Carbon Taxation and Greenflation: Evidence from Europe and Canada

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What is the effect of the green transition on inflation?

Consensus that we need to price carbon in order to address climate change.

Uncertainty around the economic effects of such policies, especially for inflation.

- Will it lead to "Greenflation" as suggested by Larry Fink (Blackrock CEO)?
  $\rightarrow$ Understanding this is critical for central banks and financial markets (e.g. ECB 2022).

What is the relevant benchmark?

- Oil price shock? 10% $\uparrow$ price of oil $\rightarrow$ 0.6% $\uparrow$ CPI (Känzig, 2021).
  $\rightarrow$ Key conceptual differences due to anticipation, revenue component of carbon tax.

Carbon tax effects are small relative to observed energy price movements in 2022.

- Implied carbon tax rates, based on EU data between January and August 2022:
  Natural gas: 862€/t, Electricity: 1838€/t, Coal: 95€/t, Crude oil: 268€/t, Diesel: 597€/t.

$\rightarrow$ Relying on results from conventional energy price shocks might be insufficient.

The first empirical paper on inflation and carbon taxation

We ask: *Does carbon taxation lead to an increase in inflation?*

We draw on three decades of carbon pricing in Europe and Canada (18 total taxes).

We estimate dynamic impulse responses (panel-LP) of inflation to carbon taxation.

Result: Carbon taxes do not lead to aggregate inflation, but change relative prices.

$\rightarrow$ Consistent with research on limited effects on growth, employment (Metcalf & Stock, 2020).

$\rightarrow$ Carbon taxes lower emissions, lead to re-allocation and relative price changes but no aggregate effects.

Literature

Carbon taxation reduces emissions:

- Murray and Rivers (2015), Best et al. (2020), Rafaty et al. (2020).

Carbon taxes have limited aggregate economic effects:

- Europe: Metcalf (2019), Metcalf and Stock (2020), Känzig (2022).
- Canada: Elgie and McClay (2013), Yamazaki (2017), Bernard et al. (2018).

What is the effect on prices? Are carbon taxes inflationary?

- Model-based studies: Bovari et al. (2018), McKibbin et al. (2014, 17).
- Empirical: **?**

VAT taxes are inflationary:

D'Acunto et al. (2022), Benkovskis and Fadejeva (2014).

Today's talk

Data

Local projections approach

European results

Canadian results

Conclusion

Data

Data

Canada

- Sample: 10 Canadian provinces, 2000–2019.
- Annual CPI data (dis-aggregated: Core CPI, Energy & Food).
- Carbon tax rates and bases (real 2018 USD).
  Sources: Statistics Canada and World Bank Carbon Pricing Dashboard.

Europe

- Sample: EU, Switzerland, Norway, Sweden, UK, 1985–2019.
  All countries are members of the EU emissions trading system.
- Annual CPI data (dis-aggregated: Core CPI, Energy & Food).
- Carbon tax rates and bases (real 2018 USD).
  Sources: OECD and World Bank Carbon Pricing Dashboard.

Robustness:

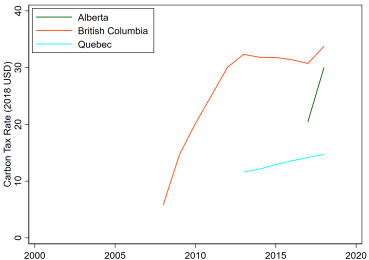
- Emissions weighted carbon price from Dolphin et al. (2019).
- Ha et al. (2021) inflation series.

Carbon tax descriptives

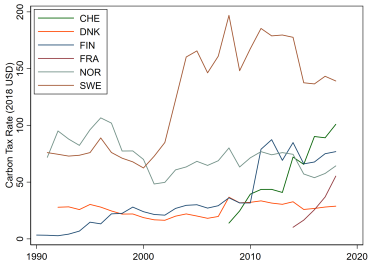
Jurisdiction	Implemented	Initial rate	2019 rate	Tax base
Finland	January 1990	3.35	76.87	0.36
Poland	January 1990	0.11	0.08	0.04
Norway	January 1991	71.87	64.29	0.62
Sweden	January 1991	75.99	139.11	0.40
Denmark	May 1992	11.94	21.45	0.24
Slovenia	January 1996	11.94	21.45	0.24
Estonia	January 2000	0.33	2.25	0.03
Latvia	January 2004	0.56	5.06	0.15
Switzerland	January 2008	13.90	100.90	0.33
Ireland	January 2010	23.26	25.00	0.49
Iceland	January 2010	9.80	35.71	0.29
United Kingdom	April 2013	8.09	25.46	0.23
Spain	January 2014	29.25	24.80	0.03
France	April 2014	10.24	55.30	0.35
Portugal	January 2015	5.80	8.49	0.29
British Columbia	July 2008	5.83	33.75	0.70
Quebec	January 2013	11.59	14.73	0.85
Alberta	January 2017	20.48	30.00	0.48

Carbon tax rates over time

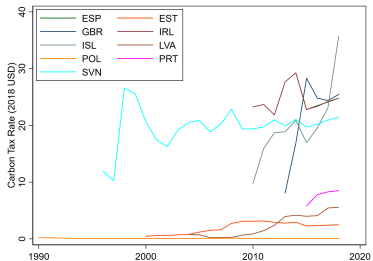
a) Canada



b) Europe



c) Europe



Empirical Strategy

Empirical strategy: Local projections

Local projections adapted to panel data:

$$\Delta CPI_{i,t+h} = \alpha_i + \Theta_h \tau_{i,t} + \beta(L)\tau_{i,t-1} + \delta(L)\Delta CPI_{i,t-1} + \mu(L)\Delta X_{i,t} + \gamma_t + \epsilon_{i,t}$$

$\Delta CPI_{i,t+h}$ is inflation over h years in economy i.
$\tau_{i,t}$: Real carbon tax rate (USD) in economy i in year t.
$\Delta X_{i,t}$ is a varying vector of economy i controls in year t.
α_i and γ_t are economy and year fixed effects.
Θ_h is the effect of an unexpected change in the carbon tax rate h years ahead.

Empirical strategy: Local projections

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Identification: Carbon tax has two components, with latter exogenous.

- One predicted by historical growth and inflation.
- One unpredicted, e.g. due to changing political preferences.

$$\begin{aligned}&\mathbb{E}(\epsilon_{i,t}|\tau_{i,t}, \tau_{i,t-1}, .., \Delta CPI_{i,t-1}, .., \Delta X_{i,t-1}, .., \gamma_t, \alpha_i) \\ &= \mathbb{E}(\epsilon_{i,t}|\tau_{i,t-1}, .., \Delta CPI_{i,t-1}, .., \Delta X_{i,t-1}, .., \gamma_t, \alpha_i)\end{aligned}$$

Empirical strategy: Local projections

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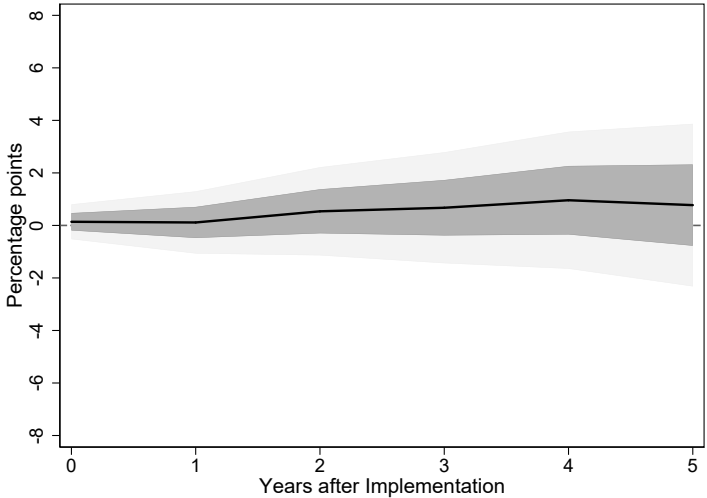
Counterfactual scenario: \$40/tCO2e carbon tax on 30% of carbon emissions.

- Interact tax rate with emission coverage.
- Panel-OLS, heteroscedasticity robust standard errors, 4 lags.

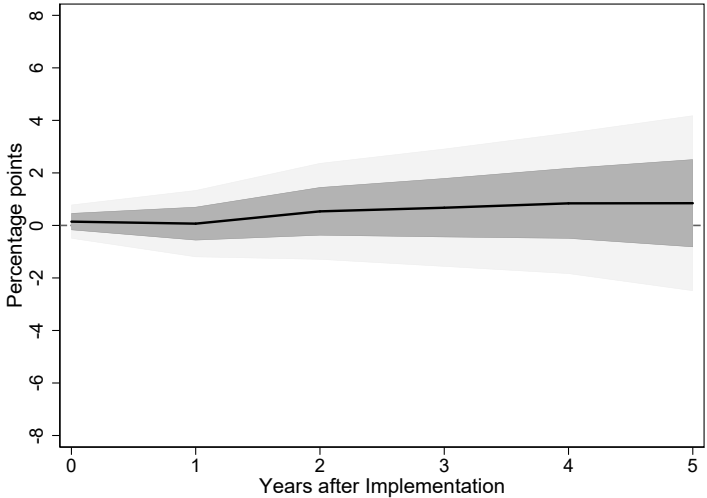
European results

Headline inflation



Notes: Response to a carbon tax of 40$/t, covering 30% of emissions.
Controls include country, year fixed effects and GDP growth, policy rate.

Core inflation



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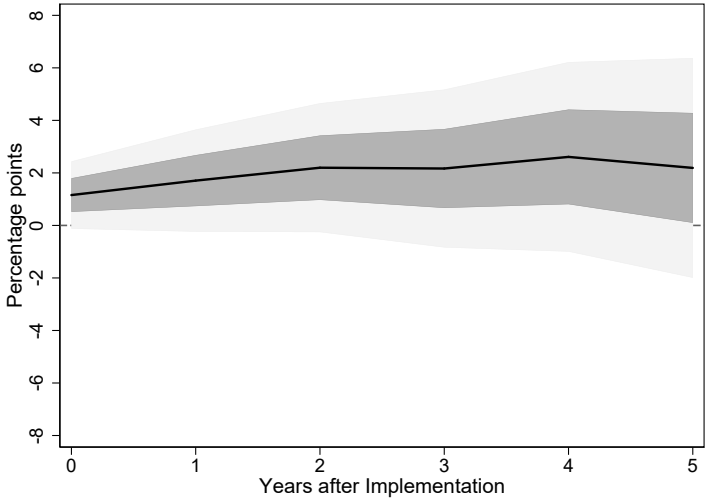
Energy and food inflation



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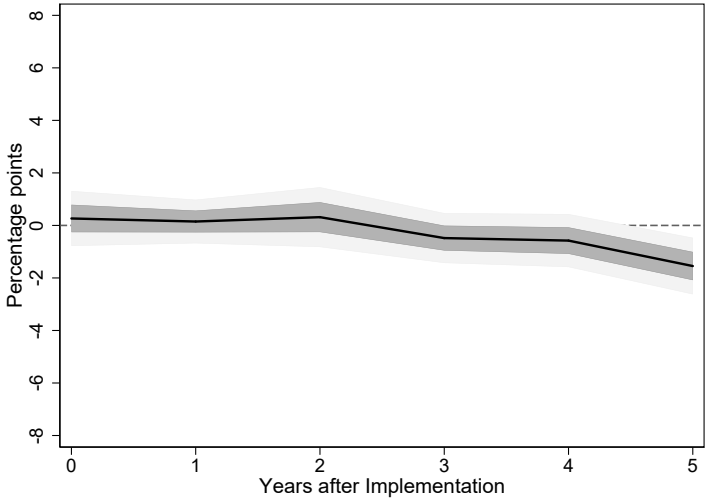
Canadian results

Headline inflation



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Controls include province, year fixed effects and GDP growth.

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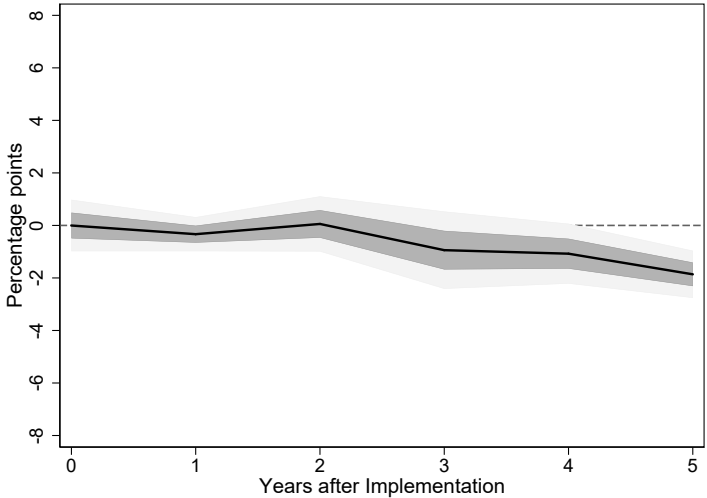

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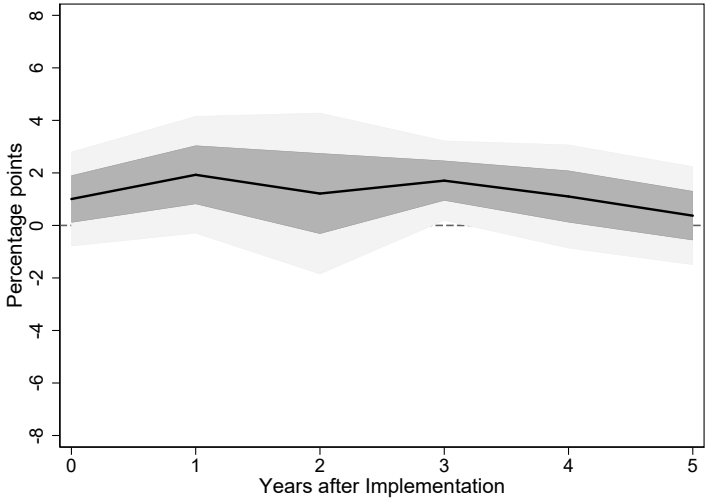

Notes: Response to a carbon tax of 40$/t, covering 30% of emissions.
Controls include province, year fixed effects and GDP growth.

Conclusion

We analyze the response of inflation to carbon taxation, based on 18 carbon taxes implemented in Europe and Canada over the past three decades.

Findings:

1. Carbon taxes do not have inflationary effects.
2. Carbon taxes change relative prices.

   $\rightarrow$ Holds both in Europe and Canada, survives various robustness checks.

   $\rightarrow$ Consistent with prior results on the limited economic effects of (national) carbon taxes (Metcalf and Stock, 2020).

Appendix

Local Projections: IRF Europe

Dep. var.	Sample	Impact in year		
		0	1–2	3–5
Headline inflation	EU+	0.42	0.14	0.25
		(0.33)	(0.31)	(0.30)
	Big	0.41	0.09	−0.01
		(0.34)	(0.30)	(0.30)
Core inflation	EU+	0.21	−0.09	0.09
		(0.40)	(0.33)	(0.29)
	Big	0.30	−0.03	0.04
		(0.38)	(0.28)	(0.22)

Dynamic responses are small and imprecisely estimated.

DLs | Robustness tax data | Robustness inflation data

The cross-section of European carbon taxes

1. Timing of implementation:
   - 1990–2000.
   - 2001–2010.
   - 2011–2015.

2. Revenue-recycling:
   - Recycling countries: Scandinavia, Portugal, Switzerland.
   - Rest.

3. Autonomous monetary policy:
   - Euro area + Denmark.
   - Rest.

LP Europe: Three waves I - headline inflation

Dep. var.	Sample	Impact in year		
		0	1–2	3–5
Headline inflation	First wave	0.32	−0.03	0.25
		(0.38)	(0.36)	(0.34)
	Second wave	1.65	1.37	1.05
		(1.09)	(1.13)	(0.69)
	Third wave	2.15	0.33	1.32
		(1.15)	(0.49)	(1.11)

Dynamic responses are more inflationary for second wave of taxes (during 2000s).

LP Europe: Three waves II - core inflation

Dep. var.	Sample	Impact in year		
		0	1–2	3–5
Core inflation	First wave	0.10	−0.27	0.10
		(0.43)	(0.38)	(0.32)
	Second wave	2.15	1.68	0.31
		(1.41)	(1.17)	(0.95)
	Third wave	−0.08	0.03	−0.43
		(0.95)	(0.52)	(1.22)

Dynamic responses are more inflationary for second wave of taxes (during 2000s).

LP Europe: Revenue recycling

Dep. var.	Sample	Impact in year		
		0	1–2	3–5
Headline inflation	RR1	0.27	−0.09	0.14
		(0.38)	(0.32)	(0.26)
	RR0	0.32	0.84	1.19
		(1.34)	(1.03)	(0.59)
Core inflation	RR1	0.01	−0.32	0.10
		(0.40)	(0.34)	(0.29)
	RR0	1.59	0.61	0.51
		(1.74)	(1.05)	(1.23)

Countries without revenue-recycling experience a more inflationary response to carbon pricing (consistent with Metcalf & Stock, 2020).

LP Europe: Monetary policy autonomy

Dep. var.	Sample	Impact in year		
		0	1–2	3–5
Headline inflation	MP1	0.16	−0.29	−0.09
		(0.41)	(0.36)	(0.29)
	MP0	1.03	1.72	1.77
		(0.39)	(0.54)	(0.53)
Core inflation	MP1	−0.10	−0.51	−0.11
		(0.42)	(0.36)	(0.30)
	MP0	1.00	1.08	0.92
		(0.73)	(0.65)	(0.50)

Countries without own MP experience a more inflationary response to carbon pricing.

Local Projections: IRF Canada

Dep. var.	Sample	Impact in year		
		0	1–2	3–5
Headline inflation	All	−0.06	0.24	−0.68
		(0.53)	(0.22)	(0.26)
	BC only	1.96	−0.75	−0.77
		(1.20)	(0.73)	(0.38)
Core inflation	All	−0.37	0.01	−0.55
		(0.55)	(0.19)	(0.17)
	BC only	1.80	−0.97	−0.34
		(1.05)	(0.42)	(0.28)

Dynamic responses are small and imprecisely estimated.

Diff-in-Diff DLs Robustness tax data

Robustness: Panel-VARs

Same identification strategy as with the LPs.

Dep. var.	Sample	Impact in year		
		0	1–2	3–5
Headline inflation	EU+	0.11	−0.09	−0.70
		(0.83)	(0.70)	(0.77)
	Canada	−0.28	−0.10	−0.56
		(0.86)	(0.97)	(1.21)
Core inflation	EU+	0.22	−0.22	−0.38
		(0.57)	(0.50)	(0.53)
	Canada	−0.75	0.00	−0.73
		(0.68)	(0.78)	(0.96)

Estimates are very similar in size to the LP-based responses.

Robustness: DL models

Identification: No feedback from CPI to carbon tax.

$$\Delta CPI_{i,t} = \beta(L)\tau_{i,t} + \delta_i + \gamma_t + \epsilon_{i,t}$$

Dep. var.	Sample	Impact in year		
		0	1–2	3–5
Headline inflation	EU+	0.70	0.26	0.19
		(0.76)	(0.43)	(0.39)
	Canada	0.34	0.07	−0.54
		(0.58)	(0.24)	(0.12)
Core inflation	EU+	0.27	0.03	0.14
		(0.78)	(0.40)	(0.40)
	Canada	−0.64	0.11	−0.63
		(0.53)	(0.20)	(0.11)

Estimates are very similar in size to the LP-based responses.

Robustness: Dolphin et al. (2021) emission-weighted tax rates

Dep. var.	Sample	Impact in year		
		0	1–2	3–5
Headline inflation	EU+	−0.54	1.68	1.91
		(3.27)	(2.02)	(1.78)
	Canada	−1.62	−1.39	2.31
		(0.60)	(0.57)	(0.50)
Core inflation	EU+	−0.09	−0.17	−0.05
		(0.90)	(0.91)	(0.40)
	Canada	−1.88	−1.60	1.30
		(1.00)	(0.55)	(0.41)

Compared to the World Bank-based carbon tax estimates, the emission-weighted carbon tax rates lead quantitatively larger estimates (both negative/positive).
No increase in core inflation for Europe (net zero for Canada).

Robustness: Ha et al. (2021) inflation data

Dep. var.	Sample	Impact in year		
		0	1–2	3–5
Headline inflation	EU+	1.00 (0.57)	0.54 (0.38)	1.06 (0.33)
Core inflation	EU+	0.07 (0.31)	0.15 (0.28)	0.19 (0.26)

With alternative inflation data, some evidence of an inflationary (headline) response, zero effect for core inflation.