PRICING CARBON IN AN EMERGING ECONOMY: THE ROAD TO PARIS FOR CHILE

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CERDI-Clermont-Ferrand, France, October 8, 2014

Outline

1. Some background information
2. Actions taken by the government so far
3. The recently approved CO_2 tax: 5 US$/ton; its political economy and its costs
4. How does Chile's CO_2 tax compare to carbon-pricing initiatives around the globe?
5. Moving forward: implementing cap-and-trade and linking to international markets
6. What to do with the transportation sector (my current research)?

I. Brackground information

Population 2013: 17 million

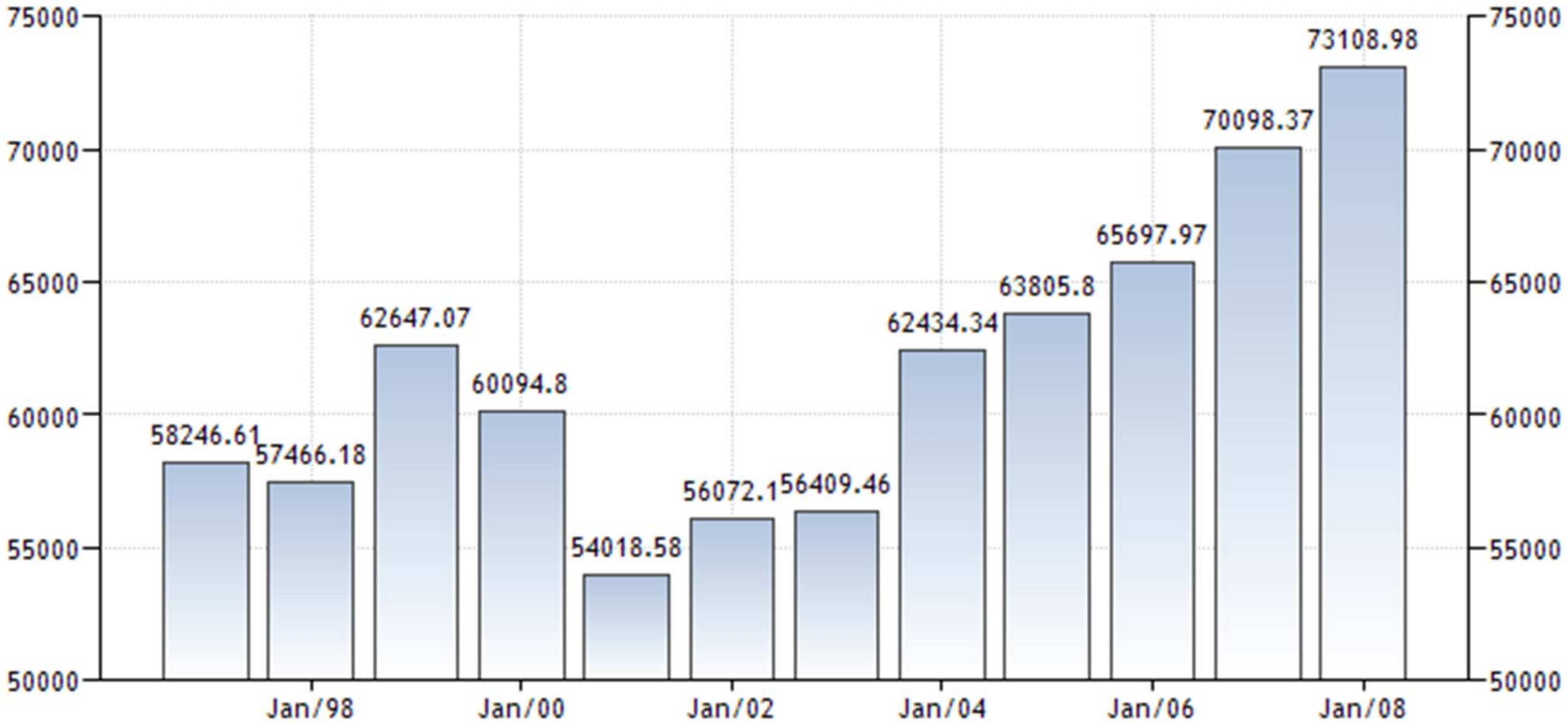
GDP 2013: 277 billion US$

GDP per capita 2013: 19,100 US$ (PPP) (15,800 nominal)

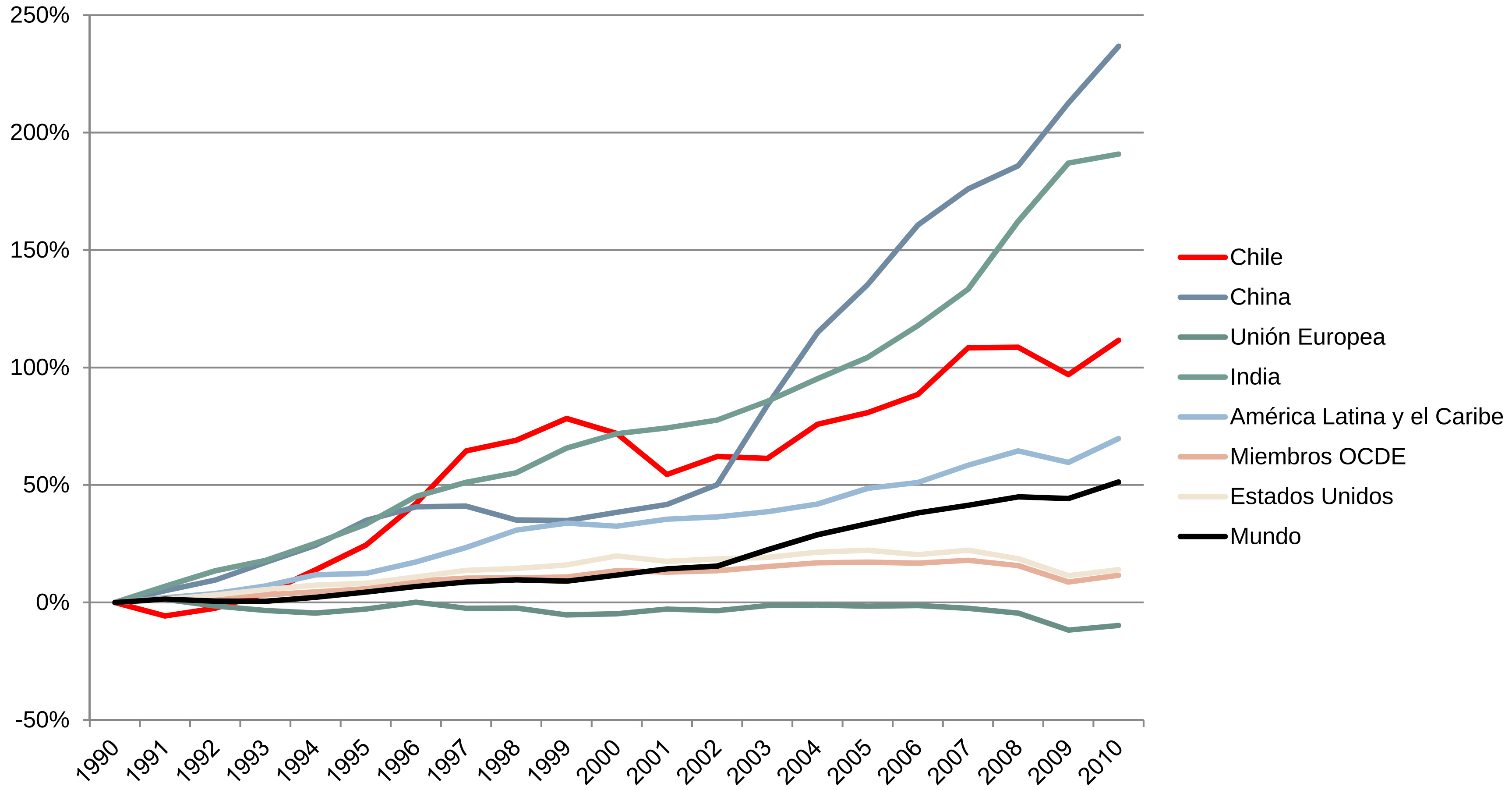
CO_2 in 2011: 80.1 million ton

and growing….(73.9 in 2009)

Evolution of CO2 (kilo tons)



Growth rate of CO2 emissions



Source: Own using data from World Bank

II. Chile’s climate policies

1. Voluntary 20/20 abatemente agreement
    1. reduce 20% of GHGs by 2020 using 2007 to project baseline
    2. announced in December 2009
    3. internally “adopted” in May 2010
2. Substantial participation in Clean Development Mechanism
3. Most important, CO_2 tax

Unexpected increase of renewables

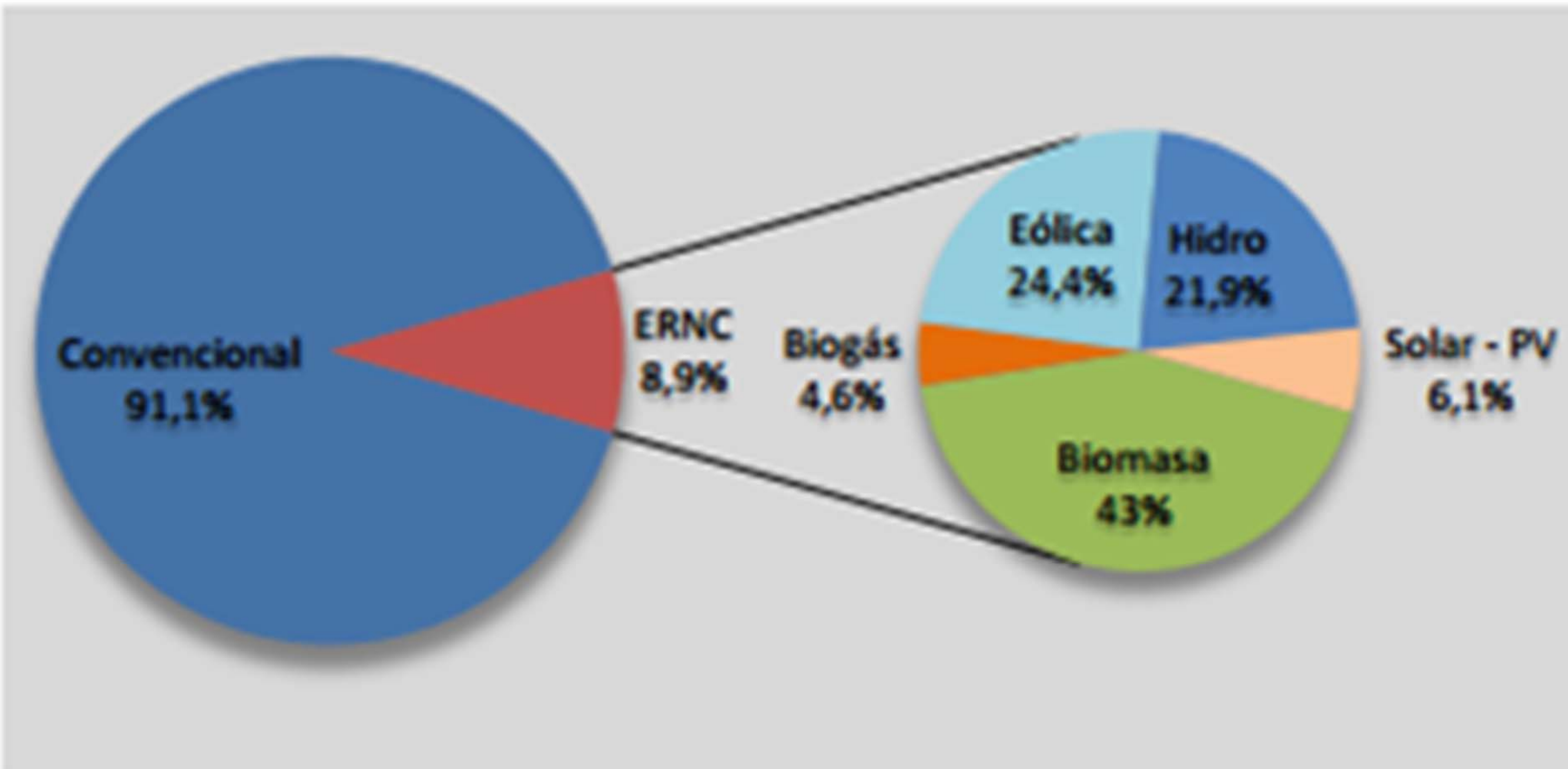
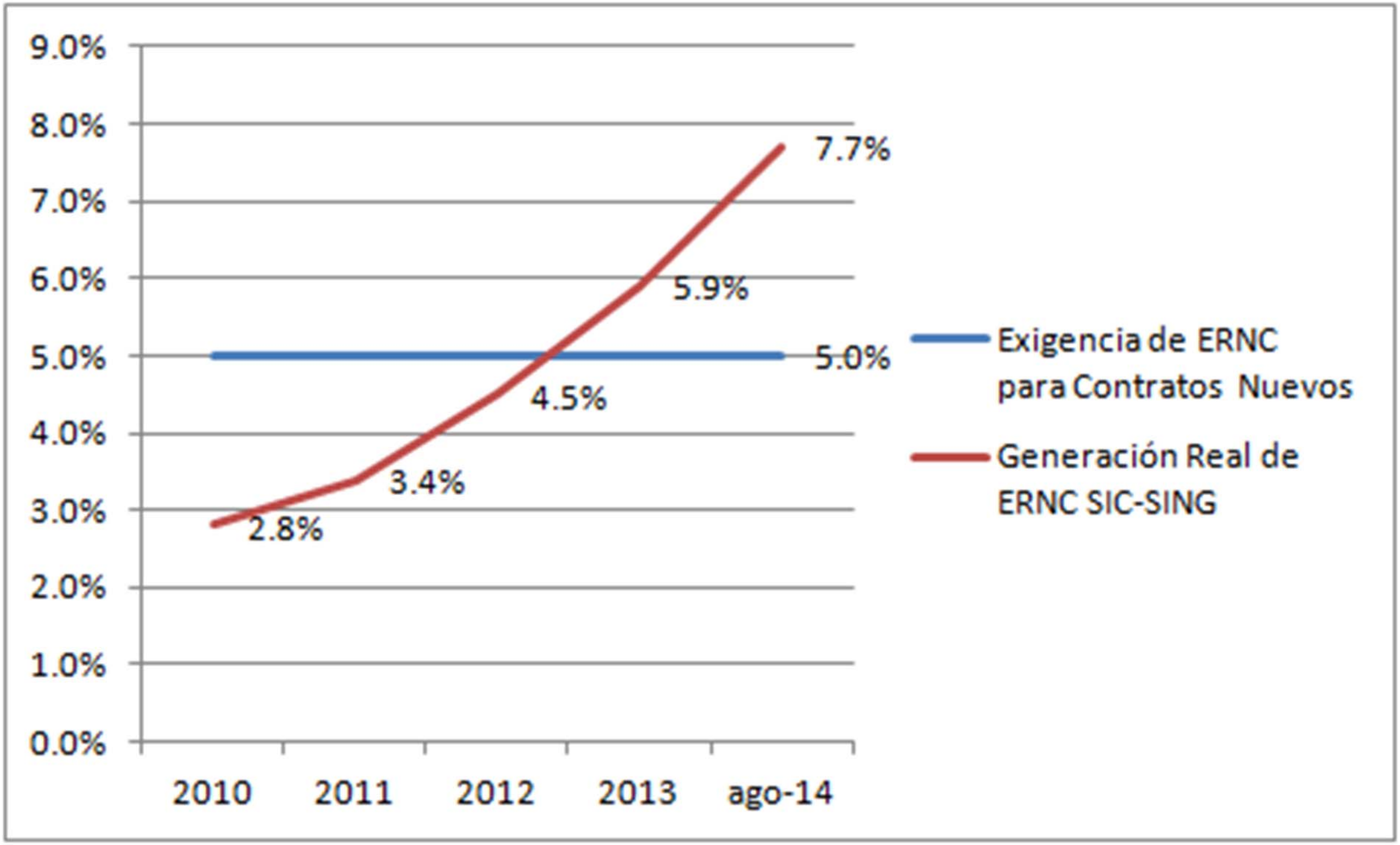


Figura 4 – Generación ERNC 2014. Fuente: CER, CNE, CDEC. Agosto 2014.

Law 20.257for the promotion of renewable not binding



Intensive use of CDM (additionality an issue?)

Tipología	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Reforestation	1				1			1				3
Biomass		2	2		1	2		2	1	1		11
Fuel switching	1							1	1			3
Methane capture	3			**10**	3	3	2	2	1			24
Co-generación	1											1
Self-generation								2				2
Wind generation					1		1	5		**11**		18
Methane reduction										2		2
Biogas generation										2		2
Geo generation										1		1
Hydro generation	1	1	2	3	3	3		**9**	5	**15**		42
N2O					1			1	1			3
Management activities										**11**	1	12
Methane recovery			3	1			1					5
Fertilizer mangement									2			2
Solar								1		**6**		7
Transporte								1				1
Total per year	7	3	7	14	10	8	5	28	11	49	1	139

Chile ranks 6th in CDM credits

CDM Credits by country	Million Credits	% of total
China	784.6	61.8%
India	170.9	13.5%
South Korea	107.1	8.4%
Brazil	81.9	6.4%
Mexico	20.3	1.6%
Chile	13.9	1.1%
Argentina	13.3	1.0%
Egypt	10.0	0.8%
Vietnam	8.0	0.6%

Source: AND-Chile, may 2013; using information from CDM Pipeline, may 2013.

III. The 5 US$/ton CO_2 tax

1. what is it? what does it cover?
2. established along with other (local) pollution taxes: PM2.5, NOx & SOx
3. its political economy
4. its costs and benefits (and its impact on CO_2 emissions)

What is the CO2 tax doing?

- Proposed in March 2014 by the new President and signed into law in September 2014
- It applies to power plants and large industrial facilities (greater than 50 MW) starting in 2018
- It covers roughly 55% of the country’s CO_2 emissions
  - 90% of CO_2 from power plants (84 out of 154)
  - 70% of CO_2 from industrial sources (233/6678)
  - Transportation (≈30%) is not affected
- the law also considers taxes for three local pollutants (PM2.5, SOx, NOx) applied to the same sources

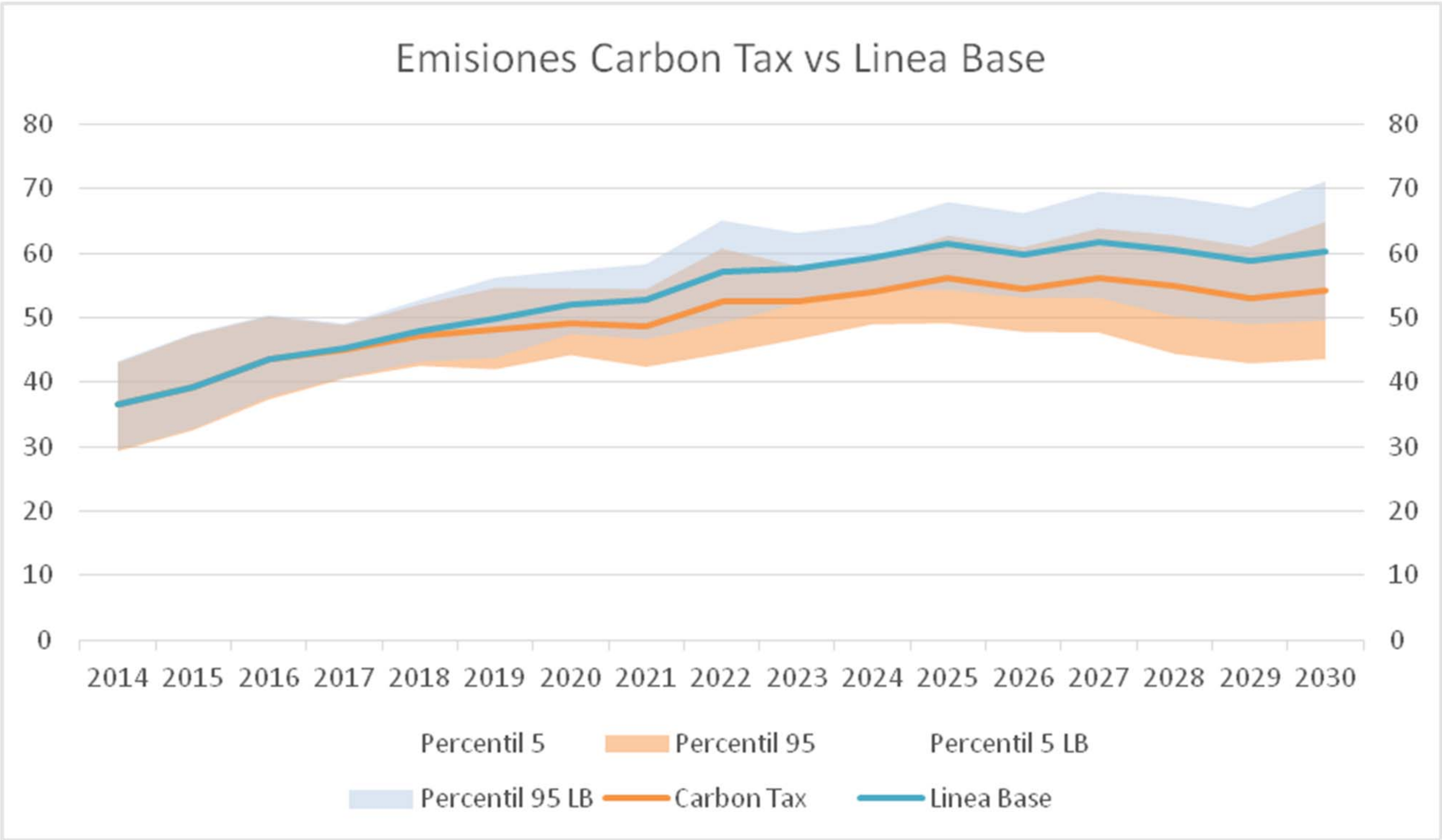
Political economy of Chile's green taxes

- the CO_2 tax is expected to raise US$ 425 million/year (roughly evenly split between industry and power sectors)
- the other local taxes are expected (according to a CGC-UC calculation) to raise another US$ 1192 million/year
- these taxes were NOT proposed and debated in isolation
- rather, were part of a comprehensive tax reform package (increasing corporate taxes mainly) aiming at collecting an additional 3% of GDP (US$ 8 billion/year)
- Very unlikely that any of these "green" taxes would have been pushed and approved in isolation
- (Mexico's CO_2 tax of 3 US$/ton, approved in Jan 2014, followed similar path)

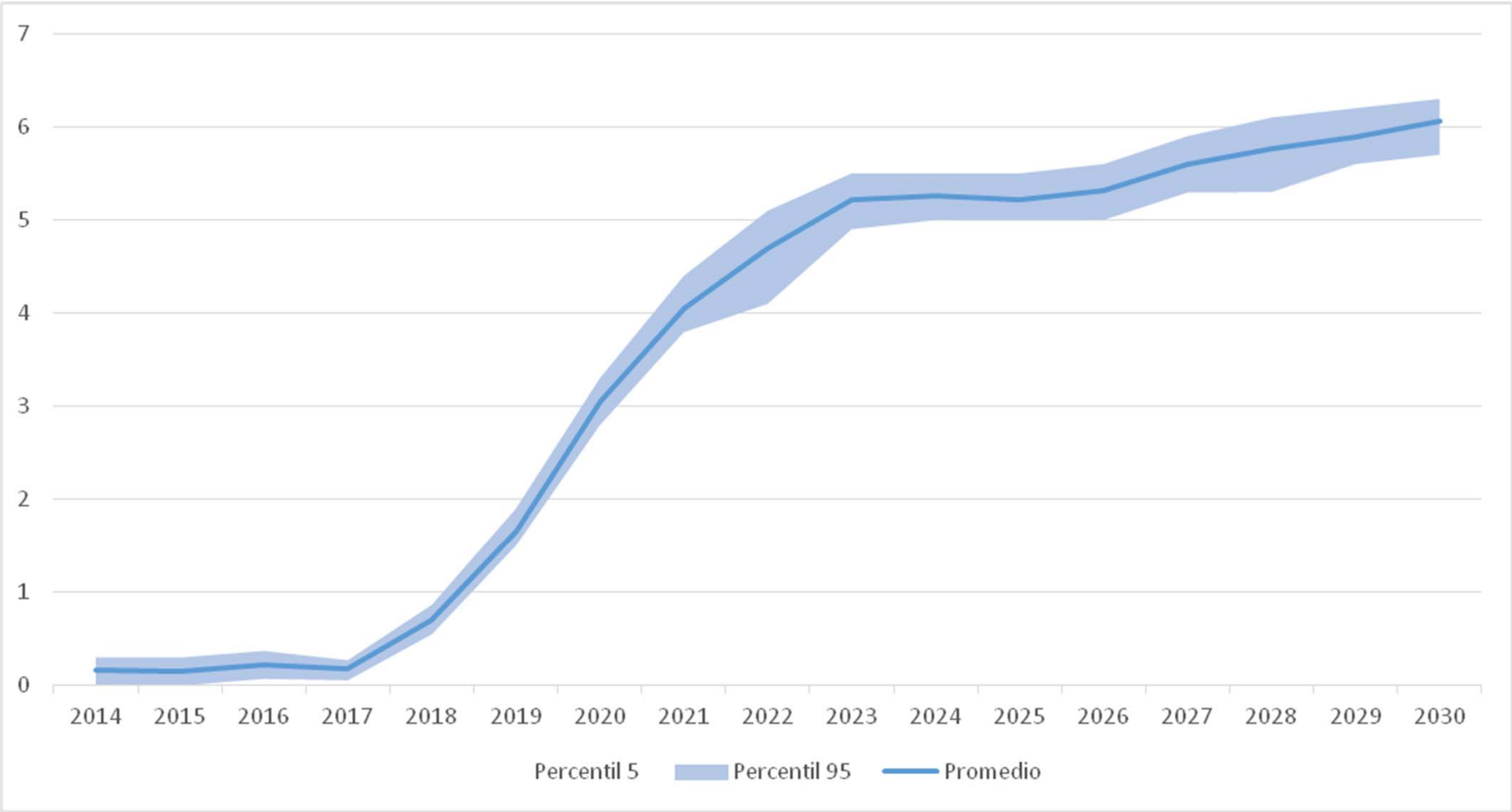
Costs and benefits of the CO2 tax (besides the extra revenues)

- Major benefit: build the institutions that will be required as we engage in more ambitious mitigation efforts over the next decade
  - monitoring, compliance
  - bring reductions from transportation and forestry sectors with offsets
- the cost for the power sector in terms of higher retail prices: 2% by 2030 (estimation CGC-UC)
- Impact on CO2 emissions and on renewables?

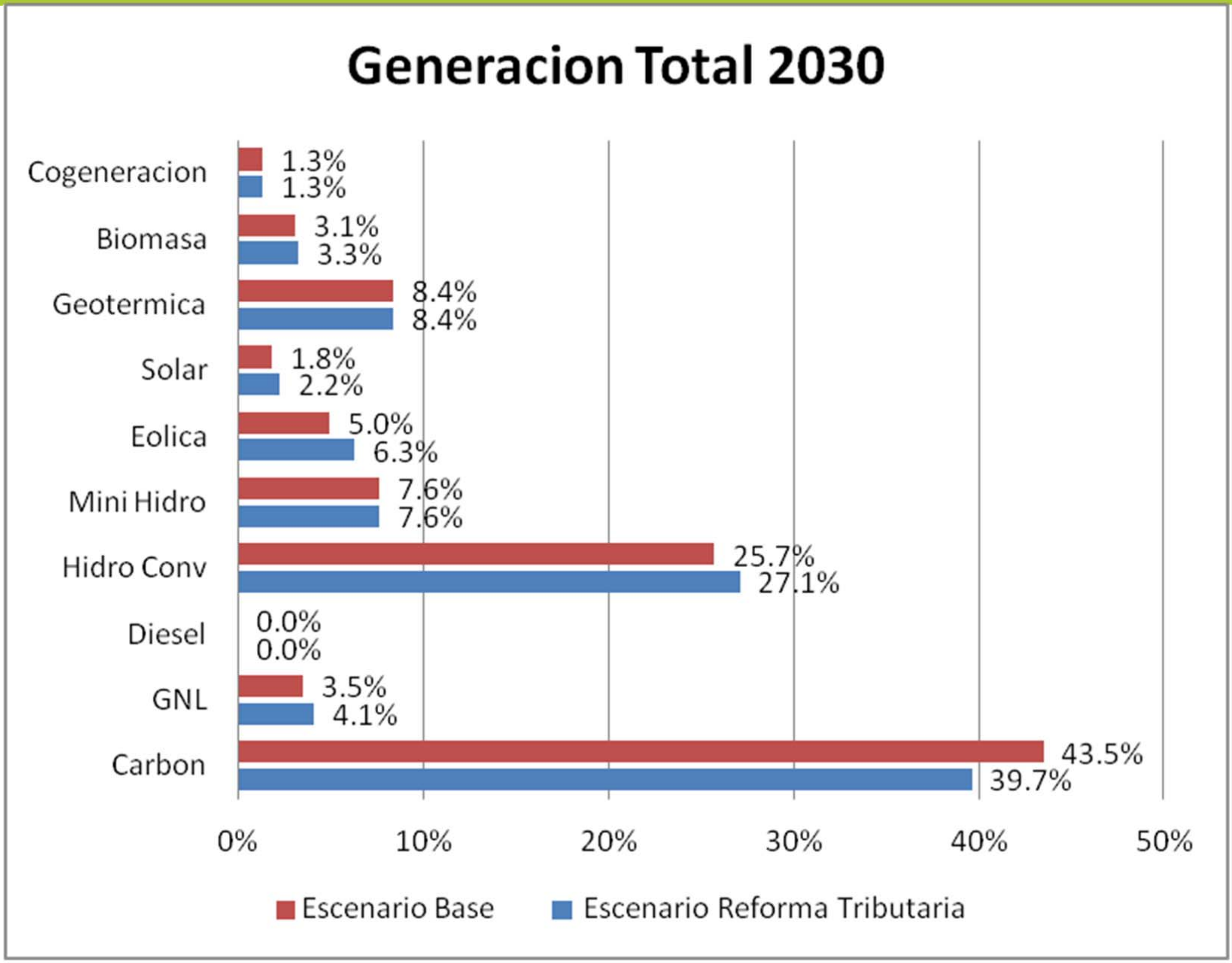
Evolution of CO2 emissions power sector: BAU v. 5 dollar tax



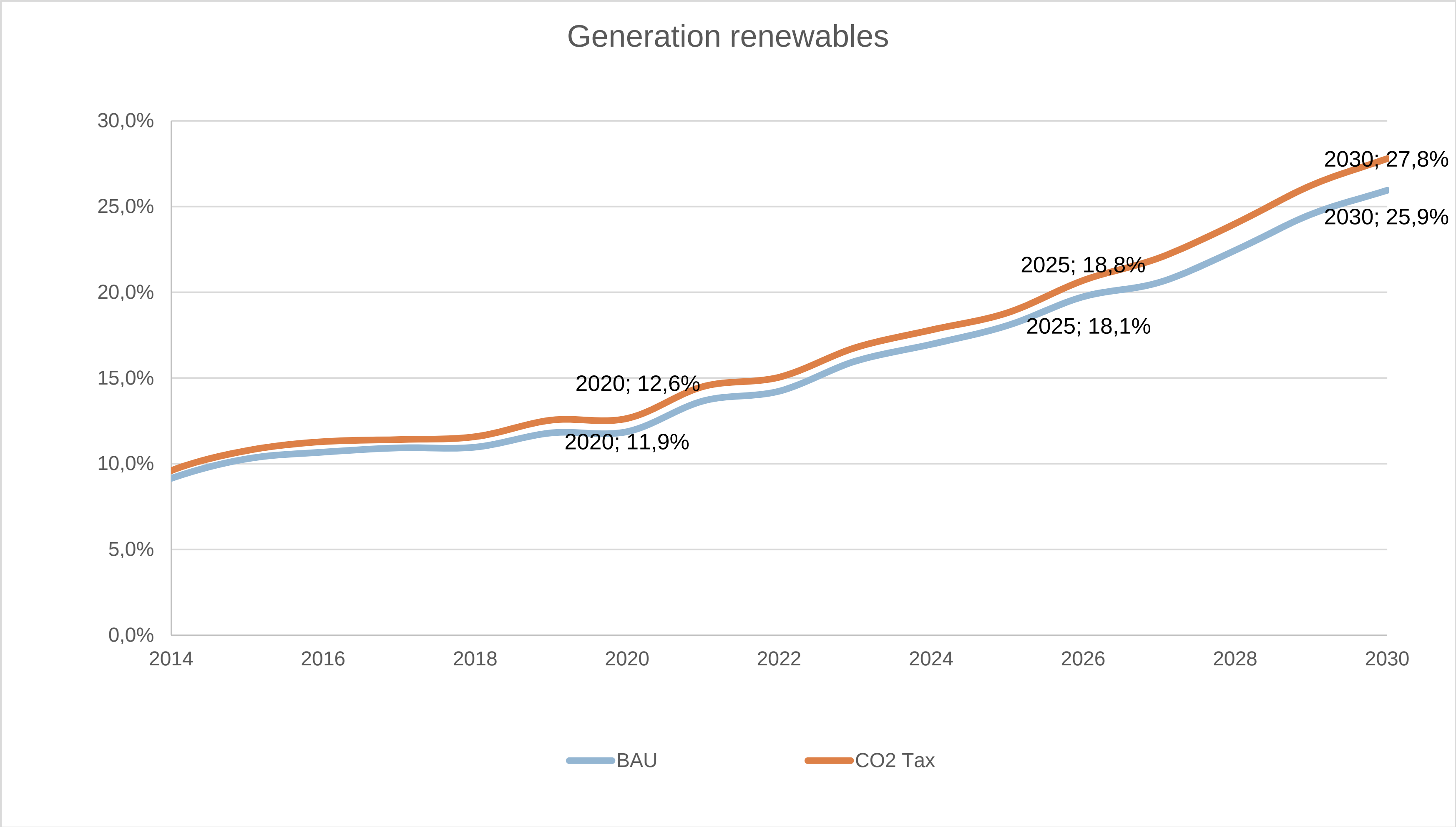
CO2 abatement: 10% by 2030



Power generation in 2030: BAU v. 5 dollar tax



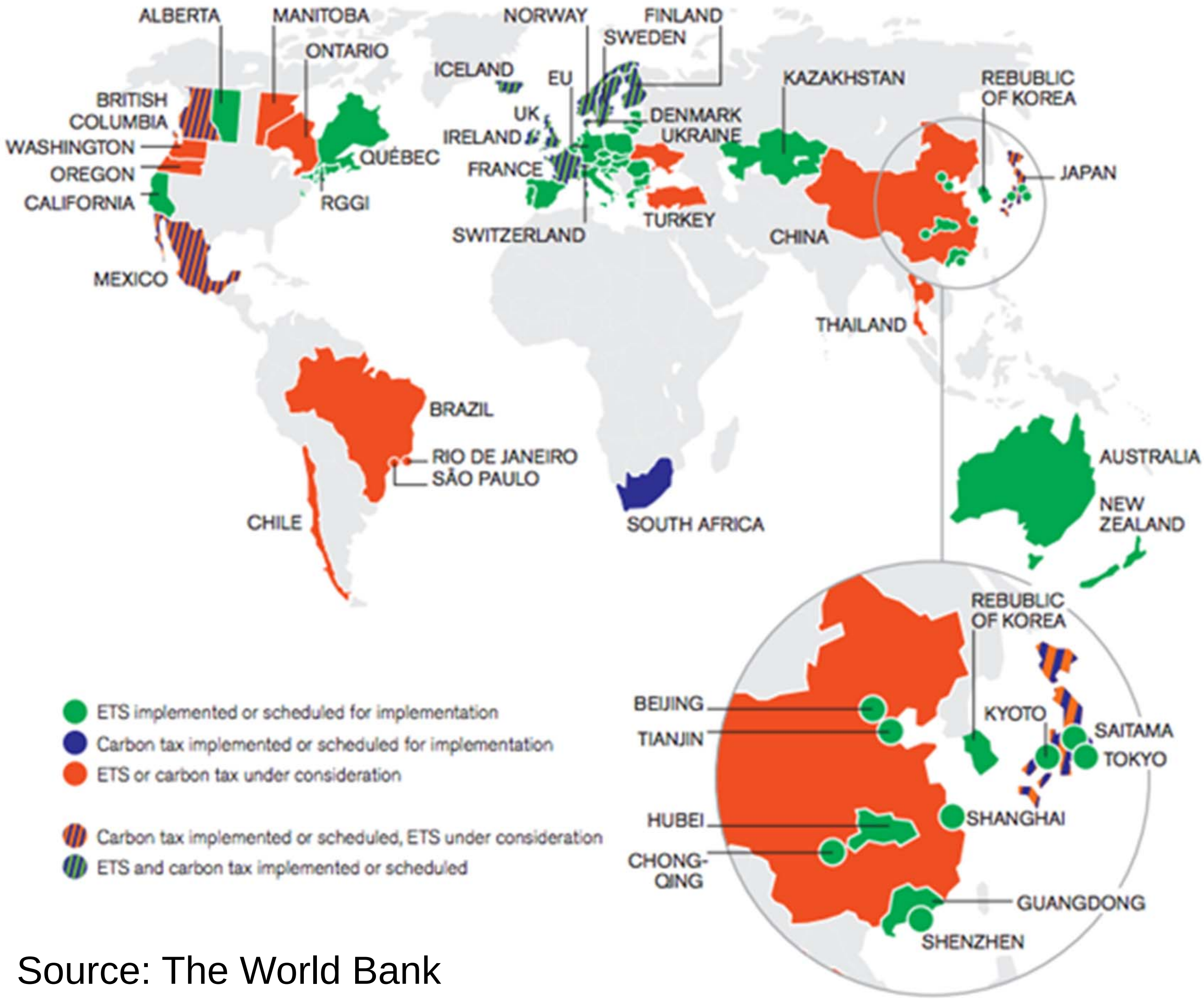
Impact on renewables



IV. Comparing to other carbon-pricing initiatives

1. To cap-and-trade systems (EU ETS, New Zealand, RGGI, California-Quebec, China 7 cities, etc)
2. To other tax systems (Mexico, Sweden)

Figure 1 Summary map of existing, emerging, and potential regional, national and sub-national carbon pricing instruments (ETS and tax)



Source: The World Bank

V. Moving forward

1. Why is important to move to a country-wide CO_2 cap-and-trade system?
2. Quantity limits at the country level; not CDM
3. Linking to international markets
4. Chile has ample experience with markets of property rights for managing natural resources (particulates, water rights, fishing quotas)
5. Already complete report to the World Bank (lead by Suzi Kerr from Motu-New Zealand) on setting-up cap-and-trade in Chile

We need to move to quantity limits at the country level

- Negotiating prices vs negotiating quotas
- Quotas superior for many reasons (despite Weitzman 2014):
  - It is easier for a country to undo the (marginal) workings of a tax (with internal policies that are not visible)
  - easier to monitor emissions at the country level (GDP, fuel mix, etc)
  - Linking easier among quantity-based regimes
  - How can a developing country sell credits in the international market when is using a country-wide tax?
  - It must necessarily have negotiated quota limits
- Nevertheless, taxes are good to start with (Australia)

Chile’s experience with quota markets

- Water markets; introduced in 1981
  - 100% "grandfathering”
  - quite successful in valleys in the central district; less so in northern and southern districts
- ITQ for fisheries introduced in 2001
  - came to replace the previous Olympic race that only set the total catch; large cost savings as a result
  - 100% grandfathering; a legal reform of January 2013 preserved ITQs
- Market for particulates in Santiago in 1992
  - based on an executive order (didn't require Congress approval)
  - 100% grandfathering

VI. Transportation sector

1. What to do with it? Offsets? Upstream regulation
2. Why not driving restrictions? incentives for a faster fleet turnover

Adopting a cleaner technology: The effect of driving restrictions on fleet turnover

Work in Progress

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driving restrictions are popular

- Driving restrictions —basically you cannot drive your car once a week— are increasingly popular for fighting congestion and (local) air pollution
- they come in different formats but all based on last digit of vehicles' license plates: some are permanent once-a-week restrictions, others work only in days of bad pollution or once a week but only during rush hours, others exempt cleaner cars from it, etc.
- why so popular? they are politically visible and relatively easy to enforce
- Cities that have or had in place driving restriction policies (in its different formats): Santiago (1986), Mexico-City (1989), São Paulo (1996), Bogotá (1998), Medellín (2005), San José (2005), Beijing (2008), Tianjin (2008), Quito (2010), Paris (March 2014)

Driving Restrictions

some unfortunate evidence on how these restrictions work

- A few papers looking at the Mexico-City restriction (Hoy-No-Circula) as implemented in 1989
  - Eskeland and Feyzioglu (WB Econ R, 1997): more cars on the road and higher gasoline consumption in the long run
  - Davis (JPE 2008): applying RDD to hourly pollution data found no effect in the short run; and also more cars in the long run
  - Gallego-Montero-Salas (JPubE 2013): looking at carbon monoxide during morning peak hours (90% comes from vehicles unlike other pollutants) found (i) a 10% reduction in the short run but a 13% increase in the long run (after a year) and (ii) great disparity in policy responses among income groups
- Also looking at the evolution of pollution data, Lin et al (2013) failed to find air quality improvements from restrictions elsewhere: Bogotá, São Paulo and Tianjin (they found some for Beijing)

this paper: driving restrictions may accelerate the introduction of cleaner cars

- there is an important long-run effect in some driving restrictions that has not been studied
- by only placing a restriction on old-polluting cars, they may help accelerate both the introduction of cleaner cars and the retirement of older cars
- the city of Santiago reformed its existing driving restriction policy in 1992 (Mexico-City in 1994) so that any new car was
  - required to be equipped with a catalytic converter (a device that reduces pollution considerably, specially lead)
  - and exempted from any driving restriction
- how did it work? not obvious for two reasons
  - there are two forces operating: some may bypass the restriction buying a new, cleaner car (sooner than otherwise), yet others may buy a second older car like in Hoy-No-Circula (which now can be even cheaper)
  - local vs global emissions (CO vs CO2)

the Santiago driving restriction

- 1985: prohibition to the import of used cars into the country
- 1986: driving restriction is introduced in the city of Santiago; but only for days of unusually bad air quality
- 1990: the restriction becomes, for practical purposes, permanent from April to October; 20% of the fleet off the road during weekdays
- **1992: cars that passed a new environmental standard (catalytic converter) would get a green sticker**
  - **new cars bought in 1993 and after without the green sticker are not allowed to circulate in Santiago's Metropolitan Region and neighboring Regions V and VI (see map)**
  - **a car with a green sticker is exempt from any driving restriction**

Santiago vs the rest of the country

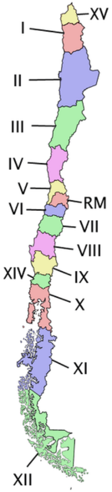

Figure: Chilean Map

Table: Some statistics of Chile and Santiago

	Chile	RM	Santiago
Population	16,926,084	6,891,011	5,015,070
Average income	\$ 241,339	\$ 292,498	\$ 331,673
# of cars*	2,162,308	994,723	797,046
cars* *p.p.*	12.75%	14.44%	15.89%

(∗) counting only particular light cars

Figure: South America

our data

- our main database consists of a panel of 323 counties/municipalities and 7 years (2006-2012) with detailed information on fleet evolution (number of cars per vintage).

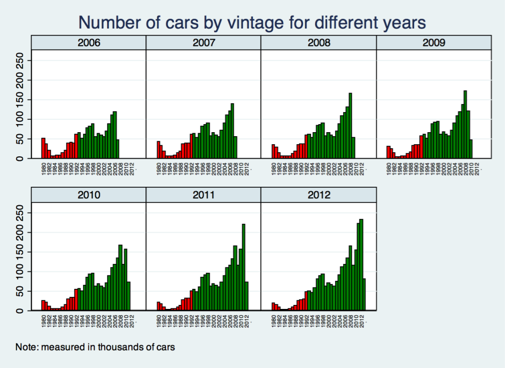

Figure: Evolution of the car fleet at the country level

Preliminary evidence: Santiago vs the rest of the country

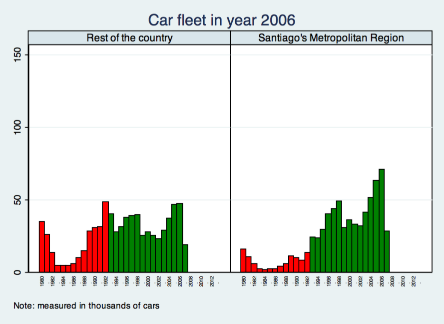

Figure: Fleet in 2006

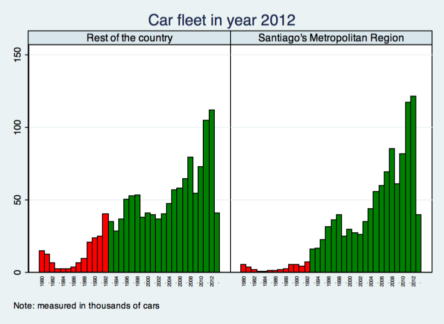

Figure: Fleet in 2012

- compelling evidence that the fleet in Santiago is cleaner than in the rest of the country
- but how much is explained by income? (Santiago is richer)

Santiago vs the rest of the country "controlling" for income

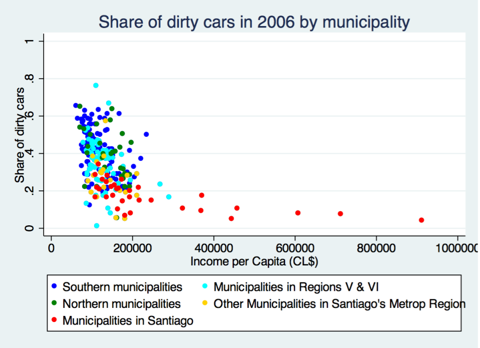

Figure: Red cars as function of income in 2006

- it seems that municipalities in Santiago (more than 30) have a smaller fraction of red cars (vintage 92 and older) in their fleets

controlling for income and used-car dynamics

- there may be different reasons behind the higher fleet turnover in Santiago
  - it could be the restriction policy
  - but also that a high turnover in high-income municipalites in Santiago results in a faster turnover in middle and low-income municipalities in the city (people get rid of a 92 car not because it is dirty but old)
- to test for this second possibility we look at the share of 92 and 93 cars, so let

$$92/93_{it} \equiv \frac{q_{1992}}{q_{1992} + q_{1993}}$$

be the 92/93 ratio in municipality i in sample year t

the 92/93 ratio: municipalities in Santiago vs the rest

- results supporting the policy effect look stronger now

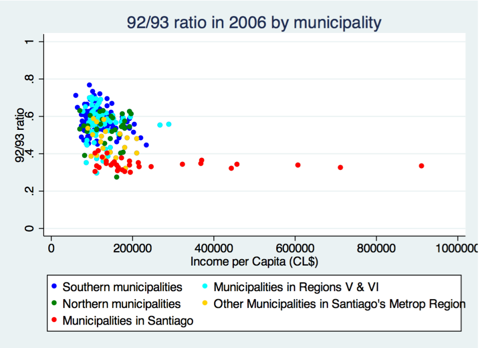

Figure: 92/93 ratio for sample 2006

more formally...

Table: OLS results for different adyacent-year ratios

	(1) 88-89	(2) 91-92	(3) 92-93	(4) 93-94	(5) 95-96
Santiago	0.0166	0.00166	-0.171***	-0.0183	-0.00646
	(0.014)	(0.013)	(0.018)	(0.015)	(0.012)
Population	-0.000208	0.00235	-0.00743	-0.00174	0.000280
	(0.005)	(0.004)	(0.006)	(0.005)	(0.004)
Income per capita	-0.00145	-0.00522	-0.00655	-0.00655	-0.0100*
	(0.005)	(0.005)	(0.006)	(0.005)	(0.004)
Distance to Santiago	-0.0626*	-0.0138	0.141***	0.0184	0.00601
	(0.026)	(0.024)	(0.033)	(0.027)	(0.022)
(Distance to Santiago)^2	0.0285	0.0200	-0.0906***	0.00330	0.00805
	(0.020)	(0.018)	(0.025)	(0.020)	(0.017)
Far away regions	0.0974**	-0.0451	0.00516	0.135***	0.0760**
	(0.034)	(0.031)	(0.043)	(0.035)	(0.029)
Income dispersion	0.00262	-0.000899	0.00143	-0.00741	0.00369
	(0.006)	(0.005)	(0.007)	(0.006)	(0.005)
North	0.0240*	0.0398***	-0.0277	0.0346**	-0.0250*
	(0.012)	(0.011)	(0.015)	(0.012)	(0.010)
Urbanization	-0.0485**	-0.0288	-0.00372	-0.00707	0.0108
	(0.017)	(0.015)	(0.021)	(0.017)	(0.014)
Constant	0.372***	0.413***	0.542***	0.559***	0.444***
	(0.014)	(0.013)	(0.018)	(0.015)	(0.012)
Observations	266	266	266	266	266
R^2	0.165	0.085	0.520	0.336	0.189

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Income per capita in hundreds of thousands of pesos.

Population in hundreds of thousands of persons.

Distance to Santiago in hundreds of kilometers.

Conclusions

- We find a great impact on the evolution of the car fleet as a result of the driving restriction policy implemented in Santiago.
- Older cars were exported from Santiago to the rest of the country, where local pollution is less of a problem (what about global pollution?)
- We built a theoretical model to better understand how different policies (different driving restrictions designs in particular) work and how close they can take us to the first best.
  - We still need to characterize the transition phase; since transitions are slow, it is important for welfare to get it right
  - We also need to better understand the trade-off between local and global pollution from moving cars from one region to another
- There is still a lot of work to be done