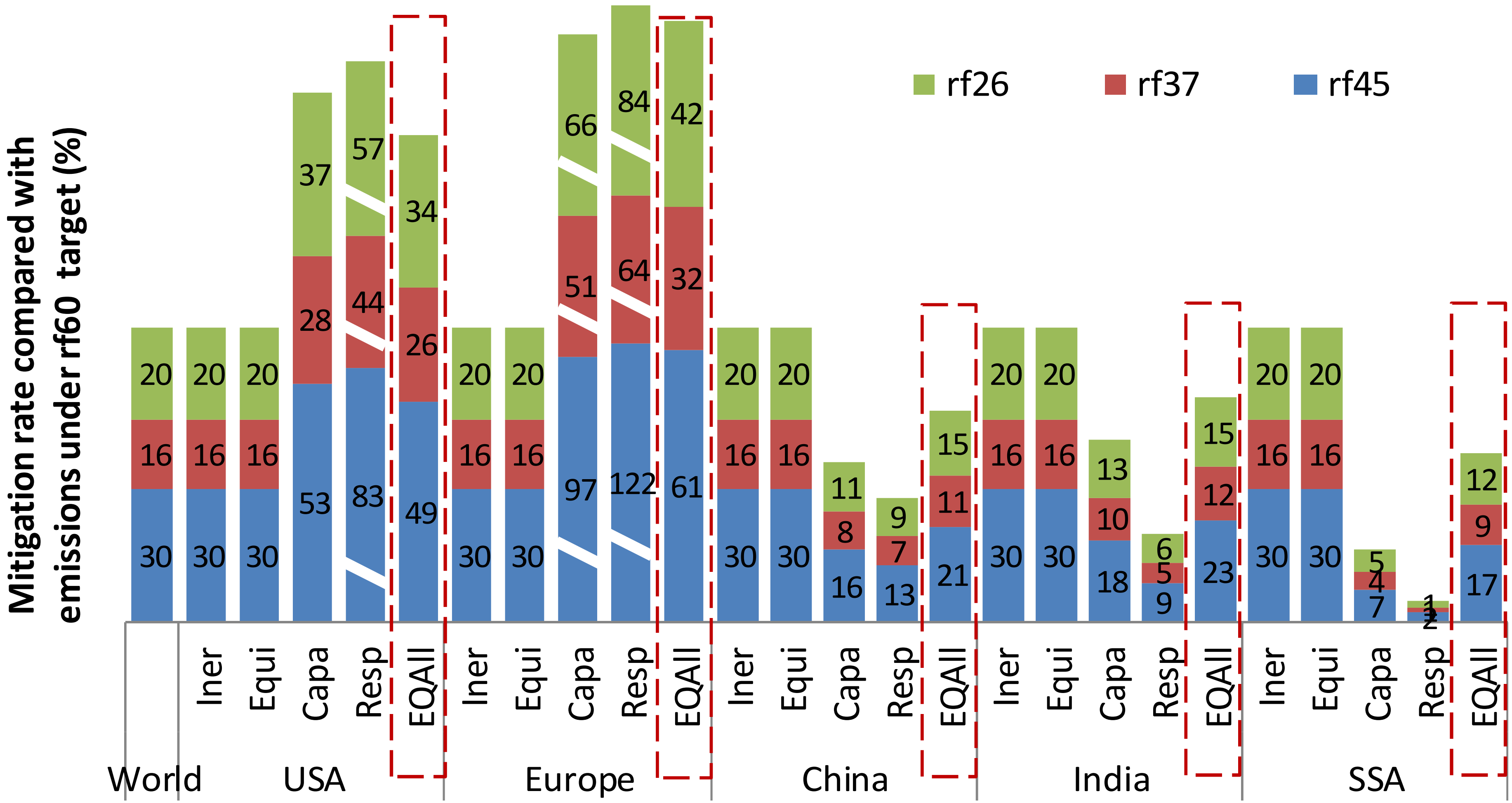


Stringency of climate targets



Stringency of climate targets

- Additional mitigation when the stringency of climate targets increases:
  - All regions need to mitigate more at the same factor as the world under RS
  - Developed regions should mitigate much more under BS



Measurement of principles:
from Static to Dynamic

Static

$$S_n^{iner} = \frac{e_{t0,n}}{\sum_n e_{t0,n}} = \frac{e_n^0}{E^0}$$

$$S_n^{equi} = \frac{p_{t0,n}}{\sum_n p_{t0,n}} = \frac{p_n^0}{P^0}$$

$$S_n^{capa} = \frac{g_{t0,n}}{\sum_n g_{t0,n}} = \frac{g_n^0}{G^0}$$

$$S_n^{resp} = \frac{h_{t0,n}}{\sum_n h_{t0,n}} = \frac{h_n^0}{H^0}$$

Dynamic

$$S_{t,n}^{iner} = \frac{e_{t,n}}{\sum_n e_{t,n}} = \frac{e_{t,n}}{E_t}$$

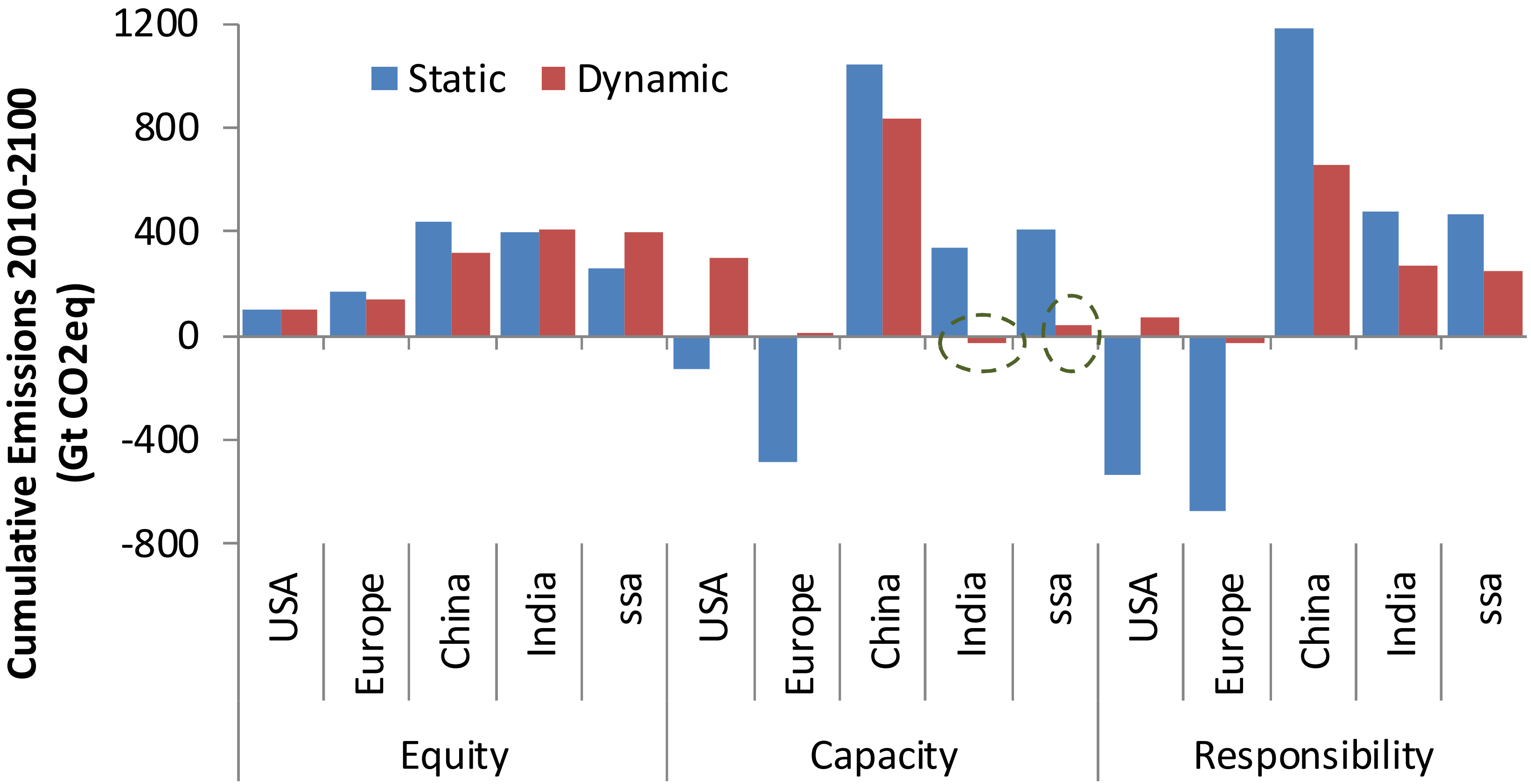
$$S_{t,n}^{equi} = \frac{p_{t,n}}{\sum_n p_{t,n}} = \frac{p_{t,n}}{P_t}$$

$$S_{t,n}^{capa} = \frac{g_{t-1,n}}{\sum_n g_{t-1,n}} = \frac{g_{t-1,n}}{G_{t-1}}$$

$$S_{t,n}^{resp} = \frac{h_{t,n}}{\sum_n h_{t,n}} = \frac{h_n^0 + \sum_t e_{t-1,n}}{H^0 + \sum_t E_{t-1,n}}$$

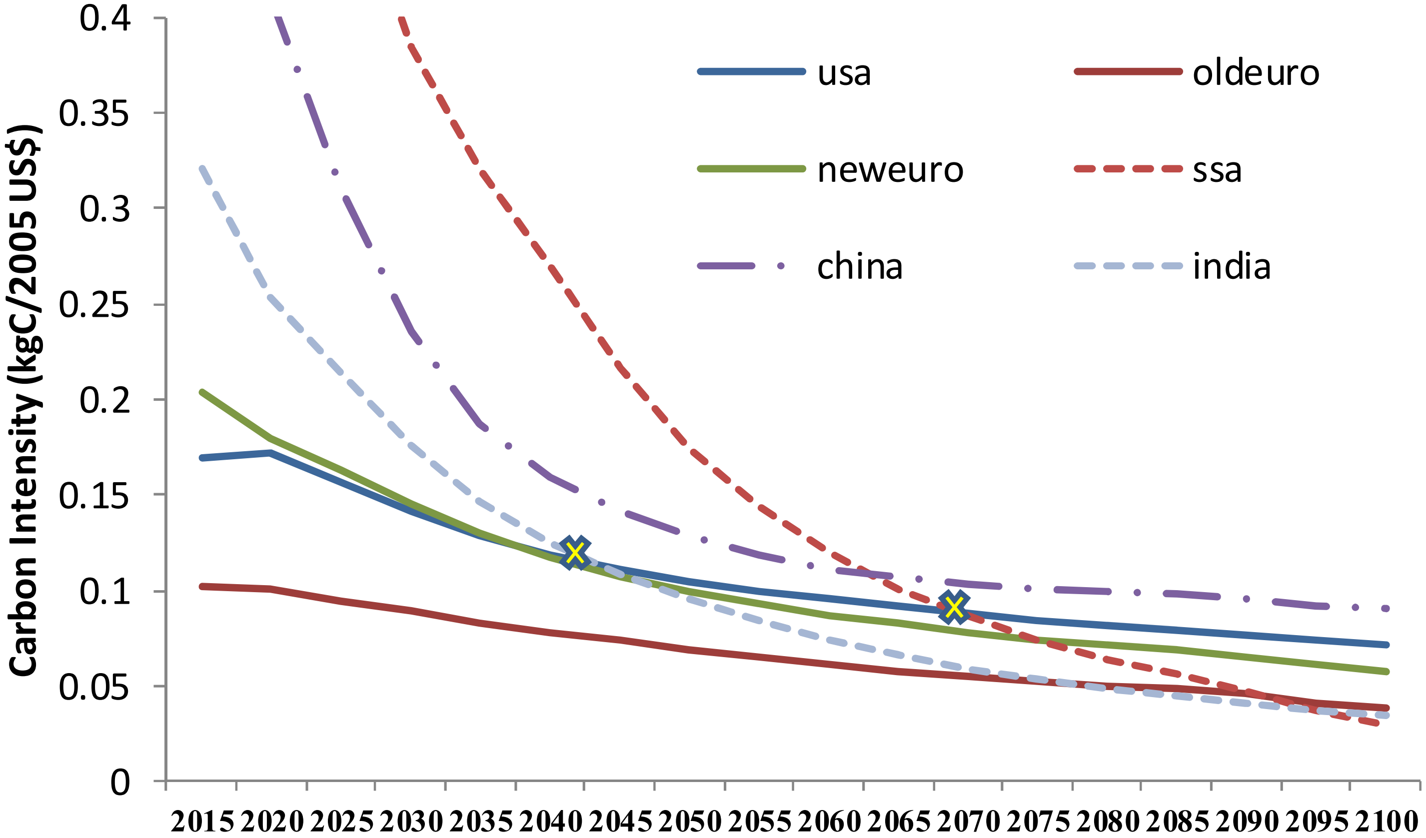
Static VS Dynamic

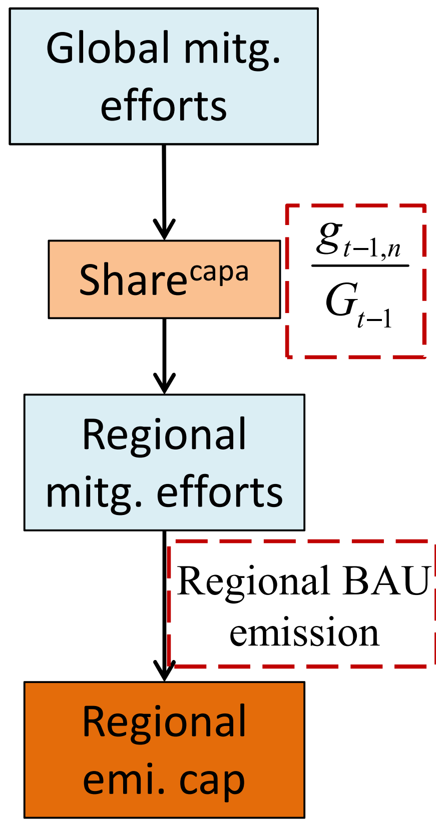
- Equi: regions with higher population growth rate will have more emission permits
- Resp: more convergent results
- Capa: US and EU better off, India and SSA worse off largely



BAU emission assumption matters

- Very optimistic assumption on carbon intensity decrease of India and SSA





Conclusion

- Time frame of peaking
  - RS: all regions are at the same pace with global emission change
  - BS: vary largely among regions
- Cumulative emission permits
  - Developing countries have much more permits under BS
  - Developed countries have negative permits under BS
- Regional emission permits
  - strongly determined by global climate targets
- Additional mitigation with climate target stringency increase:
  - All regions need to mitigate more at the same factor as the world under RS
  - Developed regions should mitigate much more under BS
- Dynamic measurement of principles has large impacts on allocation results

Future work

- Sensitivity analysis using No Policy emissions from other IAMs
- Monetary flow analysis based on WITCH and other IAMs
- Assessment of regional distribution of mitigation cost based on IAMs

Thanks!

xueqincui@gmail.com