Interaction among climate policies: The case of emission trading and feed-in tariffs

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Preamble

Policy and target coherency and interaction is one of my major interests

Objective of today's presentation:

Lin, W., Gu, A., WANG, X., Liu, B., 2015. Aligning emissions trading and feed-in tariffs in China,

Climate Policy, DOI: 10.1080/14693062.2015.1011599

Similar paper on climate targets' interaction:

- Exploring linkages among China's 2030 climate targets" published online at CPJ, 11 Jan., 2016. Co-authored with **Shuwei ZHANG**

  DOI: 10.1080/14693062.2015.1124752

Background (factual)

- Implementation of Feed-in Tariffs (FIT) at national wide for wind and solar power in China
  - Wind (onshore): August 2009-now: 0.51, 0.54, 0.58 and 0.61 yuan/kWh by regions.
  - Solar: July 2011- Aug. 2013, 1.15 yuan/kWh and 1.10 yuan/kWh; Aug. 2013 – 2016: 0.9, 0.95 and 1.0 yuan/kWh by regions.
  - Further adjustment on FIT in 2016: 0.47-0.44, 0.50-0.47, 0.54-0.51, 0.60-0.58Yuan/kWh for from 2016-2018 for wind; 0.80, 0.88, 0.98Yuan/kWh from 2016 for solar power.

- Implementation of 7 pilot carbon markets (ETS) in 2013 at local level with naitonal ETS to come into force by 2017.

This links to an EU debate on instrument coherency

- Environmental economic assessment in general is single-target or single-instrument based.

- Yet, the lack of efficient design and coordination between carbon pricing and subsidies can lead to cost-inefficiency in the climate policy package.

- E.g. the introduction of REN target (with FITs)
  - Accelerated the deployment and development of REN in Europe
  - But also entailed unwanted price reduction on the EUA of the EU ETS

Ref: Guerin & Spencer, (2011); Rathmann (2007)

Theoratical thinking

My initial concept:

After the introduction of an ETS, the carbon price generated by the ETS can interact with REN policies and lead to welfare impacts.

Some theoretical basis:

- when a pollution externality is accompanied by knowledge spillovers (REN), an optimal policy mix is pricing the pollutant with subsidies (FITs) to support the development of clean technologies

- Ref: Bennear & Stavins, 2007; Jaffe, Newell, & Stavins, 2005; Lehmann & Gawel, 2013

A possible scenario of wind-fall profit

The fact: final consumer bares the burden of supporting FIT policlies in China

- Power producers who benefit from REN FITs could build more REN installations and sell related CO2 emissions quotas on the carbon market.

- FITs already cover the external cost of REN development (if we assume so), the carbon revenue generated by selling CO2 quotas is therefore a windfall profit for power generators.

- This is a distortion of the allocation of the costs of emissions reductions (against consumers) and produces cost inefficiency in the marke-based climate policy package…

Central question

How FIT on REN should be adjusted once a national carbon market is in place?

Proxy used: equivalent carbon price that ETS and FIT generate

Without questioning the optimal level of this equivalent

Assessment framework

- Determine implicit carbon price from FITs
  - Assumption: it equals to the extra costs (CO2-related externality) for REN development in China

$$\mathrm{FIT}^{i}_{\mathrm{REN},t} - \mathrm{FIT}^{i}_{\mathrm{C},t} = eP^{i}_{\mathrm{CO_2},t}(E^{i}_{\mathrm{Baseline}} - E^{i}_{\mathrm{REN}}) \qquad (1)$$

$$E^{i}_{\mathrm{Baseline}} = \beta_i \times M_{\mathrm{C}} \times \theta \times \gamma_{\mathrm{CO_2}} \qquad (2)$$

Assessment framework

- Demonstrating the changes of FIT levels once ETS is introduced at national level
  - Assumption: linear annual increase (10,30,50%) in carbon price of ETS

$$\mathrm{FIT}^{i}_{\mathrm{REN},t_1}(1+r_{\mathrm{REN}})^{t_2-t_1} - \mathrm{FIT}^{i}_{\mathrm{C},t_1}(1+r_{\mathrm{C}})^{t_2-t_1} = eP^{i}_{\mathrm{CO_2},t_2}(E^{i}_{\mathrm{Baseline}} - E^{i}_{\mathrm{REN}}) \tag{3}$$

$$\mathrm{FIT}^{i}_{\mathrm{REN},t_2} = (eP^{i}_{\mathrm{CO_2},t_2} - P_{\mathrm{CO_2},t_2}) \times (E^{i}_{\mathrm{Baseline}} - E^{i}_{\mathrm{REN}}) + \mathrm{FIT}^{i}_{\mathrm{C},t_1}(1+r_{\mathrm{C}})^{t_2-t_1} \tag{4}$$

$$R_{\mathrm{FIT}} = 1 - \sqrt[t_2-t_1]{\frac{\mathrm{FIT}^{i}_{\mathrm{REN},t_2}}{\mathrm{FIT}^{i}_{\mathrm{REN},t_1}}} \tag{5}$$

Articulation of (some) assumptions

- The cost of wind and solar energy would fall annually by 2% and 7%, respectively (World Bank, 2011; Xie, Gao, & Han, 2009). As the FIT is obtained based on the REN investment return and per unit REN electricity generation cost, it is assumed that FIT levels for wind and solar will also fall annually by 2% and 7% from 2015 onwards.

- LINK: China actually adjusted the FIT levels in 2016 for wind and solar power.

- Installers of wind and solar power are supposed to participate in ETSs. This is generally the case in China, where major wind and solar power developers are electricity production groups.

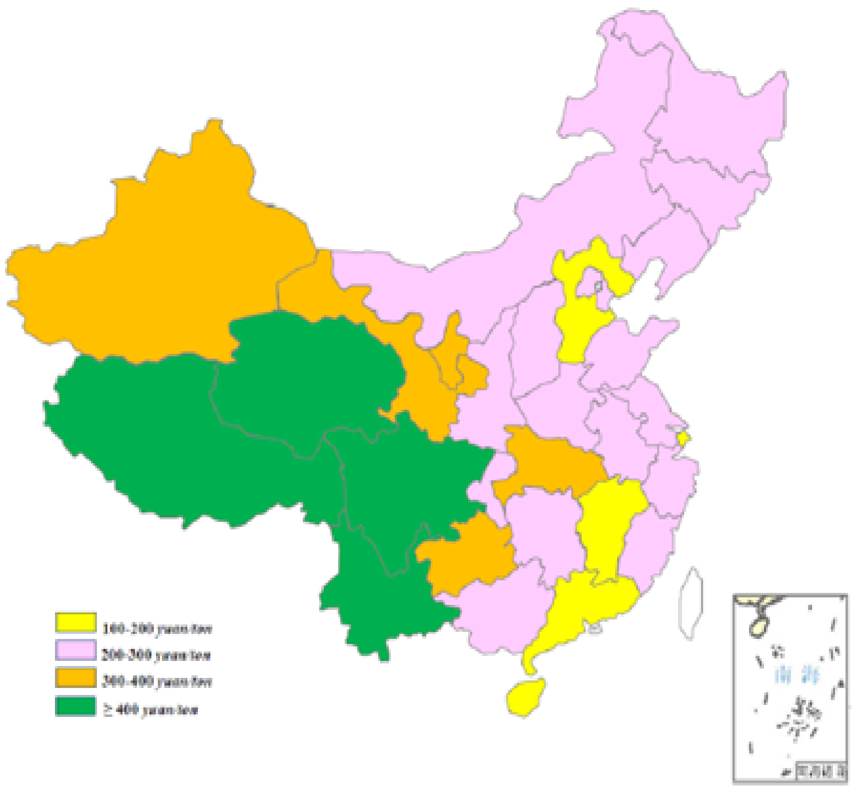
With related data as follows

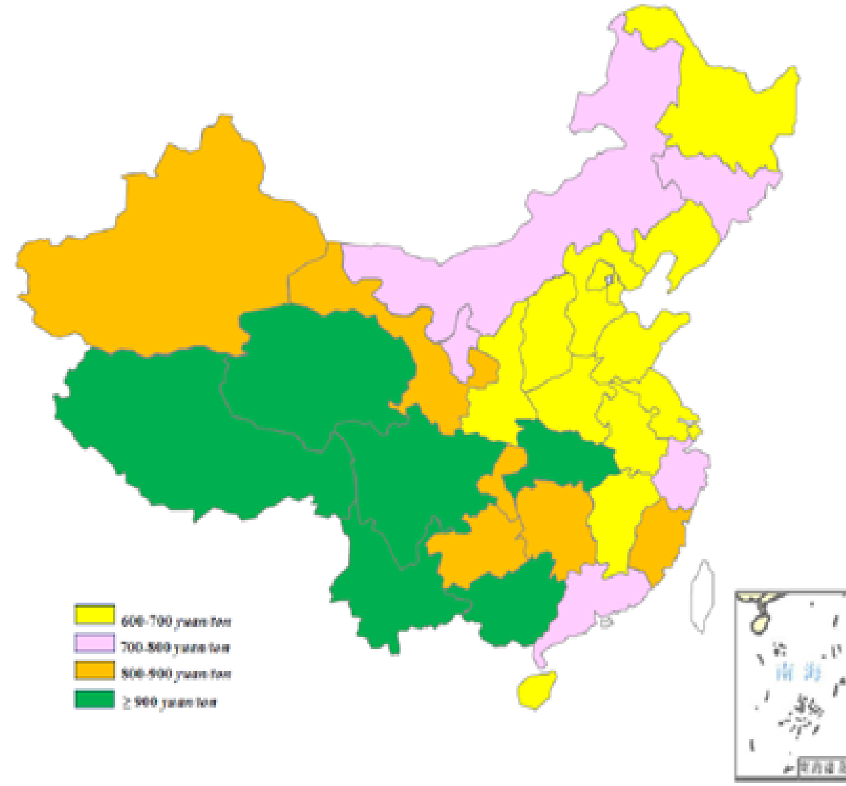
Parameter	Value	Source
FITRENi FITCi	Vary in different provinces (see Annex I)	NDRC, www.ndrc.gov.cn
MC	330 g/kwh	Annual Report of China Electricity Generation 2011 (National Energy Administration)
θ	0.725 kg/kg	IPCC (2006);
$\gamma CO2$	3.667	
rREN	-2% for wind -7% for solar PV	World Bank (2011) Xie et al. (2009)
rC	2.3%	Li and Wang (2011)

Scenarios setting

Scenario	CO_2 price 2018 (yuan/ton)	CO_2 price 2020 (yuan/ton)	Average annual growth rate (%)
S1:	40	48.4	10%
S2:	40	67.6	30%
S3:	40	90.0	50%

Result 1: Equivalent CO_2 prices for wind (left) and solar power (right)





- Wind: 191 yuan/tCO2 in Hebei to 1523 yuan/tCO2 in Qinghai province
- Solar: 626 yuan/tCO2 in Shanghai to 3477 yuan/tCO2 in Qinghai, with an average level of 860 yuan/tCO2.

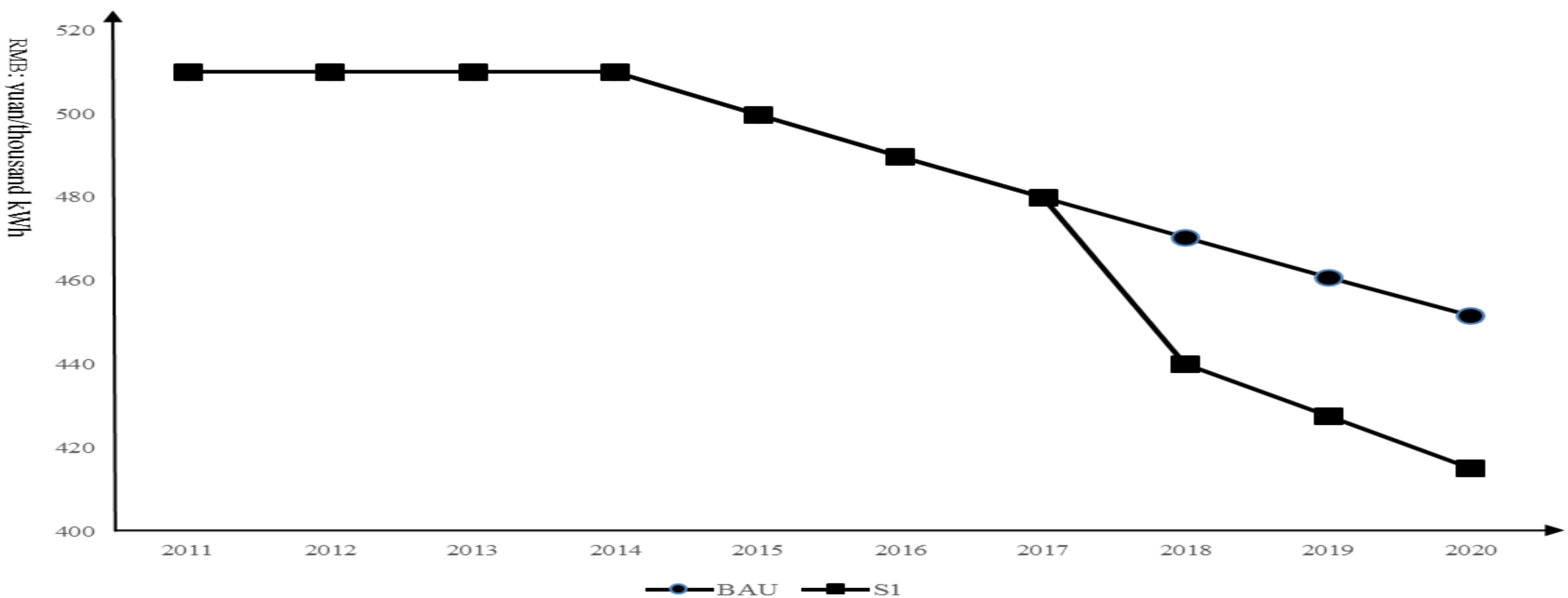
- Higher implicit carbon price indicates higher cost of development.
- **Necessity of keeping FIT** policy with ETS, since much higher implicit carbon price than ETS quota price.

Data: pilot ETS trading by end 2015

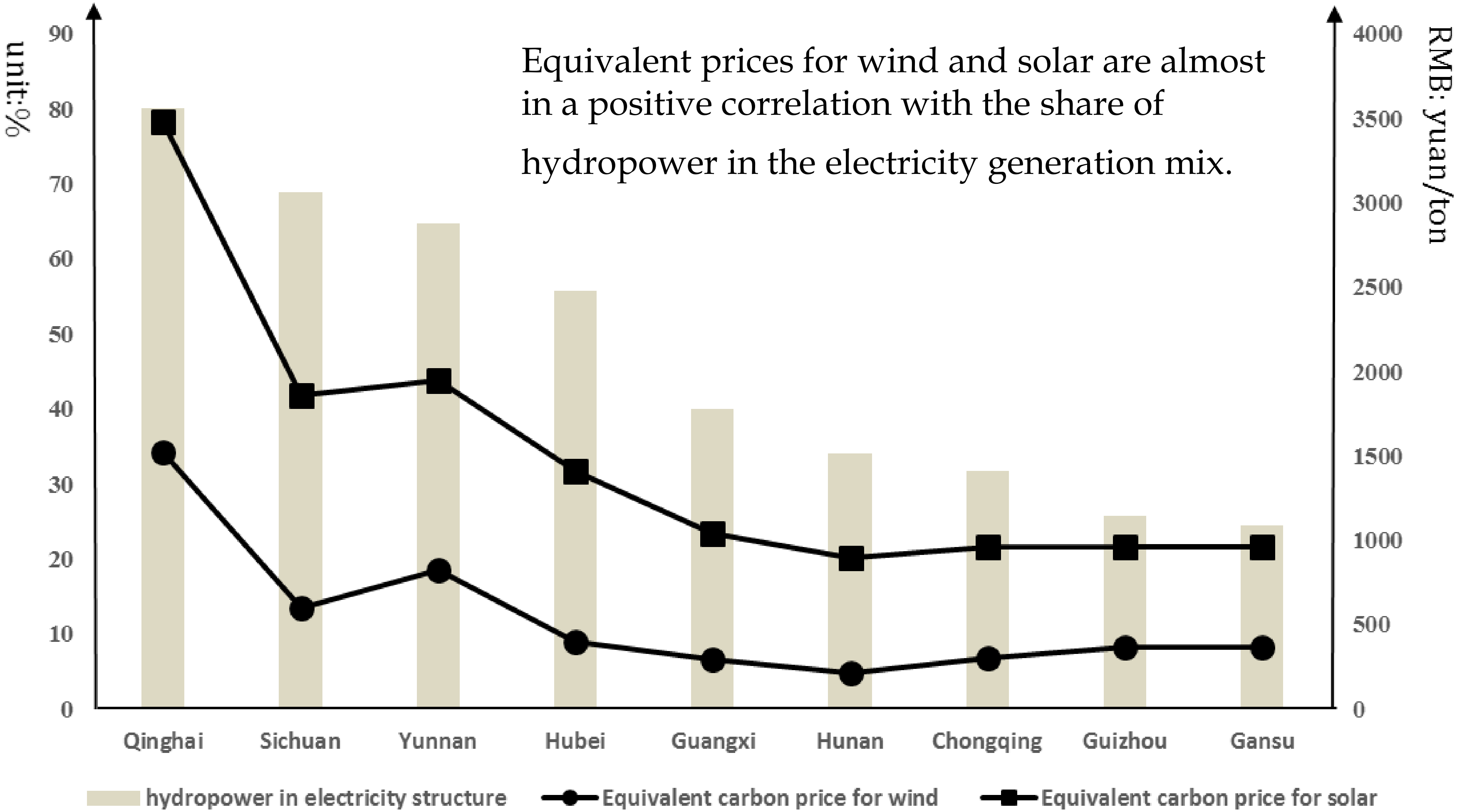
	Beijing	Tianjin	Shanghai	Shenzhen	Guangdong	Hubei	Chongqing
Accumulated amount (10ktCO2e)	531.9	204.9	493.7	653.7	834.6	2295	27.7
Accumulated amount (100MnYuan)	2.38	0.36	1.37	2.98	1.87	5.6	0.07
Average quota price (Yuan/tCO2e)	44.7	17.6	27.7	45.6	22.4	24.4	25.3

Result 2. FIT adjustment rates under ETS

	Wind power (%)				Solar power (%)		
Regions	I	II	III	IV	I	II	III
BAU	3.00				7.00		
S1	3.40	3.30	3.15	3.19	8.01	7.46	7.94
S2	3.99	3.84	3.63	3.69	8.43	7.65	8.33
S3	4.70	4.49	4.20	4.28	8.93	7.87	8.79



Discussion 1. hydropower and equivalent CO_2 price in 2011



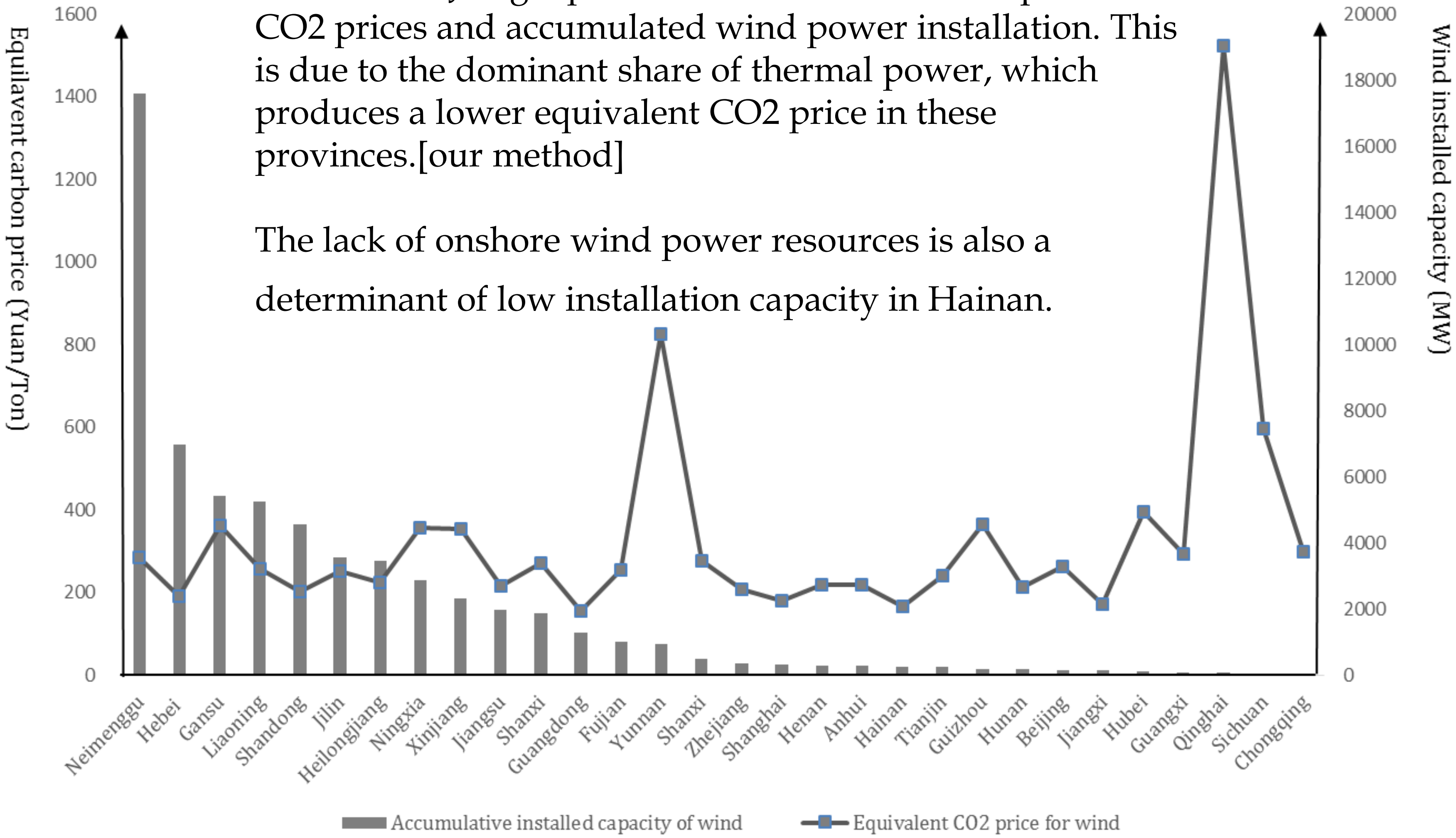
Regions with comparative advantages in hydropower tend to provide more support for hydropower, with limited budgets and administrative capacities, this could increase the cost of developing other REN. [But also due to the design of our method]

One exception: Yunan, lower on-grid conventional elec price is the major explanation.

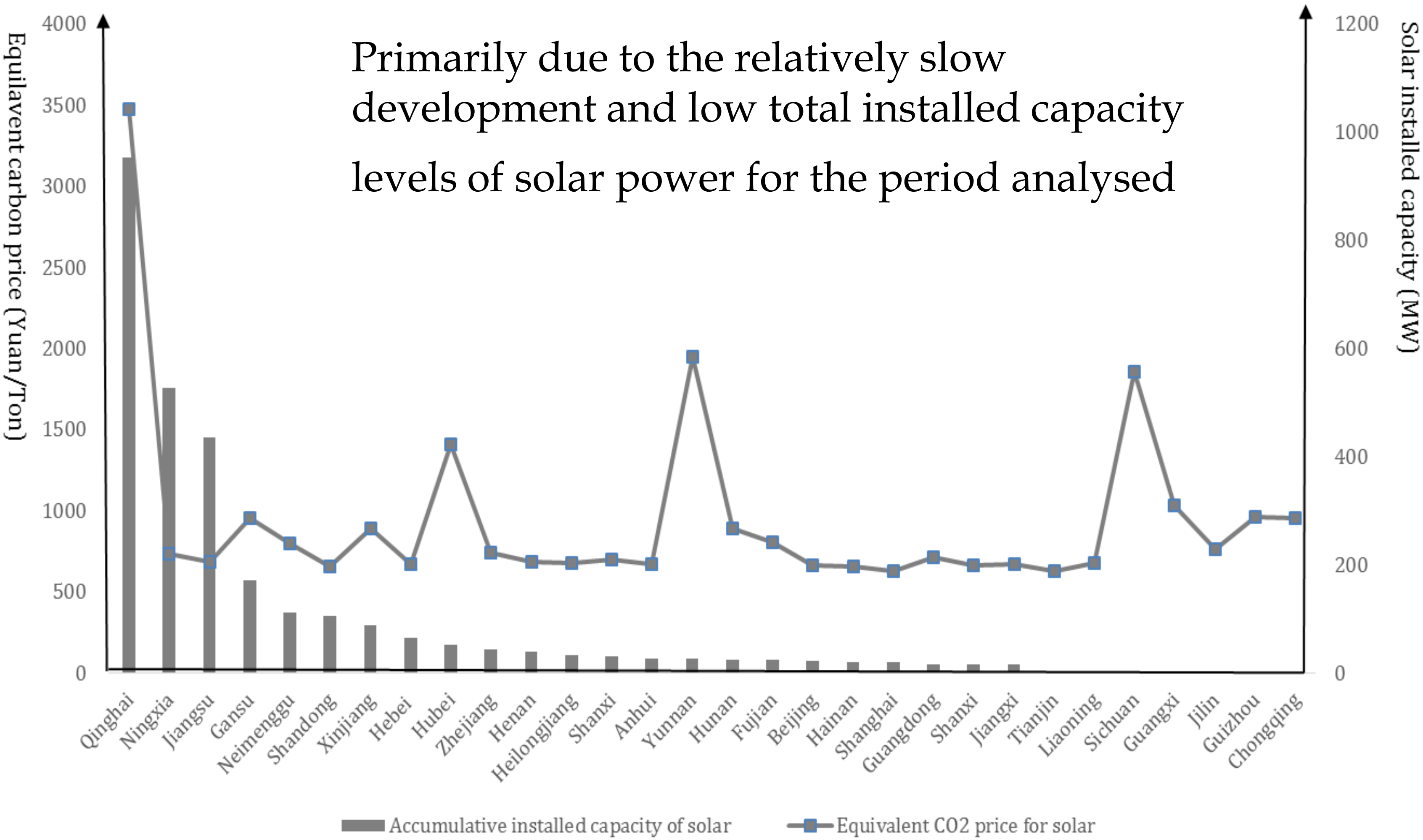
Discussion 2: equivalent carbon prices for wind are generally in a slightly negative correlation with installed capacity

Explanation for some exceptions:
Hainan and Jiangxi provinces both have lower equivalent CO2 prices and accumulated wind power installation. This is due to the dominant share of thermal power, which produces a lower equivalent CO2 price in these provinces.[our method]

The lack of onshore wind power resources is also a determinant of low installation capacity in Hainan.



Discussion 3: for solar power, no evident correlation between the equivalent CO2 price and installed capacity at provincial level.



Conclusion

If REN FIT is adjusted (decrease) by the government for cost reason, after the introduction and ETS, the FIT must also be further adjusted for such a reason.

Carbon price in ETS may actually vary (increase, decrease, constant as taken in our study), FIT level adjust can take the annual/periodical average of carbon price change in ETS.

Further need to determine optimal equivalent carbon price level (FIT+ETS)