PLADIFES

INSTITUT Louis Bachelier LABS

DATA DESCRIPTION DOCUMENT: CARBON PRICING INDEX

09/08/2024

OVERVIEW

This project was initially part of the COGEM project, aiming at estimating GHG emissions from corporates using statistical algorithms. Literature on this subject (see [1] and [2]) used State and Trends of Carbon Pricing Dashboard to get relevant data to feed the model, especially on the existence of an Emission Trading System (ETS) or a carbon tax, and the carbon price(s) that could be associated to a given country.

Yet, it quickly appears that:

1. The data that can be downloaded from State and Trends of Carbon Pricing Dashboard is an Excel file with multiple sheets on several topics (Revenues, prices, carbon credits, etc.), that is usually not usable as this and thus require some preparation.
2. The data does not allow for an immediate comparison between countries. Indeed,
    a. Some countries have several pricing instruments (ETS and/or Carbon Tax), from different regional levels (subnational, national and supranational).
    b. Some instruments have their tied prices and/or covered emissions varying depending on the sector, the greenhouse gas, the fossil fuel...
    c. Some instruments are "too specific" and require the use of additional source.

Thus, the Pladifes Team considered there was value in **creating and sharing a preprocessed version** of the carbon pricing data, **focused on easing the countries comparison**. To this end, we developed a so-called ***carbon pricing index***, **derived for each couple (country, year) where the country has implemented a carbon pricing mechanism in the considered year**.

Please note that there could be a one year delay, explained by the fact that the carbon prices from the State and Trends of Carbon Pricing Dashboard are nominal prices as at April 1 of the relevant year. These are generally based on the exchange-traded, auction or government-set prices of April 1, or the most recent prices available. Thus, a country implementing a new instrument between April and December of year *n* would see it appear only in year *n+1*.

METHODOLOGY DESCRIPTION

Raw data

From State and Trends of Carbon Pricing Dashboard, one can download “data-latest.xlsx”, and Excel file with several sheets. We based our methodology on the “Compliance_Gen Info” and “Compliance_Price” sheets.

Moreover, some additional sources were used when necessary:

- European Environment Agency data [3,4] was used to determine national jurisdictions coverages for EU countries, for the EU ETS.
- Checks were made using OECD and UNFCCC data [5,6], which allowed for some outliers correction.
- National reports were also used to perform some corrections, for Norway for example [8,9].

- Countries with subnational carbon pricing instruments usually required a custom-made analysis, based on specific sources (see [10 to 16]).

Definition of the national Carbon Price Index (CPI)

For each country c, for each year t such that it exists at least one carbon pricing mechanism, we define the Carbon Pricing Index as follows:

$$CPI_{c,t} = \sum_{instruments} coverage_{instrument} \times carbon\_price_{instrument}$$

where *coverage* refers to the proportion of the total emissions of the country affected by the taxation and *carbon price* the price tied to the instruments, usually based on the prices on the first of April.

The narrative for such formula comes from the fact that a country is usually considered more stringent on carbon taxation if it has both a large amount of its emissions covered as well as a high enough price level. Compliance and compensation arrangements could also be considered but significantly increase the complexity of the calculations.

For subnational instruments on a given region, we use the following formula to derive the coverage:

$$coverage_{sub\_nat\_instrument} = coverage_{instrument} * \frac{total\_emissions_{region}}{total\_emissions_{country}}$$

so that the influence of a given mechanism will always be proportionate to the emissions of the region. This formula applies for both subnational ETS and carbon taxes.

Used choices/current limitations

For instruments that have several carbon prices, we use the "main" one, *ie*. the one corresponding to the largest volume of emissions in the jurisdiction. When prices vary depending on the greenhouse gases, the retained one is usually the CO2 one. When prices vary depending on the used fossil fuel, the retained one is the one tied to the fuel linked to the largest amount of emissions for the country/region.

Most coverages are considered constant through time due to lack of precise data. Yet, this source of variation is arguably limited for most instruments on the considered time range.

Different sources have been used and not all are based on the same year. Some inconsistencies have been detected (such as coverages summing to more than 100%) and external data have then been used to correct suspicious values.

Completion of the final Excel file

To allow for a better understanding of the methodology and the followed choices, the calculations are split into several sheets. The "final_sheet" corresponds to the preprocessed version of the data, "ready to use" by other users. All other sheets present intermediary data used to derive the carbon prices index. All sheets are inventoried in the section Dataset Variables.

Most carbon pricing indexes are based on sum products based on "jurisdictions_covered_XXX" and "carbon_price_XXX" sheets data, which are filled using mostly the raw "Compliance_Gen Info" for the coverages and "Compliance_Price" for the prices.

The only Supranational ETS is the EU one. It has a dedicated sheet for the country coverages calculation. Derived values are then copy pasted to the "jurisdictions_covered_SupETS" sheet.

USA, China, Canada, Mexico and Japan are dealt with in the "Federated cases" sheet.

If you notice a value you disagree with/have questions on, please feel free to contact us at pladifes@institutlouisbachelier.org. We thank you very much for your feedback! The Institut Louis Bachelier thanks Jérémy VILCOSQUI for his implication on this project.

DATASET VARIABLES

Final sheet

Variable/Variable type	Description	Unit	Missing values	Type
Country identifiers*	The name/identifier of the country, according to different sources/standards (ISO, Thomson Reuters, IEA…)	-	-	String or int
Region	The region that the country belongs to	-	-	string
EU list	A Boolean indicating countries covered by EU ETS	-	-	bool
CO2 law	A Boolean indicating countries having implemented at least one instrument	-	-	bool
Implemented mechanisms	The list of the implemented mechanisms, with “No” for countries without any	-	-	string
CO2 status	An indicator of the implementation status of the instrument(s): “Implemented" or “Under consideration”	-	77%	string
Start year	The year when the first data on an instrument is available	-	79%	int
Year*	A Boolean indicating if at least one instrument was implemented for year “year”. Years ranging from 1990 to 2024	-	-	bool
Carbon pricing index (year)*	The value of the carbon pricing index for year “year”. Years ranging from 2000 to 2023. Value is 0 by default	-	-	float64

* Elements with an asterisk are variable types, referring to several columns

Other sheets

Index	The carbon pricing index calculation based on the other sheets
Total Jurisdiction covered	The total percentage of the emissions covered by all instruments for a given country
Federated cases	A sheet dedicated to handling countries with sub national carbon pricing mechanisms (*ie.* USA, China, Canada, Mexico and Japan)
Jurisdiction covered NCT	The percentage of the emissions covered by National Carbon Taxes for a given jurisdiction
Jurisdiction covered NETS	The percentage of the emissions covered by National ETS for a given jurisdiction
Jurisdiction covered SupETS	The percentage of the emissions covered by Supranational ETS for a given jurisdiction
Carbon price NCT	The carbon prices tied to the National Carbon Taxes for a given jurisdiction (in US$/tCO2e)
Carbon price NETS	The carbon prices tied to the National ETS for a given jurisdiction (in US$/tCO2e)
Carbon price SupETS	The carbon prices tied to the Supranational ETS for a given jurisdiction (in US$/tCO2e)
EU calculations	The calculations for the EU coverages

REFERENCES

[1] Q. Nguyen, I. Diaz-Rainey, and D. Kuruppuarachchi, Predicting corporate carbon footprints for climate finance risk analyses: a machine learning approach, Energy Economics, 95 (2021), p. 105129.

[2] J. Assael, T. Heurtebize, L. Carlier, and F. Soupé, Greenhouse gases emissions: estimating corporate non-reported emissions using interpretable machine learning, Sustainability, 15 (2023), p. 3391.

[3] European Environment Agency, EEA greenhouse gases – data viewer, https://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer

[4] European Environment Agency, EU Emissions Trading Systems (ETS) data viewer, https://www.eea.europa.eu/data-and-maps/dashboards/emissions-trading-viewer-1

[5] OECD Data Explorer, Air emissions – Greenhouse gas emissions Inventories, https://data-explorer.oecd.org/vis?df[ds]=DisseminateFinalDMZ&df[id]=DSD_AIR_GHG%40DF_AIR_GHG&df[ag]=OECD.ENV.EPI&dq=.A.GHG.T_LULU%2B_T.T_CO2E&pd=2014%2C&to[TIME_PERIOD]=false&vw=tb

[6] UNFCCC reports for international data comparisons and validations, https://unfccc.int/es/topics/mitigation/workstreams/nationally-appropriate-mitigation-actions/national-reports

[7] Norwegian government, Notification – CO2 tax – exemption for undertakings covered by the ETS, https://www.regjeringen.no/en/dokumenter/notification-co2-tax-exemption-for-undertakings-covered-by-the-ets2/id3028459/#:~:text=In%202023%2C%2084%20%25%20of%20Norwegian,(EUR%20200)%20by%202030.

[8] Norwegian national report, https://www.regjeringen.no/en/dokumenter/notification-co2-tax-exemption-for-undertakings-covered-by-the-ets2/id3028459/#:~:text=In%202023%2C%2084%20%25%20of%20Norwegian,(EUR%20200)%20by%202030.

[9] ICAP, USA – Regional Greenhouse Gas Initiative (RGGI), https://icapcarbonaction.com/en/ets/usa-regional-greenhouse-gas-initiative-rggi#:~:text=RGGI%20covers%20power%20sector%20emissions,2020%20between%202021%20and%202030

[10] Belfer Center, High-resolution Carbon Emissions Data for Chinese Cities, https://www.belfercenter.org/sites/default/files/files/publication/Emissions%202018.pdf

[11] INECC (Instituto Nacional de Ecología y Cambio Climático) for regional GHG emissions data.

[12] INECC, Mexico ante el cambio climatico – INEGyGEI: for national environmental data, https://cambioclimatico.gob.mx/inventario-nacional-de-emisiones-de-gases-y-compuestos/

[13] Japan's Ministry of the Environment for national and regional GHG emissions, Japan's National Greenhouse Gas Emissions and Removals in Fiscal Year 2022 | Press Release | Ministry of the Environment, Government of Japan

[14] Tokyo Metropolitan Government for Tokyo's GHG emissions, Climate Change & Energy | Bureau of Environment | 東京都環境局 (tokyo.lg.jp)

[15] International Carbon Action Partnership – Saitama Target Emission Trading System, https://icapcarbonaction.com/en/ets/japan-saitama-target-setting-emissions-trading-system

[16] Ivey, By the numbers: Canadian GHG Emissions, https://www.ivey.uwo.ca/media/2112500/4462-ghg-emissions-report-v03f.pdf