Can we have growth while reducing emissions?

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Contenido

Why should economists care about climate policy?

CO2 emissions are closely related to economic growth. View

- Many countries have decoupled economic growth from CO emissions, but others have not. View
- There are additional influences such as the energy matrix, that help to minimize the negative effects on economic growth.

One of the most widely used climate policy tools is the carbon tax.

- 37 countries have implemented a carbon pricing policy, of which 28 are a carbon tax.
- The carbon tax creates incentives for countries to switch to less carbon- and energy-intensive forms of production.
- The carbon tax assigns a price to the tons of CO2 emitted, which can vary from 2 usd/ton to 137 usd/ton. View

Does the effect of the carbon tax depend on the energy matrix?

This article addresses the following questions:

- Does the share of primary energy source influence the effect of the carbon tax on economic growth and employment?
- Under what combination of energy sources does the carbon tax favor economic growth?

How?

- Following the model of Acemoglu et al., (2012)[1]
  - Two substitute sectors clean and dirty,
  - model of directed technological change with environmental constraint,
  - considering the initial share of production using clean and dirty inputs,
  - two situations: autarky and tax on dirty production.
- Empirical strategy: Study of Events, using different samples of countries according to the composition of the energy matrix.

[1] Acemoglu, Daron, Philippe Aghion, Leonardo Bursztyn, and David Hemous. 2012. "The Environment and Directed Technical Change." American Economic Review, 102 (1): 131-66.

Environment and directed technological change.

Model specifications

- A single final good, competitively produced using "clean" and "dirty" inputs, Y_{ct} and Y_{dt}
  - The elasticity of substitution between the two sectors $\varepsilon > 1 \rightarrow$ the two sectors are substitutes.
- Environmental quality $S_t \in [0, \bar{S}]$, is depleted by production of a dirty input and partly regenerates.

Autarky

- The expected profits of innovating in the clean versus dirty sector depend on:
  - direct productivity effect: the more advanced sector reaps bigger profits, which increases the incentive to innovate it,
  - market size effect: the more advanced sector has a bigger market size, which increases the incentive to innovate in it,
  - price effect: the less advanced sector is more expensive, which increases the incentive to innovate in it,
- Without intervention in equilibrium, innovation keeps ocurring in the dirty sector, which is initially more advanced.

Optimal Policy

- Environmental policies such as a carbon tax on dirty production (τ_t) or a subsidy in the clean sector (q_t) can redirect innovations to the clean sector.[2]

Proposition

The effect of introducing a carbon tax on the GDP growth rate g_t, is an increasing function of the initial share of clean sector in the production. The greater the initial participation of the clean sector in the final product, the greater the positive effect of carbon tax on growth rate. Proof

Implications

- *Corolario 1: if* $\frac{Y_{ct}}{Y} > \lambda \Longrightarrow$ ***positive effect,***
- *Corolario 2: if* $\frac{Y_{ct}}{Y} < \lambda \Longrightarrow$ ***negative effect,***
- *Corolario 3: if* $\frac{Y_{ct}}{Y} \gg \frac{Y_{ct}}{Y} \Longrightarrow$ ***$\downarrow$negative effect, $\uparrow$positive effect.***

[2] Research subsidies correct building on the shoulders of giants externality and the knowledge externality.

From theoretical to empirical

Theoretical Prediction: Effect of the carbon tax on the growth rate.

$$\frac{\partial g_t}{\partial \tau_t} = \frac{Y_{ct}}{Y}^{\frac{\epsilon-1}{\epsilon}} \cdot \frac{1}{1-\alpha} \cdot \left(\frac{A_{ct}(1+\tau_t)^{\frac{1}{1-\alpha}-1}}{A_{ct-1}} \right) - \frac{Y_{dt}}{Y}^{\frac{\epsilon-1}{\epsilon}} \cdot \frac{1}{1-\alpha} \cdot \left(\frac{A_{dt}(1-\tau_t)^{\frac{1}{1-\alpha}-1}}{A_{dt-1}} \right) \quad (1)$$

Empirical counterpart:

$$GDP_{c,t} = \sum_{r=-S}^{-1} \beta_r \cdot D_{c,t}^r + \sum_{r=1}^{M} \beta_r \cdot D_{c,t}^r + \gamma_c + \Phi_t + \varepsilon_{c,t} \quad (2)$$

- $GDP_{c,t} \equiv \frac{\partial g_t}{\partial \tau_t}$ is the annual GDP growth rate in country c, in year t.
- $D_{c,t}^r \equiv \tau_t$ 1 if year t is r periods from the year of implementation of carbon tax.
- β_r the acumulative effect on the GDP growth relative to the year of implementation.
- γ_c country fixed effects c
- Φ_t time fixed effects.

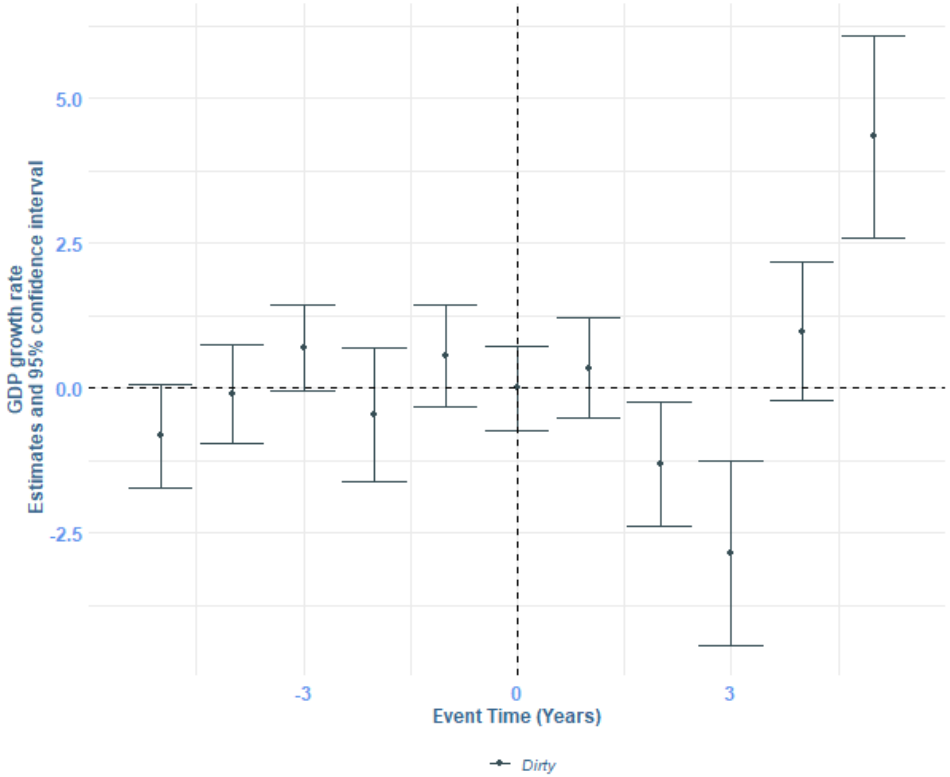
Two samples:

- Clean countries: $\frac{Low-carbonenergy}{Totalenergy} > mean \equiv \frac{Y_{ct}}{Y}$.
- Dirty countries: $\frac{High-carbonenergy}{Totalenergy} < mean \equiv \frac{Y_{dt}}{Y}$.

Effect of carbon tax on growth rate

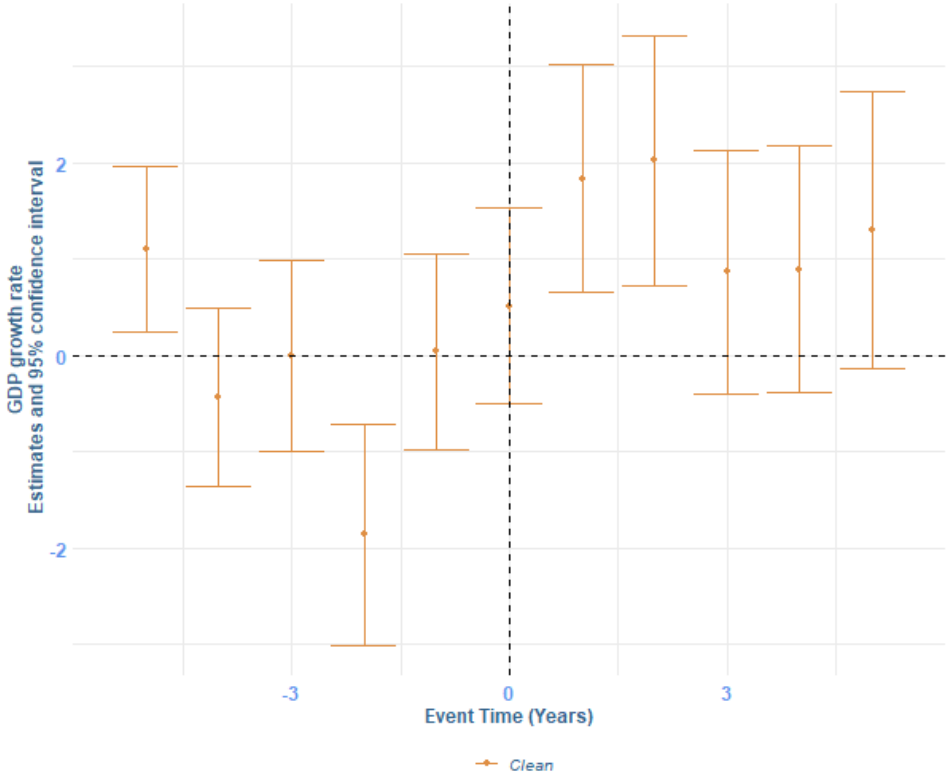
Countries with dirty energy sources.

Figura: GDP growth (% annual)



Countries with clean energy sources.

Figura: Crecimiento del PIB (% anual)

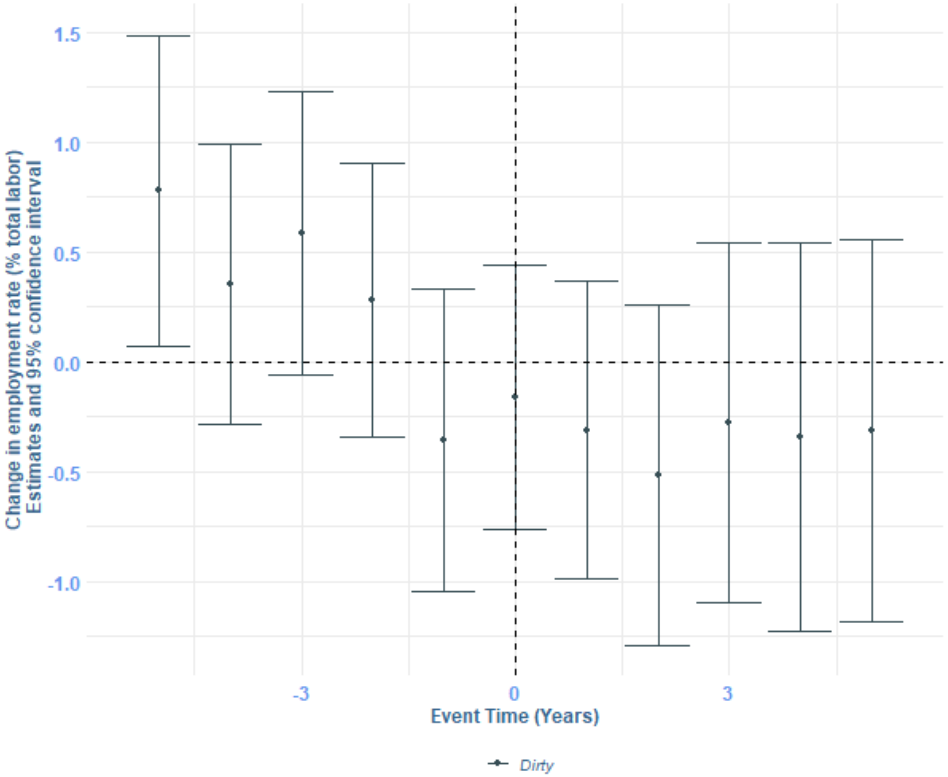


- ↓ GDP growth rate. (-1.3 percentage points at t=2 and -2.8 percentage points at t=3) in countries with dirty energy sources.
- ↑ GDP growth rate at 1.8 percentage points at t=1 in countries with clean energy sources.

Effect of carbon tax on employment rate

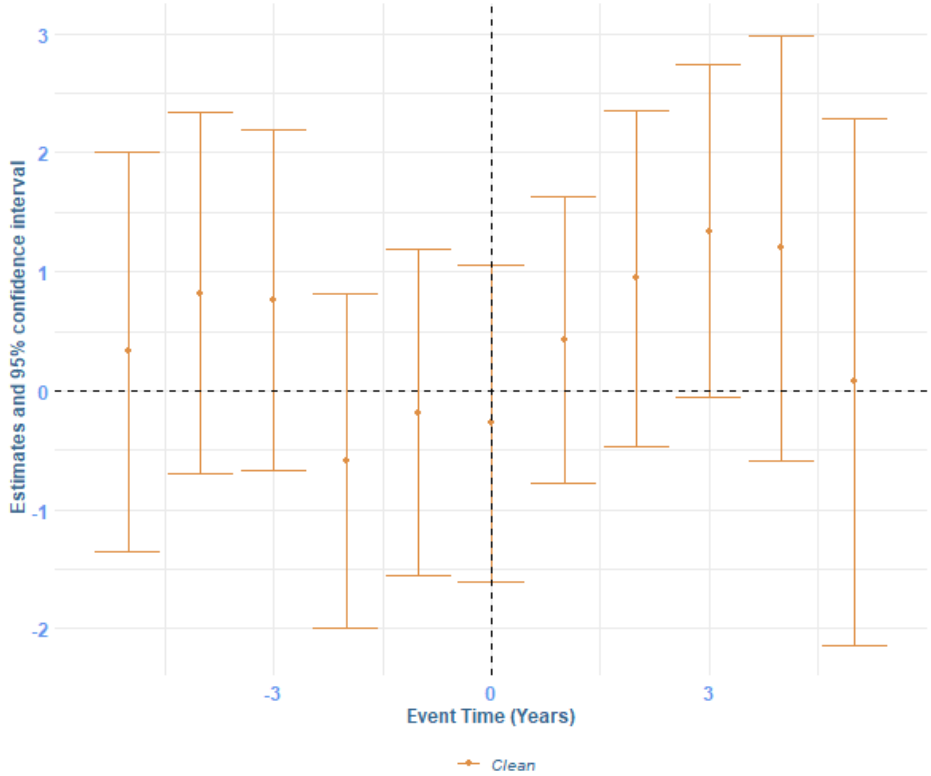
Countries with dirty energy sources.

Figura: Employment rate (% total labor)



Countries with clean energy sources.

Figura: Employment rate (% total labor)



- ↓ employment rate (-0.3 percentage points at t=1 and -0.5 percentage points at t=2) in countries with dirty energy sources.
- ↑ employment rate at 0.4 percentage points at t = 1 and 1 percentage points at t=2 in countries with clean energy sources.

Effect to different shares of clean energy.

Change in GDP growth

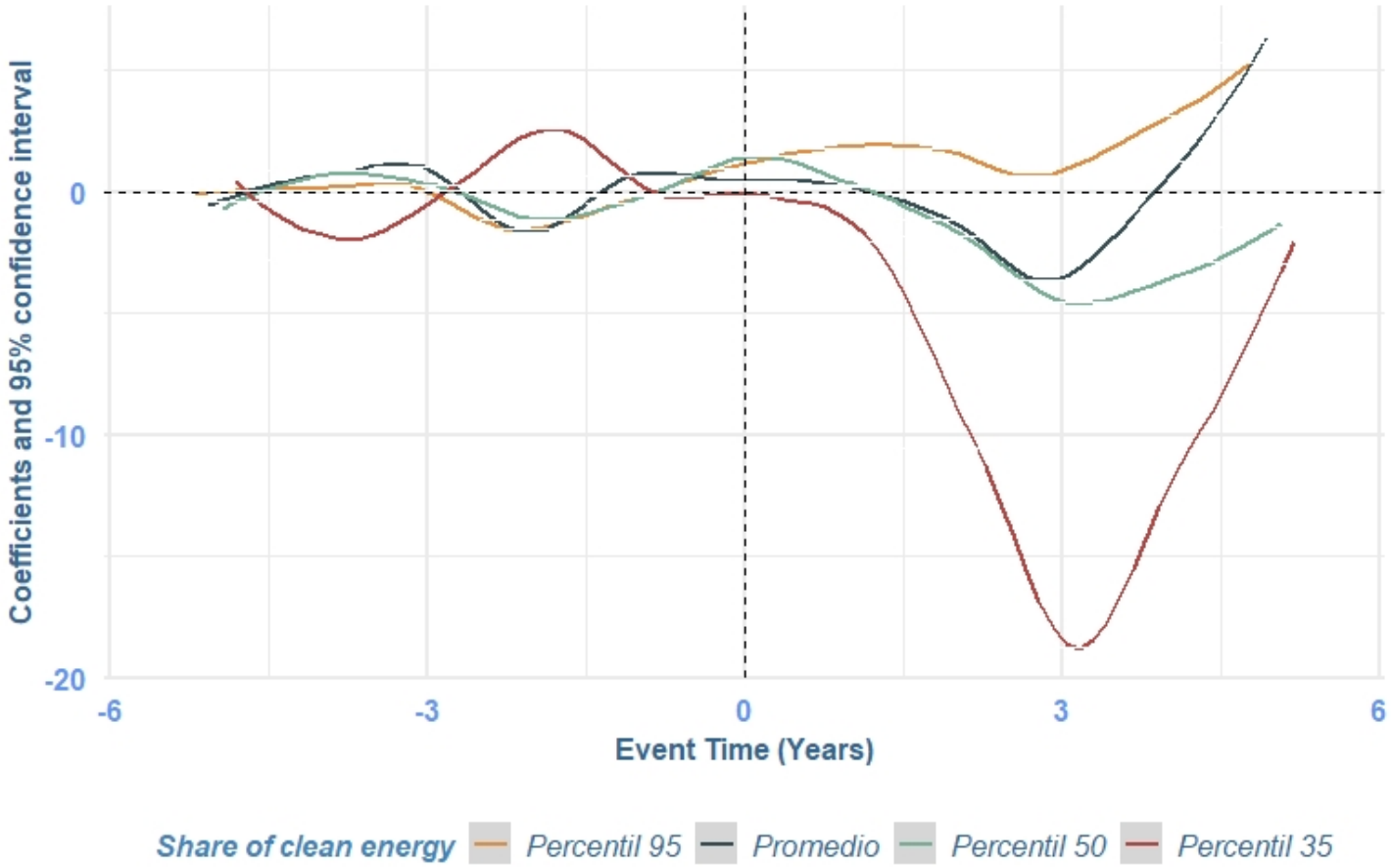


Figura: Effect of the carbon tax at different share of clean energy.

Conclusions

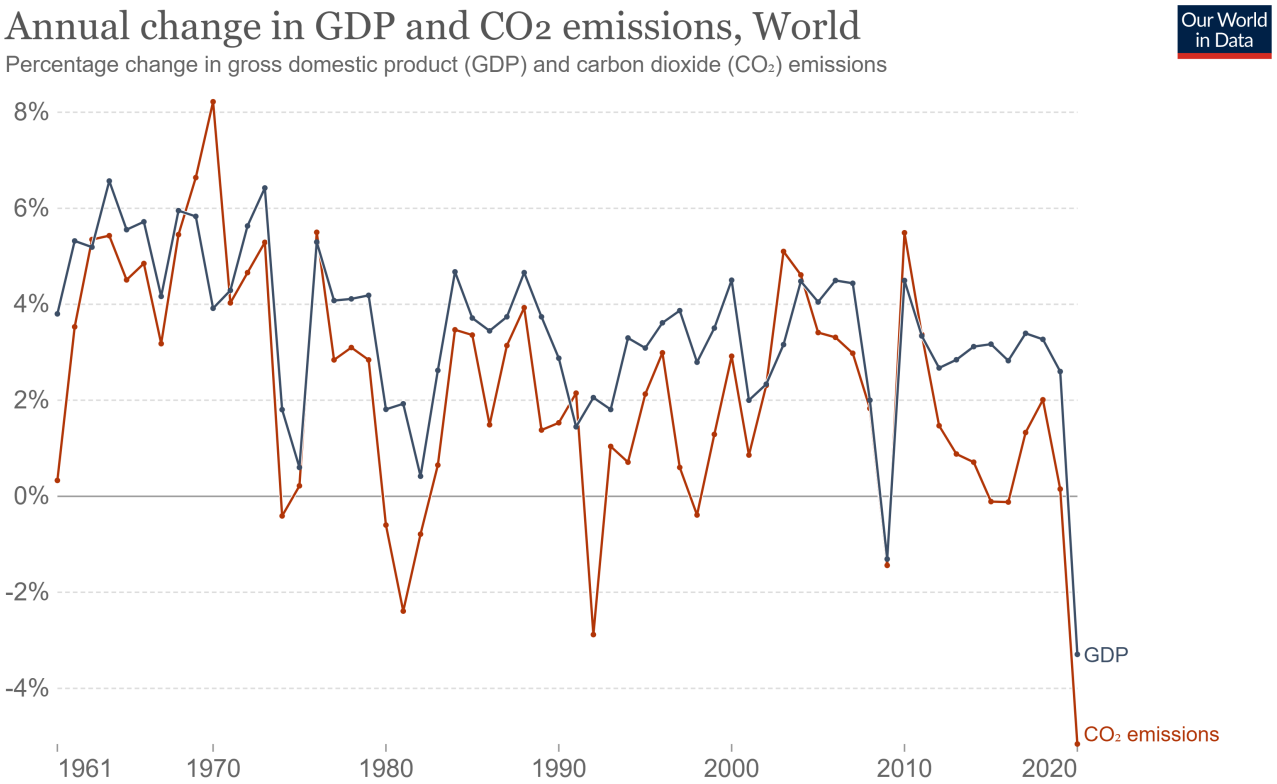
- In the absence of subsidies, carbon taxes have a negative effect of economic growth.
- The effect of carbon tax on economic growth is a increasing function of the share of clean goods in total output.
- The greater the share of clean energy in production, the greater the positive effect of a carbon tax on economic growth.

Primary energy sources can enhance or attenuate the adverse effects of introducing a carbon tax on economic growth.

- Energy matrix composed of low-carbon sources $\Longrightarrow$ positive effect on economic growth.
- Energy matrix composed of high-carbon sources $\Longrightarrow$ negative effect on economic growth.

CO2 emissions and GDP

Annual change in GDP and CO2 emissions, World.



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CO2 emissions and GDP

Many countries have decoupled economic growth from CO emissions

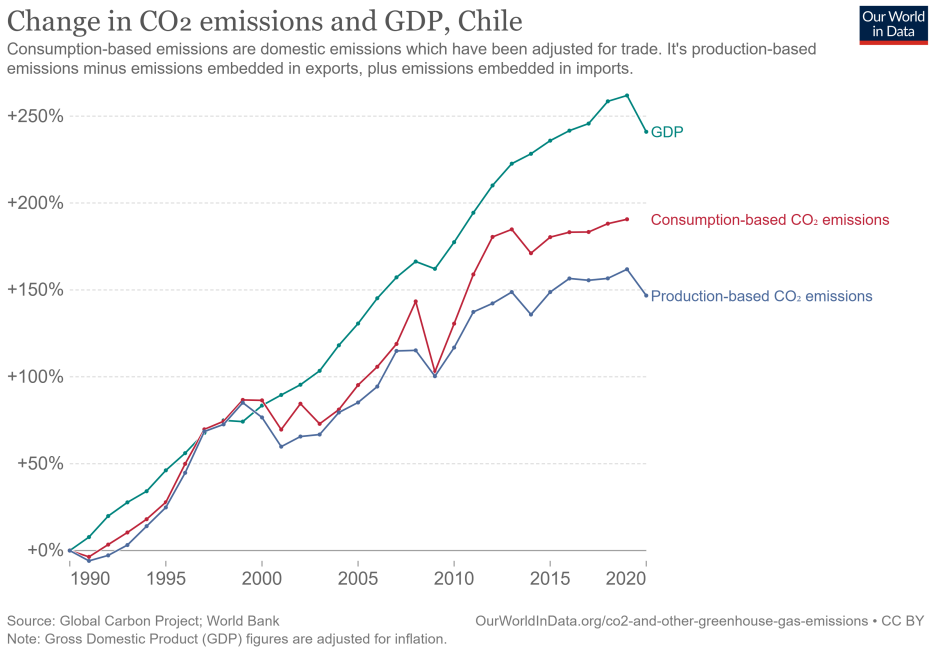

Figura: Change in CO2 emissions and GDP, Chile.

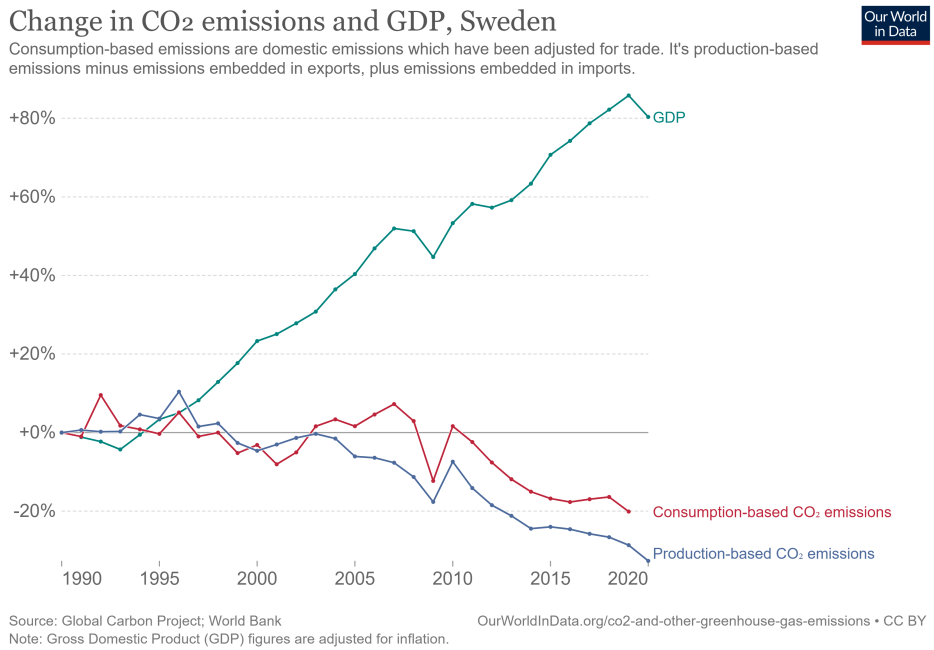

Figura: Change in CO2 emissions and GDP, Sweden.

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Summary map of national carbon tax.

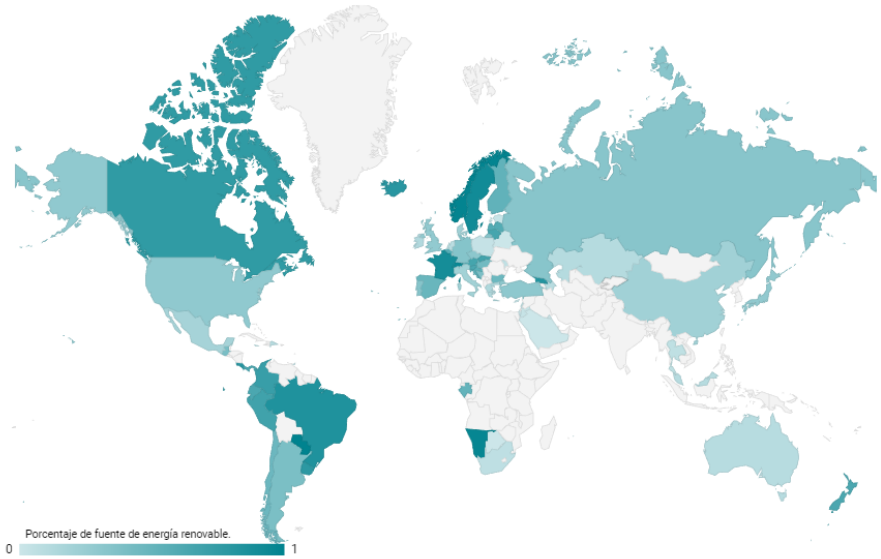

Figura: Map of countries according to primary energy share

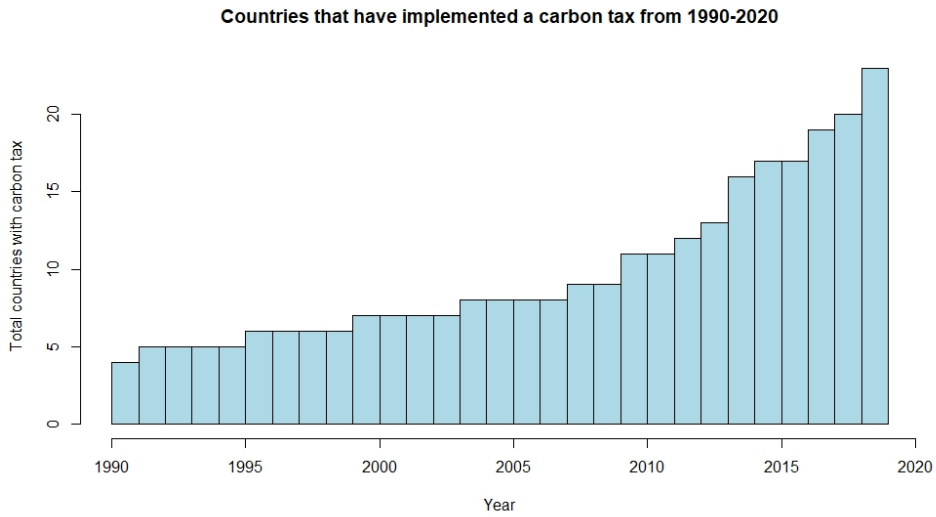

Figura: Number of countries that have implemented a carbon tax in recent years.

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Proof of Proposition

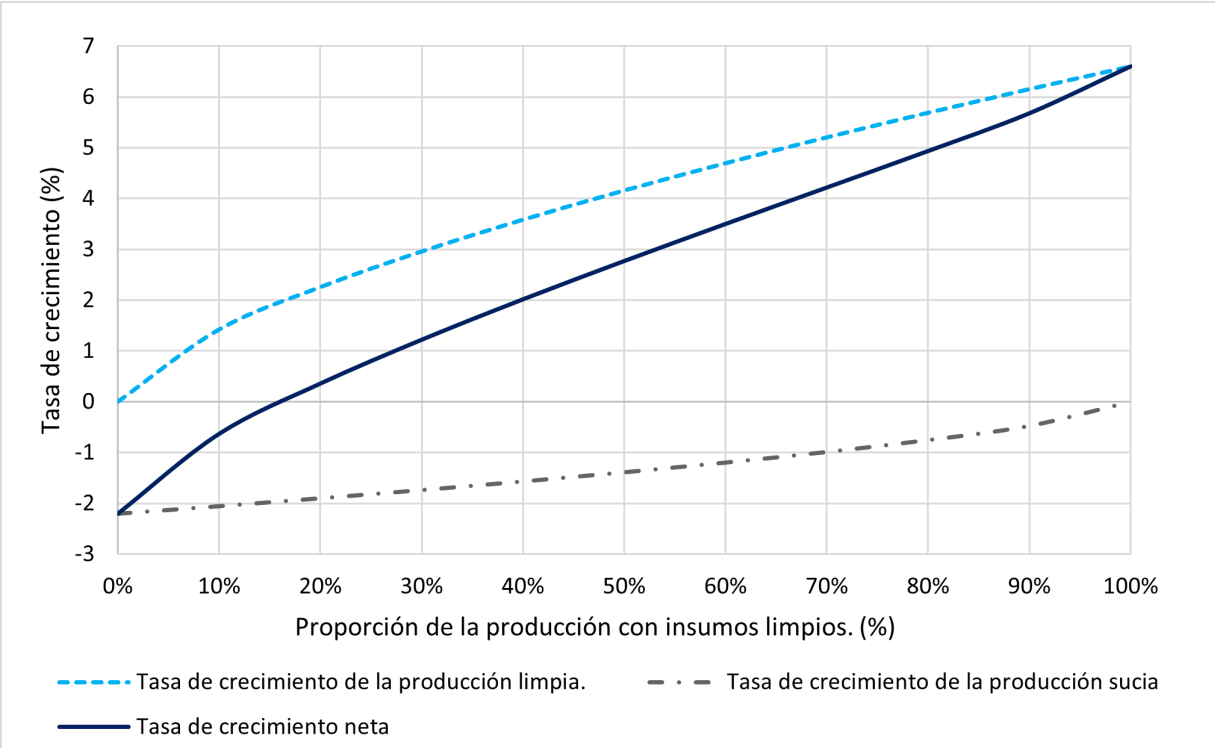

Figura: Representación del cambio en la tasa de crecimiento dada la existencia de un impuesto al carbono, (g_t/τ), según la proporción de la producción final producida con insumos limpios, λ_t.

Nota: Calibrado con los siguientes valores: $\alpha = 0{,}5$, $\epsilon = 3$, $\tau = 2$

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Anexo: Balance muestral

Variable	Media	Mediana	Desv. Estándar	Media	Mediana	Desv. Estándar
			Panel todos los datos			
	Con impuesto al carbono			Sin impuesto al carbono		
PIB real a precios nacionales constantes (millions 2017US$)	850686.90	393482.88	1082446.42	1121275.39	166135.61	3006622.00
PIB per cápita (current US$)	9.89 %	10.10 %	0.94 %	9.11 %	9.15 %	1.15 %
Crecimiento del PIB (anual %)	2.482	2.683	3.694	3.058	3.254	4.630
Tasa de empleo (% total labor)	92.07 %	92.85 %	4.75 %	92.43 %	93.02 %	4.45 %
Población (millones de hab.)	29.28	10.33	33.87	59.62	9.45	203.44
Consumo de energía primaria (TWh)	1094.63	474.96	1379.31	1855.63	254.93	5334.58
Fracción de electricidad limpia (% total consumido)	47 %	46 %	33 %	31 %	24 %	29 %
Fracción de energía limpia (% total consumido)	23 %	18 %	20 %	9 %	4 %	11 %
Países	23			51		
			Panel - Países con matriz energética relativamente 'limpia'			
	Con impuesto al carbono			Sin impuesto al carbono		
PIB real a precios nacionales constantes (millions 2017US$)	609238.88	322000.91	721705.56	654034.94	161623.54	1096710.94
PIB per cápita (current US$)	10.02 %	10.17 %	0.91 %	9.26 %	9.44 %	1.04 %
Crecimiento del PIB (anual %)	2.17	2.57	3.28	2.35	2.67	3.47
Tasa de empleo (% total labor)	92.14 %	92.70 %	4.51 %	90.99 %	91.68 %	4.23 %
Población (millones de hab.)	18.24	9.04	19.16	30.07	9.33	51.19
Consumo de energía primaria (TWh)	841.80	351.14	1103.98	748.81	232.82	1166.34
Fracción de electricidad limpia (% total consumido)	70 %	71 %	21 %	60 %	60 %	16 %
Fracción de energía limpia (% total consumido)	36 %	32 %	17 %	23 %	23 %	8 %
Países	13			12		
			Panel - Países con matriz energética relativamente 'sucia'			
	Con impuesto al carbono			Sin impuesto al carbono		
PIB real a precios nacionales constantes (millions 2017US$)	1164569.32	579572.91	1359162.31	1302519.86	168376.80	3459270.47
PIB per cápita (current US$)	9.72 %	9.86 %	0.95 %	9.06 %	9.07 %	1.19 %
Crecimiento del PIB (anual %)	2.89	2.83	4.14	3.33	3.57	4.98
Tasa de empleo (% total labor)	91.97 %	93.96 %	5.06 %	93.06 %	93.67 %	4.39 %
Población (millones de hab.)	43.62	38.34	42.42	71.08	9.45	236.58
Consumo de energía primaria (TWh)	1423.29	1010.65	1614.45	2289.49	277.86	6198.64
Fracción de electricidad limpia (% total consumido)	16 %	12 %	15 %	19 %	10 %	24 %
Fracción de energía limpia (% total consumido)	6 %	5 %	6 %	3 %	1 %	5 %
Países	10			49		

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